JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY 1884.

TRANSACTIONS OF THE SOCIETY.

I.—*The Constituents of Sewage in the Mud of the Thames.*

By Lionel S. Beale, F.R.S., Treas. R.M.S.

(*Read* 10*th January*, 1884.)

Plates I.–IV.

The particles constituting the cloud-like masses of dark-brown and in some places black mud, held in suspension in the tidal water of the Thames and carried backwards and forwards by the tide, and which subside and form the soft mud which accumulates on the surface of the submerged banks, have always afforded objects of

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EXPLANATION OF PLATES I.–IV.

Plate I.

Fig. 1.—*Objects in Mud from Crossness Southern Outfall.*—*a*, muscular fibres which have passed through the intestine and have been partly dissolved by the digestive fluids, but which have undergone further disintegrative changes in consequence of the prolonged action of the Thames water upon them. In many of the muscular fibres the tranverse markings are still visible. At *a*** is seen a fibre in which the transverse striæ are very distinct, although the tissue is itself undergoing disintegration. *c**, a portion of a very small spiral fibre from vegetable tissue. *d*, crystals of fatty acids formed by the decomposition and oxidation of fatty matter. *d**, a collection of particles of carbon, probably soot. *f*, portions of yellow elastic tissue, probably from the areolar tissue of meat. *h*, portions of yellow fæcal matter in various stages of disintegrative change. In some of these masses are seen minute particles of sand and other matters which have adhered to the surface, or have become mixed with the soft viscid matter. *k*, a small piece of mica. *l*, a portion of myelin from nerve-tissue which has been long macerated in the Thames water. *m*, collection of bacteria. *n*, bacteria in the shell of a diatom.

Fig. 2.—*Also from Crossness Southern Outfall.*—*c*, large spiral vessels from vegetable tissue (common cabbage). *c***, two small spiral vessels still connected together as in their natural position in the tissues of the plant.

Fig. 3.—*From a mud-bank off Erith.*—*d*, crystals of fatty acids, the upper *d* a collection of crystals of fatty acids. *d***, a mass composed principally of oil-globules, with perhaps a little fæcal matter. *h h*, masses consisting of yellow fæcal matter with a few oil-globules. *i*, a glistening mass of very hard fatty matter. *k*, a minute fragment of mica.

interest to microscopical observers. To give an account of the diatoms only among the many constituents of this mud it would be necessary to recount the numerous memoirs published upon this important and highly interesting class of organisms from the time of Ehrenberg. I would venture to direct attention to the observa-

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PLATE II.

Fig. 4.—*Bodies found in mud from Barking Outfall.*—*a*, fragments of muscular fibre, partly dissolved by the action of the digestive fluids. The specimen on the left still retains its transverse striæ very distinctly. *c*, portion of spiral fibre of vegetable tissue, free from membrane. *f*, fine fibres of yellow elastic tissue, probably from areolar tissue of meat taken as food. *h*, portion of yellow fæcal matter undergoing disintegrative change.

In the following figures in plate II. objects found in mud from *a sewer close to Woolwich Pier* are represented.—Fig. 5, fragments of deal wood. Fig. 6, *a*, muscular fibres exhibiting transverse striæ very distinctly, with the exception of one, *a*, in the lower part of the figure to the right, which is a representation of a very small fragment partly dissolved. *d*, crystals, probably of fatty acids, set free by the decomposition of fatty matter. *e*, sporules of fungi. *f*, fibres of yellow elastic tissue. *g*, a collection of granules, probably altered fæcal matter. Fig. 7, *a*, fragments of muscular fibres in various states of disintegration. Fig. 8, *c*, spiral fibres from vegetable tissue; the lower figure represents a portion of a fibre set quite free from its enveloping membrane.

PLATE III.

From an outfall of a sewer near to Trinity Ballast Office.—Fig. 9, *a*, muscular fibres acted upon by the juices of the alimentary canal in much the same condition as when they left the body with the fæcal matter to pass into the sewer. Fig. 10, *d*, free crystals of fatty acids resulting from the decomposition of fatty matter. Fig. 11, *c*, spiral fibres from vegetable tissue. Fig. 12, *a*, muscular fibres partly acted upon and disintegrated. *h*, epidermis from a leaf.

From a mud-bank off East Greenwich.—Fig. 13, *a**, muscular fibre partly dissolved but still showing a few transverse markings. *d*, crystals of fatty matter with some fæcal matter. Fig. 14, *d*, fragments of white fibrous tissue, much decomposed and rendered granular by the action of the water and disintegrating agencies. *f*, portion of thick yellow elastic tissue from the coat of a large artery. Fig. 15, *h*, portions of stercoraceous matter with granules and oil-globules imbedded in them.

PLATE IV.

From a mudbank off East Greenwich.—Fig. 10, *o*, fragments of coal. *r*, epithelial cells, probably from the mouth. Fig. 11, very fine fibres of yellow elastic tissue.

From a mudbank at Chelsea.—Fig. 12, *a*, muscular fibre much disintegrated. *h*, masses of yellow fæcal matter undergoing disintegration by the action of the water.

From an outfall of a sewer near to Trinity Ballast Office.—Fig. 13, *c*, fragments of spiral vessels from vegetable tissue. *d*, crystals of fatty acids set free by the decomposition of fatty matter. A collection of the same is represented in Fig. 14 at *d*. *e*, sporules of fungi. *f*, fibres of yellow elastic tissue, many exhibiting transverse markings produced by boiling old fibres.

From a mudbank at Chelsea.—Fig. 14, *c*, vegetable cells with spiral fibres. Fig. 15, *s*, a portion of cellular tissue from some vegetable, probably turnip. Fig. 16, *p*, fragment of white fibrous tissue much disintegrated and with numerous granules therein. *a**, a portion of muscular fibre nearly transparent from maceration, but a few transverse markings still remain distinct. *f*, a small fragment of yellow elastic tissue showing vestiges of transverse markings. *o*, fragment of coal. Fig. 17, *a*, portion of muscular fibre changed by maceration. *o*, fragment of coal. Fig. 18, *o*, fragments of coal. Fig. 19, portion of a very large mass of fæcal matter containing many silicious and other fragments imbedded in it, and which adhere to the viscid matter of which it is in great part composed.

tions of this authority upon the diatoms of the Elbe, to those of Mr. T. F. Bergin on the deposits of the mud of the Liffey,* to those of Professor Bailey on the diatoms found in the Mississippi, to the paper of Mr. F. C. S. Roper on the Diatomaceæ of the Thames,† and lastly to the memoir of Dr. Bossey on 'Thames Mud in relation to Sanitary Science.'‡ Mr. Roper in 1854 and Dr. Bossey more recently have carefully studied the species of diatoms in different parts of the river, and have shown that the valves belonging to fresh-water species growing in the upper parts of the river may be carried down by the tide towards the mouth of the Thames, while the valves of those living in salt or in brackish water are to be traced as far up as the tide extends. These beautiful silicious skeletons so easily recognized and identified, being very light, are carried backwards and forwards by the tide, and are deposited on the mud-banks. They may be regarded as evidence of the course taken by other light particles suspended in the water of the river, and afford one of many indications of the movements of the sewage. Thus we are able to show that at any rate the least dense of the constituents of sewage may be carried from the outfall at Barking up to the first lock in one direction and below Gravesend in the other.

It is impossible to exaggerate the importance of investigations concerning the course of the sewage in the river considered in connection with the changes effected in it by various agencies during its suspension and after its subsidence as mud. That our river is fouled by the presence of sewage is patent to every one, while most of us feel that its state is a disgrace to our city. The serious question which presents itself to Londoners, and indeed concerns England, is whether this constant pollution of the river by the pouring into it daily of more than 100 millions of gallons, nearly 450,000 tons, of sewage can be continued without increasing risk to the health of the people, to say nothing of the disagreeable effects on the senses of sight and smell, and the very unpleasant considerations suggested by the contamination.

Some years ago there was unmistakable evidence of the occurrence of a very nasty kind of decomposition proceeding in the Thames water. The air of all the streets bordering the river was polluted with offensive odours. During the last few years, however, we have not been so seriously annoyed. But it must be borne in mind that we have had a remarkable series of cool and wet summers, favourable to excessive dilution of the sewage and unfavourable to organic decomposition. What the state of things

* 'Cooper and Busk's Microscopic Journal,' ii. (1842) p. 68.

† Trans. Micr. Soc. Lond., ii. (1854) p. 67.

‡ 'Proceedings of the Holmesdale Natural History Club,' December 12th, 1879.

would be if we had a very dry hot summer succeeding to a spring with less than the usual rainfall it is not pleasant to contemplate, for I am afraid it is probable that the considerable reduction of the volume of water in proportion to the sewage would result in a concentration of the dissolved and suspended organic matters, which, gradually rising in temperature from day to day to 70° or higher, would perhaps almost suddenly undergo a form of putrefactive change resulting in the setting free of large volumes of highly fetid gases, which would poison the air far and wide. Such a nuisance might persist for weeks, and only disappear when by the autumn rains the tidal water had become greatly diluted and its volume increased by fresh water pouring in from above. How far such a state of the river would be injurious to health it is not possible to say. I do not think anything of the kind upon so large a scale has ever happened, and any suggestion as to possible danger to health, not being backed by actual facts, would only excite counter observations and assertions as to the excellent health enjoyed by those who spend much of their time in the sewers, and a review of facts, carefully selected by no impartial hand, with the object of convincing people that stinks were not unwholesome, and that possibly to the trained they might be actually enjoyable; that the presence of decomposing animal and vegetable matter suspended in water was rather an advantage than otherwise; that countless multitudes of harmless organisms while ministering to their own enjoyment and advantage, exerted a beneficent influence by appropriating the products of disintegration just prior to decomposition; and that upon the whole we ought to consider ourselves fortunate in possessing in our midst a large river reeking with filth, because in this way the noxious substances are slowly resolved into simpler gaseous and soluble matters instead of the whole contributing to increase the already sufficiently ample mud-banks, which—and at a constantly accelerating rate—would add to the difficulties of navigation, and at length interfere with the passage of all but the smallest craft.

Method of Examination.

The large amount of gritty silicious particles, as well as their considerable size, renders the examination of small portions of mud just as it is obtained from the mud-bank very difficult. The layer placed on the glass slide and covered with thin glass will be too thick for examination by any but the lowest powers, and in consequence, some of the most minute but most important of the constituents of the mud will not be discerned. If a little of any specimen of mud be mixed with water, covered with thin glass, and then examined in the usual way, nothing but large sand-grains,

with here and there black particles of coal or carbon, will be seen. By mixing a small portion of mud with a considerable quantity of water, stirring it up, and then pouring off the upper part of the fluid after allowing a few seconds for the subsidence of the heaviest and coarsest particles, a deposit may be obtained in a state fit for examination under tolerably high magnifying powers, and if the process be repeated again and again, the mud may be separated into several portions differing from one another in density and in the coarseness of the gritty particles. But this plan is found not altogether satisfactory, for many of the organic substances in the mud are only imperfectly seen, while it will be impossible for the observer to form any idea of the relative proportions of the various constituents of the mud thus divided into separate portions differing from one another as regards the size and lightness of the component particles.

After having tried many different methods of investigation, I found that admixture with an equal quantity of glycerine afforded the best results. In this process the specimen can be kept for a length of time without undergoing change and be submitted to examination at intervals. The refracting property of the glycerine enables the observer to make out details of structure which could not be seen in specimens immersed in water, while in each specimen almost all the constituents of the mud are rendered clearer and more distinct.

Another important advantage is gained by this method of examination, inasmuch as the observer is able to form a notion of the relative amount of the several substances in each specimen examined, and also the relative amount of each in any given specimen. By this plan every constituent of the mud may be seen in one preparation, and specimens prepared in this manner have the additional advantage of preserving their characters for many years without change.

If a portion of the mud is simply mixed with water and then stirred up, the heavier particles allowed to settle while the lighter ones are poured off into another vessel and then allowed to subside, a very wrong idea may be formed of the number of the lighter substances present, because nearly the whole of these in the quantity of mud operated upon may be separated, and the microscopical specimen would in that case appear as if it consisted almost entirely of this one class of constituent particles.

This paper is based upon the results obtained by the microscopical examination of twenty-five specimens of mud from various banks between Gravesend and Chelsea taken under the direction of Dr. Collingridge, the Port of London Sanitary Officer, in the course of an inquiry undertaken at the request of the City of London for the purpose of obtaining evidence to bring before the Royal

Commission appointed to consider the question of Thames Pollution. I have received permission to communicate the results to the Society, and to publish them.

The observations made by me relate chiefly to the organized constituents of the sewage which can be demonstrated in the mud of the Thames by microscopical examination. Many of the particles found in the mud have been identified as substances which had entered into the formation of human excrements. I have endeavoured to ascertain what changes some of the most important of the fæcal constituents undergo in their passage from the houses along the drains into the river until their disintegration is at last completed or they have been deposited and form part of the mud banks of the Thames.

The broad and important fact which is, in my judgment, fully established by the investigation is this—that several constituents of human fæces are present in all the specimens of mud submitted to examination. The amount of these differs considerably, though no adequate means have been discovered of making an accurate estimate of the quantity of any one of them, or of instituting more than a very rough comparison between the muds obtained from different banks.

It must be borne in mind that the river mud is continually undergoing change in its character, the surface of the bank being often washed away, and old matters being mixed up with the elements of recent sewage; these being deposited together in other and perhaps distant banks, as determined by the varying quantity of water, the rate of its flow, and a number of other circumstances. Thus the mud of any given bank will vary considerably in its characters at different periods of the year, and it is quite supposable that a bank, which at one time would be found to consist of nearly pure sand, at another might seem to be almost entirely composed, at least on its surface, of the blackest and foulest organic matter undergoing rapid putrefactive changes.

It is well known that the quantity of organic matter in the mud is small. If a certain portion of the mud be dried and then exposed to a red heat for a time, the loss in bulk owing to the total destruction of the organic matter and the dissipation of all volatile substances is very slight. On the other hand it is to be remarked that neither the disagreeableness nor the danger to health of organic matter in a state of decomposition is dependent upon or varies according to the amount present. From a quantity of certain forms of organic matter so small that it would fail to turn the most delicate balance, as for example a fraction from the specimen of sewage taken from an outfall near Trinity Ballast Office, an odour of a most detestable character might emanate and be diffused over a considerable area. But it must be borne in mind that as regards

animal and organic poisons dangerous to life, it is an admitted fact that a quantity easily carried by a very small fly might be sufficient to infect a considerable number of persons; and therefore the fact of the small proportion of organic matter in the Thames mud and in suspension in Thames water cannot reasonably be adduced as an argument in favour of its innocuousness or of its unimportance. But the relative proportion of the organic matter as well as its deleteriousness no doubt varies greatly at different times. I believe all the specimens of mud examined by me have been taken when the river was in flood, or soon afterwards, and at a time of the year when putrefactive decomposition is slowest. From the state of things under these favourable conditions it is hardly possible to determine how very unsatisfactory might be the state of the mud and of the river in hot dry weather. Year by year the actual quantity of sewage must increase, while the amount of water remains the same. In recent years the amount of water in the river and the rainfall have been above the average. At this time (November–December 1882) the degree of dilution is no doubt ample in proportion to the amount of sewage flowing into the river, but even under these favourable conditions disintegration is a very slow process. As the sewage poured into the Thames remains diffused in the water for a substantial time, at some periods of the year the putrefying sewage will be in too large a quantity in proportion to the water in which it is suspended to be properly disintegrated and oxidized, and in too concentrated a form to be appropriated by living animals.

Constituents of Food found in Thames Mud.

Of the constituents of human food altered by the process of digestion and by subsequent maceration and disintegration, and by oxidation, not a few are to be found in the mud of the Thames, deposited from the water as it flows up and down the river. It might be supposed that in consequence of the long distance traversed in the sewers and the length of time during which they are suspended in the tidal water, few of the matters in question would be obtained from the mud-banks in a state in which they could be recognized with any certainty by microscopical examination. But in fact a number of bodies with well-marked and unmistakable characters have been found. Among these may be mentioned starch-granules, fragments of vegetable tissue, large spiral fibres of various plants, but particularly of common cabbage, all of which have already passed through the alimentary canal. Tea-leaves, fragments of cooked muscular tissue and yellow elastic tissue in a state in which one often finds them in fæcal matter, cotton fibres, probably from paper, fatty matter, and crystals of

fatty acids. Even blood-corpuscles of man or of one of the higher animals have been detected in the mud, having withstood all the destructive agencies to which they have been exposed during probably many months. Fragments of paper and rags and many other things are also present, but it is to those substances which are found in the excrements that my attention has mainly been directed.

Fragments of Vegetable Tissue in Thames Mud.

In every specimen of mud examined many fragments of vegetable tissue have been found, but considerable variation exists in different banks, both as regards the character as well as the quantity of vegetable tissue present. Some of the fragments of vegetable tissue found in the mud of the Thames are doubtless derived from plants which grow on the banks, and which in various ways and from many sources find their way into the river; but that the great majority of such fragments are derived from the sewage and have already passed through the alimentary canal is proved by the yellow colour they have taken from the fæcal matter. If healthy fæces be examined after a person has eaten a quantity of cabbage or other vegetable, many fragments of vegetable tissue stained of a deep yellow colour will be found, and the appearance of these is very similar to that of many of the fragments seen in my specimens of mud taken from the mud-banks. It is remarkable that, in its passage through the intestines, colourless greenish or pale-brown vegetable tissue becomes infiltrated with yellow colouring matter, and is thus sometimes deeply stained of a bright yellow, and this stain is very persistent.

Spiral Vessels.

In nearly all the specimens of mud I have examined I have found fragments of spiral vessels, many of which are very large and of great length. The majority are undoubtedly derived from the common cabbage, while some are clearly connected with portions of tea-leaves, of which numerous fragments have been discovered in most of the specimens submitted to examination.

If a portion of the stem of a well-boiled cabbage-leaf be examined numerous large spiral vessels exactly like those I have found in the mud will be discovered. In most of them the membrane of the vessel is destroyed or so softened by boiling that the spiral fibre protrudes, and in many cases is almost entirely uncoiled. On comparing these spiral fibres with many of those in the mud the similarity will be at once recognized. The resisting power of the spiral fibre is shown by the fact of its retaining its remarkable characters not only after prolonged boiling, but after it

has been exposed to the action of the digestive fluids poured into different parts of the alimentary canal, after it has passed through the sewers, and after it has been carried backwards and forwards by the tide, and exposed perhaps for months to various disintegrating actions constantly taking place on the mud-banks of the Thames. Spiral vessels, plate I. figs. 1 *c**, 2; plate II. figs. 4 *c*, 8; plate III. fig. 11; plate IV. figs. 13 *c*, 14.

Starch-granules.

In several specimens of mud I have found starch-grains, and have been able to distinguish wheat starch, potato starch, and rice starch by the shape and size of the grains and by the action of iodine. Many specimens of wheat starch are much altered, and look as if partly digested. These I think have probably been derived from bread, and have passed through the alimentary canal. Starch has also been found in many cells of vegetable tissue, the exact nature of which I have not been able to determine.

Muscular Fibres.

In almost every specimen of Thames mud examined by me muscular fibres or bodies which were recognized as the result of changes in muscular fibres were found. The fragments varied much in number as well as in size in different specimens of mud, but were most numerous and the anatomical characters of the fibres most distinct in the sewage taken direct from the mouth of the sewer and in the muds near the outfall. Many of the fibres were firm and hard, and had all the character of muscular fibres which had escaped the action of the digestive fluids in their passage along the alimentary canal, and which are very frequently, though not constantly, found in fæcal matter. The fibres in question are for the most part derived from beef. It is most interesting to study the changes which may be observed in the character of the fibre as it passes from the condition in which it is found in recent fæces, with its well-known and remarkably well-marked anatomical characters, to its final disintegration in the river and on the mud-banks of the Thames. Some of the most remarkable alterations in the microscopical characters of the fibres are illustrated in my preparations and represented in my drawings. In fresh fæcal matter some of the fibres exhibit the ordinary character of coagulated and well-cooked muscle tissue which has escaped the action of the gastric juice and intestinal fluids. The transverse markings are very distinct and are sharply defined, the fibres are firm and hard, and bear considerable pressure without being damaged.

In other specimens the action of the digestive fluids upon the fibres is very manifest, all appearance of transverse striæ being lost

and the substance of the fibre appearing clear and jelly-like and of a faint yellow colour. Some of these transparent yellow masses are evidently undergoing disintegration and are pervaded by minute granules. Actual bacteria, which are active agents in destruction, are also often present in great numbers. In the muds of different banks it is not difficult to find examples of muscular fibre which illustrate every stage of disintegration up to the final conversion of the substance of the fibre into adipocere. Some of the fibres are probably softened at the time they leave the body. These are soon further disintegrated, silicious and other particles adhering to them; and the compound masses thus formed are gradually and at length completely disintegrated. Fragments of muscular fibres in various stages of disintegration are represented in plate I. fig. 1 *a*; plate II. figs. 4 *a*, 6 *a*, 7; plate III. figs. 9, 12 *a*, 13 *a**; plate IV. figs. 12 *a*, 16 *a**, 17 *a*.

Yellow Elastic Tissue.

Many fragments of different kinds of yellow elastic tissue are found in the mud-banks of the Thames. This substance long resists decomposition, and it is probable that many months or even years may elapse before some of the firmest particles are completely disintegrated. The characters of elastic tissue vary according to the texture from which it has been derived. The fibres differ so much in structural peculiarities that it is often possible by microscopical examination to say whence they had been derived. I have identified fibres from the ligament of the neck, probably of the sheep, yellow elastic tissue arranged as a network from the coats of a large artery from the same animal, fibres from the lung and from the areolar tissue of the body. Not only so but some of the yellow elastic fibres in my specimens exhibit those peculiar transverse markings which show the fibres to be old and also indicate that they have been well cooked. (Plate IV. figs. 13 *f*, 16 *f*.) Yellow elastic tissue, it seems, passes through the alimentary canal without being acted upon by the digestive fluids and is therefore always found in the fæces when it has been taken with the food. Portions of yellow elastic tissue are represented in plate I. fig. 1 *f*; plate II. figs. 4 *f*, 6 *f*; plate III. fig. 14 *f*; plate IV. figs. 11, 13 *f*, 16 *f*.

Yellow Fæcal Masses.

Among the most striking constituents of Thames mud are yellow granular masses varying much in size. The smallest of them are mere granules or small collections of very minute granules, and less than 1/100,000 of an inch in diameter, the largest as much as the 1/50 of an inch in diameter or even more.

These yellow masses have been described by Dr. Tidy in a Report to the Conservators of the river Thames, written in the year 1881.

The colour of these masses varies from a dull or dirty brown to a bright yellow colour. Some are smooth and homogeneous in parts, others rough and irregular containing particles of many different kinds, some of which have been associated with the yellow matter from the first, while others have been added while the matter was in the sewer or in the river.

As portions of fæcal matter are driven backwards and forwards by the tide, besides undergoing disintegration as has been already described, the opposite process of integration is also going on. The collection and aggregation of particles of many different kinds to form oval masses is always taking place. These composite masses consist of numerous minute particles of sand, many fragments of carbon, small portions of diatoms, oil-globules, fatty acids, and many other things apparently cemented together by the yellow viscid substance which forms an important constituent of fæces. Many of these compound masses are as much as the 1/50 of an inch in diameter.

Incessant changes, mechanical as well as chemical, are continually proceeding in the organic matter of sewage, but, as has been shown, these changes are not purely destructive and disintegrative.

It may be said that all the animal and vegetable tissue and other constituents of fæces with actual fæcal matter present, do no harm because they are constantly being disintegrated, while many low vegetable and animal organisms live at their expense and grow and multiply exceedingly and consume them. It may be said that by these means and by oxidizing and other disintegrating processes, all the organic matters present in sewage are gradually resolved into substances which are not in the least degree deleterious either to fishes and other organisms living in the water of the Thames or to the inhabitants of the houses near the river. Such statements may be made and supported by facts. Arguments telling in the same direction may be freely admitted without the strong objections to the presence of these things in a tidal river being in the slightest degree diminished, much less removed. Yellow fæcal masses of various sizes are seen in plate I. figs. 1 *h*, 3 *h h*; plate II. fig. 4 *h*; plate III. fig. 15 *h*; plate IV. figs. 12 *h*, 19.

Fatty Matter, Oil-globules and Fatty Acids.

The fatty matter varied much in different specimens of mud. It existed in the form of amorphous granules, in globules, and as crystalline particles probably consisting of fatty acids set free in consequence of decomposition. Many compound masses were made

up of granules and globules of oily matter, minute granules of silicious and other inorganic substances, fragments of vegetable tissue, starch-globules, all connected together by a viscid cementing substance of a yellowish colour which was probably the fæcal matter already referred to.

Such complex masses no doubt slowly undergo disintegration. By mere attrition the organic matter on the surface would be gradually removed and would form at length a very fine mud which would slowly settle, while probably a smaller portion would be subjected to chemical change and be ultimately dissolved. Fatty matter and crystals of fatty acids are seen in plate I. figs. 1 *d*, 3; plate II. fig. 6 *d*; plate III. figs. 10, 13 *d*.

Particles of Soot and Coal.

There is no difficulty in discovering minute pieces of coal in the mud, and in some instances I have found indications of vegetable structure in the sections and delicate fragments of coal which have accidentally resulted from the action of the water and the rubbing together of particles as they were driven backwards and forwards by the current.

Much of the soft black matter present in the mud is no doubt soot. Even particles of silica are sometimes found soot-stained. Perhaps such black sand is derived from the smoke-impregnated granite débris of the macadamized roads. Black particles of coal and other forms of carbon are represented in plate I. fig. 1 *d**; plate IV. figs. 10 *o*, 16 *o*, 17 *o*, 18.

Diatoms.

More than 100 different species of diatoms are found in the Thames, some being peculiar to fresh water, some to salt water, while the natural habitat of some specimens seems to be water which is always brackish.

The silicious skeletons of the valves of diatoms that have died, and multitudes of fragments of valves in every degree of disintegration are found in Thames mud. After the removal of the particles of sand a considerable portion of the inorganic matter of the mud that remains probably consists of the débris of the valves or shells of these organisms.

As long ago as 1853 Mr. F. C. S. Roper published some interesting observations on the 'Diatomaceæ of the Thames'* and gave a list of 104 species from the mud of the Isle of Dogs alone. Of these 30 are decidedly marine, 29 belong to brackish

* Trans. Micr. Soc. Lond., ii. (1854) p. 67.

water, and the remaining 45 are fresh-water species. As would be supposed, some of the marine species are carried up the river, and the fresh-water species downwards towards the sea. Mr. Roper found marine species at Hammersmith, but very few fresh-water species were met with as low as Gravesend. "At Gravesend, out of 47 specimens 8 only are decidedly peculiar to fresh water, whilst at Hammersmith we find there are 29 fresh-water species out of a total of 43, showing however that the influence of the flood tide, even at that distance from the sea, gives a decided character to the diatomaceæ deposited by the water."

Of the diatoms met with in Thames mud, some are found in a living state, but the majority are not only dead but they do not belong to the particular locality where their remains have been discovered. The silicious shells or valves of these organisms are very light and are often transported long distances. Suspended in the moving water, many pass up and down the river and probably form a part now of this bank, now of that. By this continual movement, and by rubbing against sharp particles of sand and by being buried in it, and then again disturbed, such delicate structures necessarily become disintegrated, and are at last broken into those very minute silicious fragments which exist in great numbers in the mud of all the mud-banks examined.

Mud-banks, especially on the surface, are in a state of constant change. Formation and destruction, accretion and disintegration are continual, and, when the facts are considered, one cannot feel surprised that organisms which are formed high up or low down the river, or at least parts of them, should eventually be discovered in a resting place at a long distance from the seat of their development. Bodies formed high up the stream may be deposited at its mouth, and those which inhabit the sea or brackish water may be carried far up into the region traversed by and exposed to the action of fresh water only. In fact, the ascent and descent of light particles is clearly shown by the distribution of the diatoms on the banks in different parts of the river, and this fact alone would render it certain that many of the constituents of sewage would in like manner be carried up and down by the tide, and that some would be found a long way from the point where they first entered the Thames.

Bacteria.

are found in immense numbers in all the muds I have examined, and exist in multitudes in Thames water, and in connection with all the particles of organic matter held in suspension in the water, or which have subsided to the bottom, or have fallen on the leaves of plants or other objects which have prevented their further subsidence. Bacteria are so very minute that they may easily be

passed over unless a very thin stratum of the fluid which holds them in suspension be examined. Though so small, they are probably bodies of the very highest importance in the disintegration of sewage compounds. The germs of these organisms are excessively minute, many being less than the 1/100,000 of an in. in diameter, whilst the smallest are probably not to be seen when amplified by the highest magnifying powers at our disposal. So very small are they that they must grow for some time before they are of a size sufficient to be rendered visible by an objective which magnifies upwards of 5000 diameters. Bacteria germs exist everywhere in countless multitudes, not only in air and in water and on the surface of every kind of matter, but in the interior of bodies living as well as non-living wherever fissures exist, and chinks are seldom absent through which germs so minute can pass. Not only are bacteria always to be found upon every part of the surface of all living beings, but they exist within the blood, and in the very substance of the tissues however distant from the external surface of the body, and however far from any direct communication with the outside air. In all animals and in all plants, at all temperatures consistent with life—in every part of the world—bacteria are living at this moment, and they have lived, and probably in the same way as they live now, in every period of the world's history from the earliest dawn of life. Soon after the death, and in many instances long before the death of a man or an animal has taken place, the bacteria germs, which have been dormant in the tissues and fluids, begin to grow and multiply enormously, so that in a very short time every part is freely pervaded with countless hosts which soon stop all ordinary action and efface all characteristic structure. Then begins that long series of changes which ends at last in the formation of products of comparatively simple character and very stable nature.

Extremely minute division of the organic matter of sewage and its equable diffusion through a large volume of water in constant motion are favourable to the conversion by bacteria, of noxious matter into chemical compounds, which are inodorous and harmless, and which undergo but slight change whether moist or dry, and which are usually at last disposed of by becoming the food of plants. In the case of sewage this desirable change into innocuous compounds is rendered very slow in consequence of the matter not being spread out in a sufficiently thin layer to be quickly appropriated by the bacteria.

The rate of growth and multiplication of bacteria varies greatly at different periods of the year. These organisms are not destroyed by ordinary cold; nay, there is evidence that bacteria multiply after having been exposed even to intense cold, but of course very slowly as compared with their rate of increase under

favourable conditions. The changes effected by them on the products resulting from the death of man, the higher animals, and plants, are, and probably have ever been, the same in their essential nature at all times, but a longer time is required for the completion of the changes in cold than in warm weather.

Although chemical change, irrespective of the action of living forms, and especially the action of oxygen, undoubtedly plays an important part in the disintegration and reduction to simpler and more stable compounds of some of the constituents of sewage, particularly the excrementitious matters of the human body, by far the most extensive changes, and those effected on the largest scale, are brought about by these minute organisms. Bacteria are among the lowest and simplest living forms in nature, and as I have mentioned are universally present, or at least are to be found wherever moisture-laden air exists. Some forms of these bodies do not even require oxygen for their subsistence. They can live in nitrogen, carbonic acid, and probably in gases of the most poisonous and deleterious character for a length of time, though they do not grow and multiply quickly until conditions favourable to them are established.

In the present state of knowledge it is not possible to explain precisely how these organisms act upon the offensive sewage matter, but it is probable that as they grow and multiply they actually feed upon and consume the noxious material. After living its life the bacterium dies, and the products arising from its decay and disintegration are harmless indeed as compared with the substances upon which it has fed, and which for the most part it is our great anxiety to be rid of. The matters resulting from the disintegration of bacteria in turn become the food of plants. If not taken up by vegetation these compounds would remain passive as a soft brown granular material which is stable, and undergoes scarcely any change whether it remains constantly moist, as in mud, or sometimes dry and sometimes wet as the humus of earth. Few organic substances undergo so little change from century to century, nay, from age to age, as for instance those products of plant decay which constitute the principal constituents of various kinds of peat. The same may be said of the last products of the decay of animal matter. For after the offensive gases which characterize the ordinary putrefactive change of animal matter have been evolved, and the putrefactive process has run its course, slow evaporation takes place, and, after hundreds and thousands of generations of bacteria have passed through the several phases of existence and have died, there results a brown substance which preserves its characters for centuries, and probably undergoes no further change at ordinary temperatures.

In the disintegration of the substances resulting from the death

of the higher plants and animals there is no doubt that many forms of life take part, but when at length these have lived and disappeared, bacteria continue the processes, and it is, as I have remarked, by their action that the organic matter is caused to assume its final form in which it may remain for any period innocuous to all forms of life. The brown matter which remains after decay has run its course, consists mainly of the lifeless remains of bacteria.

Disintegration by bacteria begins in the living organism itself. There is no part of the alimentary canal or of any of the ducts, tubes, or cavities opening into it, in which multitudes of these organisms, growing and multiplying in countless millions, cannot and at all times be found. It has undoubtedly been assumed by many observers that whenever bacteria are discovered in the cavities, tissues, and organs of living animals they have been introduced from without. But the assumption and the conclusions based upon it are erroneous, as any one who will make the investigation with due care may easily convince himself. In the cavity of the mouth they are always and in all states of health in all animals growing and multiplying excessively. Even in the interior of the cells of plants, cabbages, lettuces, watercresses, &c., as well as in the interstices of the inmost tissues of the higher animals and of man, they or their germs exist, and when the conditions become favourable, they grow and multiply in enormous numbers. Many of the bacteria present in the water and in the mud of the river have no doubt been derived from bacteria which existed in the excrementitious matter before it left the organism in which it was formed. These probably go on growing and multiplying in the organic matter while in the Thames, and are not the least important agents in its disintegration and ultimate resolution into harmless compounds.

Practical Considerations.

In conclusion, I shall venture to make a few observations concerning the practical inferences which are suggested by the present inquiry. Although no doubt a physician is likely to take a rather limited, fragmentary, and possibly not impartial view of many of the most important matters which bear upon the great question of the proper disposal of sewage, while to effectually grapple with the difficulties, engineering knowledge and skill are required which none but the trained engineer can possess, it nevertheless seems permissible, and since no harm can thereby result, I think it may be desirable that those engaged in other departments of the inquiry should briefly give expression to their views. The subject is one which cannot receive too much consideration before the mode

in which it is to be practically dealt with is decided. I have often wondered whether, besides the Thames, there is another river in the world, on the mud-banks of which could be found in equal quantity, particles of fæcal matter, fragments of muscular fibre in every stage of disintegration, fibres of yellow elastic tissue, spiral fibres from vegetables, and many other constituents of food which have passed through the human intestinal canal, with other organic matters in a state of decomposition, discharged as sewage, to undergo disintegration in the river, and there become resolved at last into harmless matter.

It is said with truth that London is the healthiest city in the world, but the possibility that our river may any summer seriously damage our reputation must not be lost sight of: year by year the proportion of sewage to the water increases, and the particular point at which the sewage contamination becomes dangerous to health is unknown, for there is no experience to guide us, while so many circumstances contribute to the maintenance of its present harmless condition on the one hand, and such comparatively slight departures from the ordinary conditions might cause disaster on the other, that the problem is one of the most complex and difficult that could be presented for solution; while it is doubtful whether the precise changes that would endanger the public health could be discovered by experiment and determined beforehand. In fact there is much uncertainty, though little ground for satisfaction.

Granting for a moment the correctness of all that has been said in favour of the state of the river at this time, granting that at present the sewage is carried away, there remains the important question whether without very considerable changes the removal of the sewage in the course of a few years will be as efficiently carried out as it is now. The amount of sewage is constantly increasing, the amount of water by which it is diluted remains the same. Must not the time come when the proportion of sewage to the water becomes so large that its disintegration and harmless decomposition within the proper time will be impossible?

As long as the sewage is passed into and immediately mixed with a very large volume of water, our drainage system is no doubt very effective, possibly as near perfection as can be expected in a case where the removal of the sewage of a population of four millions has to be provided for. During the greater part of the year the sewage is no doubt sufficiently diluted as it passes along the sewers, while these are well scoured by the flow through them; but when little rain-water is added to the water supplied by the companies, what will be the state of the sewage? So far, therefore, from the surface rain-water being diverted and prevented from passing into the sewers, every arrangement ought to be made to facilitate its flow into and exit from them.

The smell of the river and of the mud some years ago, when the amount of sewage poured into the Thames probably did not amount to more than half the quantity now traversing the sewers, perhaps affords some idea of what might happen if the conditions favourable to the development of smell were repeated and augmented in intensity, as will probably obtain when a very dry hot summer follows a winter and spring in which the rainfall shall have been considerably less than the average, unless in the meantime some more effectual and quicker means of disposal of the colossal amount of the sewage should be discovered and carried into practice. As London increases, therefore, every effort should be made to keep up and increase the amount of water mixed with the sewage at its source so that it may attain the greatest degree of dilution that is practicable during its transit along the sewers.

Any one who has seen the vast volumes of water in the upper Thames during the time of flood will be convinced that there is water and more than enough to flush the sewers of a city even considerably larger than London. If only a small portion of this vast quantity of wasted water could be husbanded till the time approaches when the amount at our disposal for diluting the sewage could be thus supplemented, the efficiency of the present system would doubtless be greatly increased. Unless the plan for dealing with the sewage can be completely changed, it will be necessary, as time goes on, to further enlarge the present sewers, to divert into them sewage which even now finds its way into some of the tributaries of the Thames, and to carry further and further towards the sea the mains which receive the sewage and drainage collected from that increasing area included in Greater London. That such operations would entail vast and lasting expenditure is obvious, but basing our conclusion on the practical results achieved during the past thirty years and more, is it not highly probable that all that can be desired would be gained? On the other hand, it may be asked which of the several other suggested schemes of sewage disposal has been found to succeed on a sufficiently large scale, and for a sufficient length of time, to justify its adoption in place of the main drainage system now in operation?

By mixing sewage with large quantities of water the gradual disintegration and oxidation of many of its constituents and the slow conversion of all its deleterious principles into substances which are at any rate harmless, is insured. The changes are in part mechanical and chemical, and partly due to living organisms, which play no unimportant part in the ultimate reduction of noxious organic matters to harmless compounds. The rapidity and completeness of the purification of the contaminated water in great measure depend upon the degree of dilution. If the sewage is concentrated, the decomposition which ensues is of a different kind and

results in the formation of compounds of a most offensive and deleterious kind, which are afterwards only very slowly converted into harmless substances. If the sewage passed into the sea in such a manner that it became quickly diluted, it is probable that for miles round, at a considerable distance from the outlet, organisms of many kinds would grow and multiply in vast numbers. Many of these would become the food of fishes, which in their turn would be taken and help to support the population which had already supplied their sustenance.

That objections may be advanced to some of the details of the drainage system now in operation is no doubt true, but the experience of many years has conclusively proved that it is workable, and the results of its working may, I suppose, be considered fairly satisfactory. The practical working of the main drainage system seems to have shown that if only sufficient quantity of water for dilution can be provided, and a good outlet to the sea obtained, the sewage of a city, however large, might be quickly and thoroughly disposed of, and the sanitary condition of houses, however numerous, at least as far as sewage is concerned, assured, while the alterations rendered necessary by the gradual increase of population, could be carried out from time to time as required, by the enlargement of the sewers and their extension towards and into the sea.

II.—*On the Mode of Vision with Objectives of Wide Aperture.**

By Prof. E. Abbe, Hon. F.R.M.S.

(*Read 12th April*, 1882.)

The idea of "all-round vision" as a peculiar capacity of wide-angled lenses has been put forward with opposite aims. The object of one side has been to indicate an *advantage* of wide aperture-angles in the vision of *solid* objects, depending on the angles *quâ* angles and the admission of rays from all sides of the object at the same time. The other opinion claims that this must be a *disadvantage*, constituting an unnatural mode of vision, causing particles to look spherical (when sufficiently minute) even if in reality cubes, and giving rise to a confusion of dissimilar images.

The tacit supposition of both views is, that the optical conditions of microscopical observation are essentially the same, even with the minutest objects, as those of naked-eye vision—that a solid object is depicted through the Microscope in the same perspective, in which it would appear to the eye in ordinary vision, if it were looked at *in the direction of the delineating pencils.*

They assume, for example, that a minute die *a b c d* (fig. 1) if depicted by means of oblique pencils *r* (such as are admitted through the marginal zone of a wide-angled objective) will appear in the microscopic image with the perspective in which it would be seen by an eye in the direction of *r*. It would thus appear as the projection of the die on a plane P *perpendicular to the direction r*, or, which is the same thing, as if it were placed in an *inclined position* on the stage under axial illumination (fig. 2).

Fig. 1.

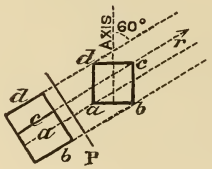
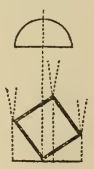


Fig. 2.



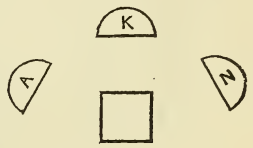
In fact it is supposed that obliquity of the delineating pencils to the axis of the Microscope is equivalent to and produces the same effect, in regard to the manner of projection of the image, as an oblique position of the object under perpendicular (axial)

* The paper (received 3rd March 1882) is written by Prof. Abbe in English. Its publication has been delayed pending the completion of Prof. Abbe's paper in the last volume.

incidence of the pencils, and on the basis of this view the natural conclusion of course is that as a wide aperture admits pencils of very different obliquities at the same time, the resulting image must embrace as many different perspectives of the solid object, depicting them to the observer's eye at the same time, just as if many narrow-angled objectives (or eyes) A, K, Z, &c. (fig. 3) were arranged around the object and their images united.

According to the point of view adopted, or to the private taste of the writer, this, as I have said, is considered either as an advantage of wide-angle vision, or as a drawback.

Fig. 3.



The fact is, however, that neither the one nor the other of these views is correct, because no delineation of the objects takes place in the manner supposed. This is shown by the following consideration, which also shows at the same time the error of the view that the resultant image of an objective of wide aperture is composed of *dissimilar* images projected by rays of different inclinations, for this is based on the same hypothesis essentially as the others just referred to.

First consider the case of a *plane* object. The course of the rays through a wide-angled objective is shown in fig. 4, the object being at A B. If we suppose the objective to be well corrected (or aplanatic) all rays emanating from the axial point A (i.e. the *whole* pencil a) will be collected at *one* point A*, and the same is true not only for an axial point, but for an eccentric point B also (up to a certain moderate distance from the axis at least).† Consequently the whole pencil β from the point B will be collected also to one distinct point B* of the image.

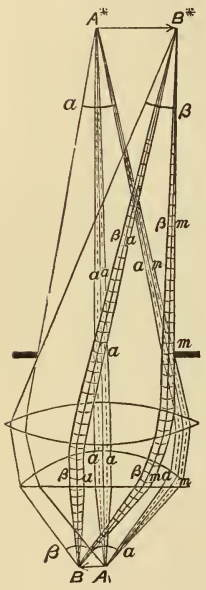
Now it is an evident inference that the plane A B must be delineated exactly in the same manner (as the *same* plane A* B* of the image) whether it is delineated by the two *axial* pencils $a\,a$ and $\beta\,a$, or by any two oblique pencils $a\,m$ and $\beta\,m$, whatever be their inclination to the plane of the object. For if *all* rays from B are collected to the same point B*, the two partial pencils $\beta\,a$ and $\beta\,m$, which are parts of the whole pencil β, cannot be collected to different points.

† This idea of a well-corrected system has been considered formerly as quite unconditional. It has been supposed that whenever the rays from the *axial* point A are collected to a sharp focus, the rays from excentrical points B would always be collected to sharp foci by themselves. I showed in 1873 that the latter is *not* a necessary consequence of the former, and that a particular condition must be fulfilled in order to have the same collection of rays from excentrical points as is obtained from an axial one when the spherical aberration is corrected. This condition is the *law of aplanatic convergence*—proportionality of the *sines* of the angles at the foci A and A*.

Thus it is certain from the simple notion of an aplanatic system that pencils of different obliquities must yield *identical* images of every plane object or of a single layer of a solid object. However large an aperture may be, the resultant image of the object cannot therefore be composed of *dissimilar* images, and the wide aperture cannot be the cause of confusion, &c.

We see also at the same time that the delineation of an object through the Microscope does not exhibit differences of perspective according to the obliquity of the delineating pencils to

Fig. 4.



α the *entire* pencil starting from the axial point A of an object, and collected to the axial point A* of the image.

β the *entire* pencil starting from an excentrical point B collected to the excentrical point B* of the image.

α *a* and α *m* an *axial* and a *marginal* elementary pencil from A which are contained within the pencil α.

β *a* and β *m* corresponding *axial* and *marginal* elementary pencils of the whole pencil β.

The two *axial* pencils α *a* and β *a* pass through the central part, *a*, of the clear opening: the marginal pencils α *m* and β *m* touch the margin of the opening at *m*.

The limiting diaphragm of the clear opening is assumed to be at the plane of the posterior principal focus (as is always the case approximately with high powers) in order to obtain the corresponding rays of the two pencils α and β *parallel* in front of the system, or the *same obliquity* of α *m* and β *m*.

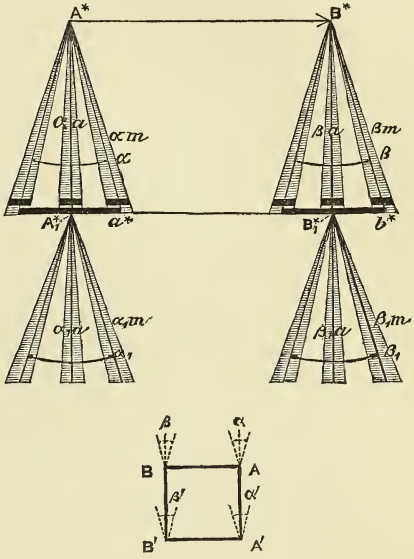
the plane of the object, as is the assumption of the all-round vision theory. The image of any plane surface A B (e. g. the upper surface of the minute die) is always the same whether the rays are admitted to the Microscope in perpendicular or in any oblique direction. If that theory was right, the image of A B, by the oblique pencils α *m* and β *m* ought to be shorter (according to the perspective shortening of the lines in oblique projection) than the image by the axial pencils α *a* and β *a*, as we should of course have a shorter image of A B if we observed it through a low-power Microscope with inclined axis.

This absence of perspective shortening of the lines according to the obliquity of the rays exhibits therefore an essential geometrical difference of microscopic vision, which renders it uncomparable to macroscopic observation.

Secondly, consider the delineation of a *solid* object such as a minute die.

This is of course perfectly defined by determining the delineation of the upper plane surface A B, and of the lower A_1 B_1 (fig. 5). The result of the previous consideration must apply to both plane surfaces successively, provided their distance along the axis is sufficiently small. For in this case, an objective which is aplanatic for the conjugate points A and B will still be aplanatic for the neighbouring pair of conjugate points A_1 and B_1.

Fig. 5.



$\begin{pmatrix} A^* & B^* \\ A^*_1 & B^*_1 \end{pmatrix}$ air image of the object $\begin{pmatrix} A & B \\ A_1 & B_1 \end{pmatrix}$ as projected by the objective to the field of the ocular.

The diagram shows the manner in which the two successive layers A B and A_1 B_1 of the object are delineated by means of the *whole* pencils (full aperture pencils) α, β and α_1, β_1, or by means of the *elementary* pencils α α, β α, and $\alpha_1\alpha$, $\beta_1\alpha$, or α m, β m and $\alpha_1 m$, $\beta_1 m$, and indicates the manner in which the image of the upper layer is seen projected upon the image of the lower layer. The thick lines indicate the diameters of the circles of indistinctness which represent the points A* and B* under various circumstances at the plane of the *lower layer* (in one case broad and in the other small) on the assumption that this lower layer is exactly focused and seen in perfect distinctness.

Consequently the *whole* pencils α and β from the surface A B will yield a distinct image A* B* at a certain plane, and at the same time the *whole* pencils α_1, and β_1, from the other surface A_1 B_1, will also project a *distinct* image A_1* B_1* at another (lower) plane.

Suppose (1) that the image is delineated by means of *narrow axial* pencils α α and β α, and the ocular focused to the exact level of the lower layer A_1* B_1*. The points A* and B* of the upper layer will in this case appear as *small* dissipation circles projected upon the distinctly seen points A_1* and B_1* of the lower layer, the centres of these circles coinciding with the latter.

Suppose now (2) the image to be delineated by the whole aperture, i. e. by the *wide* pencils α and β, and the ocular focused to the lower layer as before. The points of the upper image, which is not exactly focused, will now give much broader dissipation circles projected on the sharply seen points A_1* B_1* but the centres of the two sets of points will still coincide.

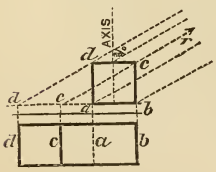
What is the difference between these two cases? The small dissipation circles in the first case may still be capable of affording a pretty distinct vision of the upper layer at the same time as the lower, and we say that the depth of the object is within the range of the depth of distinct vision *for pencils of narrow aperture.* The broad dissipation circles resulting from the wide pencils of the full aperture will in all probability render the image of the upper layer very indistinct, so that the image of the *whole* object will appear indistinct also. The *causa efficiens* of this indistinctness is simply too great a depth of the object compared with the small depth of vision attendant upon a wider aperture. If we take a similar solid object, but of *much smaller depth*, we should see its upper and lower layers in sufficient distinctness, notwithstanding the wide aperture.

Consequently the indistinctness of an object which is not quite flat if observed with a wide aperture, does not arise from any dissimilarity of the images by axial and by oblique pencils, but solely on account of the *reduction of the depth of vision.*

Suppose now (3) an image projected by *narrow oblique* pencils $a\,m$ and $\beta\,m$ through a marginal or intermediate part of the aperture. The sharp images of *both* layers A B and A_1, B_1, will be exactly the same as the sharp images by the axial pencils $a\,a$ and $\beta\,a$, or the sharp images by the whole pencils a and β. But as these images occur at different planes they will show a *parallactic displacement.* If the ocular and the eye are focused to the level of $A_1{}^*$ $B_1{}^*$, the points A* and B* will appear projected to the points a^* b^* and will be seen as dissipation circles with those points as centres. We have once more always similar images, only displaced horizontally.

This must give rise to a mode of projection of solid objects which is essentially different from the ordinary *perspective* projection under oblique vision. Suppose the die (fig. 1) delineated at an oblique direction of 60°. A true perspective image, such as would be obtained by an eye receiving it in the direction r, or if the Microscope were directed to it in this direction, would give the projection on a ground plane *perpendicular to the line r.* But the image of the die as depicted by the oblique pencils in an objective of 120° aperture-angle will be a projection to a ground plane *perpendicular to the axis of the Microscope* (fig. 6), and not to the rays r. Both surfaces, $a\,b$ and $c\,d$, will therefore be projected with their true diameter, but displaced horizontally, and not shortened as in fig. 1.

Fig. 6.



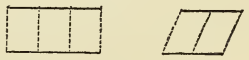
If we compare now the image of the solid object by the oblique

pencils $a\ m$ and $\beta\ m$ to the image by the axial pencils $a\ a$ and $\beta\ a$, or to the image by other oblique pencils (say of *opposite* obliquity), we have dissimilar images. But this dissimilarity relating solely to the projection of *successive* layers, and being nothing else but different parallactic displacement of successive layers, cannot be effective in microscopic vision unless these images are produced by different portions of the aperture *separately*, that is, if the effective pencils (or the effective portions of the aperture) are separated, and the one conducted to one image and the other to another image, as is done by the various arrangements for stereoscopic vision. As long as various portions of the aperture are effective *at the same time*, producing *one* image, we have only an increase of the dissipation circles at those planes which are not exactly focused, and a reduction consequently of the depth of distinct vision. We have no "all-round *vision*" because *vision ceases* as soon as the "all-round" becomes effective.

The result of the whole consideration therefore is:—(1) In a well-corrected (or aplanatic) objective the images of a flat object by pencils of different obliquity are always strictly similar. The obliquity of the rays at the object does not produce any difference of perspective, as it does in ordinary vision, or when the same object is observed by a Microscope in an oblique direction. The Microscope therefore does not delineate solid objects perspectively, and has no capacity of all-round vision, either as a drawback or a benefit.

(2) The images of solid objects arise from the projection of their successive layers in perfect similarity, however large the aperture may be (refraction of the rays by structural parts within the layers disregarded). As long as the depth of the object is within the limits of the depth of vision corresponding to the aperture and amplification in use, we obtain a distinct *parallel projection* of all successive layers on one common plane perpendicular to the axis of the Microscope (a regular ground plan), either strictly orthogonal (fig. 7) when the delineating pencils, narrow or wide, are axial, or with a certain obliquity of projection if these pencils (i. e. the axes or principal rays of the pencils) are inclined to the axis of the Microscope. If the depth of the preparation is greater than the depth of tolerably distinct vision, this projection must become indistinct, because the layers above or below the range of distinct vision give rise to broad dissipation circles confounding with the distinct portion of the image. Since the depth of vision, other circumstances being equal, decreases with increasing aperture, good "definition" of wide apertures is confined to *thinner objects* than good definition of narrow apertures.

Fig. 7.



(3) Dissimilarity of the images of *solid* objects by different parts of the aperture is solely difference of projection (orthogonal projection *versus* oblique projection—or one degree of obliquity by axial pencils against an opposite obliquity by oblique pencils). It relates therefore exclusively to the manner in which *successive* layers are seen projected to the common ground plane (perpendicular to the axis of the Microscope) or to the *perception of the depth*, and not in any way to the delineation of the plane layers themselves. The effectiveness of this dissimilarity for microscopic *vision* is confined to the case of an actual separation of the images by stereoscopic apparatus; for if this dissimilarity should be *perceptible* and the partial images *not* separated (viewed by distinct eyes), the out-of-focus layers would appear confused, and no *vision* of the depth could be possible, as explained just above. We have, then, no advantage from the said dissimilarity.

(4) Stereoscopic vision in the Microscope is entirely based on the said dissimilarity of projection exhibited by the different parallactic displacements of the images of successive layers on the common ground plane of projection. There is no *true* perspective difference of the images by different portions of the aperture, because the microscopic image does not admit of a perspective shortening of the lines, which are oblique to the direction of the delineating pencils.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Influence of Gravity on Cell-division.†—Dr. E. Pflüger's experiments were conducted with the eggs of the frog. Each egg consists of a dark and a light hemisphere, and after fertilization the dark hemisphere always comes to lie uppermost, the "axis" of the egg being therefore vertical. When the black hemisphere is uppermost the line connecting its middle point with the middle point of the white hemisphere is termed the "primary axis"; to the primary axis correspond, of course, a primary equator and meridian. The "secondary axis" passes through the point at which the first and second planes of cleavage cut each other. The "tertiary axis" finally is any perpendicular diameter of the egg that is not coincident with either of the two former axes. The first two cleavages pass through the axis of the egg, and the third cuts it at a right angle; the question therefore arises, is there any real connection between the direction of cleavage and the axis of the egg, or do the first cleavages pass through the axis of the egg because it happens to coincide with the direction of gravity? By preventing the rotation of the eggs, by fixing them to a watch-glass in various positions after fertilization, Dr. Pflüger was able to show that the latter interpretation is the correct one; the first cleavages do not follow the axis of the egg but the direction of gravity passes along the vertical diameter, whether it happens to coincide with the axis or not. In the normal egg left to assume its own proper position with the dark hemisphere uppermost, it is well known that the process of division is far more energetic in the upper dark hemisphere, and this was believed to depend upon

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Pflüger's Arch. f. gesammt. Physiol., xxxi. (1883) pp. 311–8.

some property special to this hemisphere. If, however, an egg be turned upside down during the process of division, it is found that the cleavage proceeds more vigorously in what is now the upper half and ceases to be so well marked in the lower half, and therefore clearly has nothing whatever to do with any special quality of different portions of the egg itself, but depends entirely upon its position.

Another point to which Dr. Pflüger directed his researches was the relation that exists between the first cleavage and the axis of the future embryo; the experiments made appeared to show that the two are identical, and that each of the two cells therefore formed by the first division corresponds to one half of the body of the future embryo: and also, a fact of the greatest importance, that the various parts of the body appeared to arise from the light or dark hemispheres according to the position of these latter; when the light hemisphere was uppermost the whole nervous invagination was seen to be clear and transparent. This part of the subject, however, the author does not consider to be as yet placed on a firm basis and intends to continue his investigations.

In a second paper on the same subject * the author notes that among the tadpoles developed from the eggs some were remarkable by the dorsal surface being entirely free of pigment, owing to the fact that the light hemisphere had been fixed in the uppermost position; later, however, the pigment seemed to spread over the whole body, and no recognizable difference between the dorsal and ventral surfaces could be detected. The albinos also showed occasional abnormalities and soon died. A further investigation was made upon the eggs of *Bombinator igneus;* the main results appear to be the following: Quite normal embryos were developed when the upper hemisphere had a larger clear portion; but if it became almost entirely made up of the clear hemisphere the embryos were abnormal and died, though it was perfectly evident that the axis of the egg might be at any angle whatever with the direction of gravity, and not interfere in the least with the early developmental stages.

In the earlier communication it was stated that the axis of the embryo coincided with the axis of the first cell-division, and that the central nervous system was formed out of the dark or the clear hemisphere, or out of both according to their position; a more careful investigation has shown that the central nervous system is always developed from the clear hemisphere.

This fact appears to show that the egg is after all not "isotropous," and that a given organ arises from some particular region of the egg entirely independently of gravity; but another series of facts tends towards the opposite conclusion; in eggs fixed in an abnormal position the anus of Rusconi was *never* to be seen upon the upper hemisphere; again, when the primary axis was inclined at an angle the medullary groove was always developed with the anterior end in the upper portion and the posterior end in the lower portion of the white hemisphere, which latter, of course, was also obliquely

* Pflüger's Arch. f. gesammt. Physiol., xxxii. (1883) pp. 1–79 (2 pls.).

inclined to the horizontal. The position of the anus of Rusconi affords still further proof of a "relative isotropy"; it always appears upon the white hemisphere, and is intimately connected with the direction of the axes of the egg.

The paper concludes with some observations on the development of *Marsilia* made by Dr. H. Leitgeb; it appears that in the embryo of this plant, the position of the first divisional septum in every case coincides with the axis of the archegonium; it is, however, capable of rotation round the latter, and as soon as the axis of the archegonium ceases to be vertical, takes such a position that the embryo is divided into an upper and lower half.

The occurrence of the same principle of development in two such widely different types is evidently an indication of its wide-spread importance.

Influence of Physico-Chemical Agencies upon the Development of the Tadpoles of Rana esculenta.*—E. Yung subjected tadpoles just hatched to the action of saline solutions of various strengths. The salts employed were obtained by the evaporation of the water of the Mediterranean, and the larvæ were placed in solutions of 1, 3, 5, 7, and 9 per 1000, which were renewed at the same time in all the vessels, and the whole were in other respects placed under precisely the same conditions. As a general result, M. Yung states that the tadpoles are developed the more slowly the more considerable the degree of saltness of the water. In the solution of 9 : 1000 no transformation took place, though some tadpoles live long enough to acquire hind limbs. In a solution of 10 : 1000 very young tadpoles die in a few hours: elder ones survive for a few days. The author remarks upon the importance of placing equal numbers of individuals in each vessel in experiments of this kind, as their development is found to be slower in proportion to the number living together.

M. Yung also subjected young tadpoles, which normally live in quiet water, to continuous agitation in a vessel containing two litres of water regularly renewed and suitable food. Under these conditions the eggs developed well; but the newly hatched tadpoles, being too feeble to seize their prey in so disturbed a medium, died of hunger, unless care was taken to give them daily a few moments of repose to take their food. If these tadpoles be compared, at different periods, with others of the same brood developing in quiet water, it is found that the developing of the former is slower, that they are less pigmented, which indicates bad nutrition, and, lastly, that their tails are relatively more developed, especially in width, which is explained by the greater use they are obliged to make of the organs in struggling against the waves.

Colours of Feathers.†—The colours of the feathers of birds are of two kinds: (1) *Objective*, that is, colours caused by the presence of definite pigment, or by structural peculiarities of the feather itself, or

* Arch. Sci. Phys. et Nat., x. (1883) p. 347. See Ann. and Mag. Nat. Hist., xiii. (1884) p. 72.

† Proc. Zool. Soc. Lond., 1882, p. 409.

finally by both causes combined; (2) *Subjective* colours are caused by the various effects of broken or reflected light.

The colours owing to the presence of pigment are always black, brown, and red of various shades; only one instance is known of a green colour produced by pigment, and that is in the feathers of the Touracous. The violet and blue tints are never due to pigment alone, and often depend merely upon lines and grooves on the surface of the feather. There are numerous colours which appear to be due to the combination of definite pigmentary bodies within the substance of the feather, and the structure of the feather itself, and this is the case especially with blue feathers. If one of the blue feathers of a Macaw be pressed and broken so as to destroy its structure it appears to be of a brownish grey colour, which is owing to the presence of pigment of that colour. Dr. H. Gadow has published some interesting observations upon these colours. He finds that the blue feathers of many birds consist of an outer structureless sheath, beneath which is a layer of "cones" covered by a system of extremely fine lines running parallel with the long axis of the cone; below these cones lies a layer of brownish-yellow pigment, which appears black when present in great quantity. The whole surface coating of the feather varies not only in different birds, but in the different feathers of the same bird, and is in any case too thick to allow of the blue colour being explained in the way that other colours are produced by thin plates. The fine ridges upon the cones seem to be the source of the blue colour.

The colours of yellow feathers are sometimes due simply to the presence of yellow pigment; but since many yellow feathers contain no pigment, this explanation will not hold in every case. In all probability a system of fine lines observed upon the outer surface of the feather is the cause. Similar lines occur in violet feathers, but they are finer and not quite so straight, and in this way, perhaps, the difference in colour is produced.

With regard to the green colour of many feathers, the suggestion of Krukenberg, that it is caused by an admixture of yellow pigment and a blue optical structural colour, is not a sufficient explanation inasmuch as most green feathers do not show the same peculiar structures that are met with in blue feathers. All the green feathers examined show the following structure: a transparent smooth sheath covers the barbs and barbules; beneath this is a system of ridges and fine pits; the ridges are less regular than those of the yellow coloured feathers; beneath this layer is yellowish or brownish pigment.

The second group of colours (subjective) are produced by a transparent sheath which acts as a prism. They are the so-called "metallic" colours, which change according to the position from which they are viewed. In describing the colours of birds a good deal of confusion has arisen from this fact, and Dr. Gadow suggests the desirability of introducing a standard method of describing these metallic colours in order to insure uniformity, and gives a diagram illustrating three positions in which the bird should be placed in order to describe its colours.

Rudimentary Sight apart from eyes.*—Prof. V. Graber has instituted experiments to ascertain whether, and if so to what extent, eyeless and blinded animals are sensitive to light. As an example of the former he chose the earthworm; for the latter, *Triton cristatus*.

The worms were placed in a box containing a number of cells of equal size, each with front and hind wall made of glass; the whole box was further divided into three parts, each of which had two front and two hind windows; the latter were turned from the light; and one of the windows of each cell was darkened, or supplied with a differently coloured light from that of the others. At the bottom of each was placed a layer of mud not sufficient to conceal earthworms. Twenty to thirty worms were first put into each cell and the box placed with one side towards a window with a north light. The number of worms found on the light and the dark sides respectively were counted at the end of every hour, and were replaced by fresh every four hours. Seven readings show that 40 specimens were found in the light, and 210 in the darkened spaces, giving a proportion of five of the latter to two of the former.

Using opaque glass for one set of windows, 326 worms were found in the partitions thus relatively darkened, and 204 in the absolutely light ones. In employing light of different colours, care was taken that the one colour chosen should be very decidedly lighter than the other. As it soon became evident that red was more attractive to the worms than blue, a much darker shade of blue was chosen than that of the red; then in 12 divisions 193 specimens were found in the pale red light, and only 57 in the dark blue; this difference is the more remarkable as the worms, being naturally lovers of darkness, would, so far as *intensity* of light was concerned, have been expected to prefer the dark blue; it indicates an appreciation of the *quality* of the light. In like manner, white light, deprived of the ultra-violet rays, attracted 87, ordinary white light only 13 worms; of pale green and dark blue, the former colour attracted 138, the latter 42 individuals; of pale red and dark green, the former attracted 168, the latter only 72. In examination of a statement, that it is only the anterior end of the body which is sensitive to light, experiments were made upon worms deprived of this part to a length of four or five rings; they gave the proportion of worms found in the dark as 2·6 to 1 of those in the light, and that of those in red light as 2·8 to 1 of those in the blue—results tending in the same direction as those obtained from entire specimens. Applying the same method to newts, Graber found that while, of 160 uninjured specimens, only one was found in the light area, the rest being in the dark, 135 specimens from which the eyeballs together with a considerable length of the optic nerves had been removed, were found in the light, and 308 in the dark. The same result was obtained after the filling up of the eye-cavity by wax in some of the blinded animals, proving that the optic nerve had no action in producing this light-sensitiveness. Using coloured light, it was found that 192

* SB. K. Akad. Wiss. Wien, lxxxvii. (1883) p. 201. Cf. Naturforscher, xvi. (1883) pp. 437–9, and 'Journ. of Science,' v. (1883) pp. 727–32.

normal specimens appeared to prefer pale red against the 8 in dark blue; of blind individuals, 536 were found in the first, and 406 in the latter colour; with colours of about equal intensity, 474 were found in the red, and 176 in the blue.

The proportion of individuals preferring a good light devoid of ultra-violet rays was as 2 to 1 of those found in darkish ultra-violet light; as between green and blue, the proportion was 3 to 1 of the respective colours for unblinded, and about $1\frac{5}{8}$ to 1 for blinded individuals. Thus blinded animals are shown to be sensitive to both quantitative and qualitative differences in light.

Graber considers the above facts to be in accordance with the theory of evolution of special optical organs (eyes) from generalized ones (skin); as the reactions of these hypothetical dermal organs resemble those of the former, and their inferior activity is quite natural. This agreement favours the interpretation of the phenomena as due to an inferior degree of vision, and not to the results of thermal or chemical influences acting on the animals experimented on.

B. INVERTEBRATA.

Nerve-centres of Invertebrata.* —W. Vignal has examined the nervous system of various groups of the higher invertebrates and comes to the following, among other, conclusions :—

In the Crustacea the cells of the ganglia are nearly all unipolar, and almost always consist of a viscous granular substance, in which the nucleus is slightly and the nucleoli highly refractive. Bipolar and multipolar cells are also present. The nerve-fibres forming the connectives, the commissures, and the nerves have a proper wall, on the surface or in the interior of which there are oval nuclei; the inclosed substance is viscid and slightly granular, and contains a central bundle of fibrils, or the fibrils are isolated. The central nerve-chain and the nerves are invested in two sheaths, one of which is structureless, and appears to be of a cuticular nature, while the other is formed of imbricated lamellæ, which, in the macrourous crustacea, forms a partition in the connectives. The nerve-cells on the ventral face of a ganglion send off prolongations into its centre; this centre is formed of nerve-fibres, and of prolongations from the cells; the two are closely united and form a plexus whence the nerves are given off. The gastro-intestinal nerves are composed of fine fibres which have the same structure as those of the ventral chain. They form two plexuses, along which nerve-cells are to be observed.

In the Mollusca bipolar or multipolar cells are very rarely found among the cells of the ganglia, and this is especially the case in the Gasteropoda. The nerve-cells are formed of a ganglionic globe on the surface, and in the interior there are fine fibrils; among these are fine fatty granulations, which are sometimes variously coloured. The ganglionic globe, which has no investing membrane, contains a large nucleus and one or more nucleoli. The nerves and connectives are formed by fibres of very various sizes, which are separated from one

* Arch. Zool. Expér. et Gén., i. (1883) pp. 267–408 (4 pls.).

another by partitions developed from the sheath of the nerve. The fibres themselves are made up of fibrils which are inclosed in a slightly refractive and feebly granular substance. The myenteric plexus forms, along the digestive tube, a triple plexus, on the branches of which ganglionic cells are irregularly scattered. The centre of the ganglia is formed by a fibrillar substance and a slightly refractive body, which is of the same nature as the peripheral matter of the cells; the central fibrils have no definite arrangement; the nerves arise from the centre of them. The envelope of the nervous system is formed by a lamellar connective tissue, which is composed of fine fibrils. Among the cells of the ganglia a peculiar kind of connective cell was observed; this was oval, and contained a large nucleus; from the two poles of the cell long fibrils are given off.

In the Hirudinea all the ganglionic nerve-cells are unipolar; those of the gastro-intestinal system have the same essential structure but are not invested in a proper membrane, the sheath that invests them being part of that system which has been compared by Ranvier to Henle's sheath in vertebrates. The fibres that make up the nerves vary in size, and are separated from one another by thick partitions, and are composed of fibrils inclosed in a slightly granular protoplasm. The sympathetic system forms a double plexus along the digestive tube, and on its branches are developed ganglionic cells. The connective chain is formed by three nervous cylinders; no nuclei are to be seen either in the protoplasm of the connectives or of the nerves. No multipolar nerve-cells are to be found in the centre of the ganglia, as Walter and Hermann have imagined. The investment of the nervous system is a continuous sheath which is only open near the ends of the nerves.

The last group dealt with is that of the Oligochæta, and in it we find that the nerve-cells of the cerebral and ventral ganglia are mostly unipolar, and are formed of a viscous slightly granular substance. Near the homogeneous nucleus fatty granulations are to be found. Bipolar and multipolar cells are also to be observed, but they do not occupy any definite position. The nerve-fibres form the columns of the chain, have no proper walls, but are simply bounded by the partitions of connective tissue; these tubes are formed of a viscous and almost homogeneous substance, which is only feebly coloured by osmic acid; these fibres anastomose with one another.

The giant nerve-tubes are three in number, and extend along almost the whole length of the chain. The central, which is the largest, commences at the middle of the first ganglion, and the other two at the second; they end at the terminal ganglia. They appear to have no relation to the nerve-fibres.

The nerves have the same structures as the fibres of the columns.

The whole system (with the exception of the cerebral ganglia) is completely invested in three sheaths—epithelial, muscular, and structureless (of a cuticular character); the first and third are alone formed on the cerebral ganglia.

All the ventral ganglia give off three nerves on either side. The first is very sharply distinguished into two halves.

Tracks of Terrestrial and Fresh-water Animals.*—T. M'K. Hughes describes some peculiar markings on mud, the manner of formation of which he has been able to observe, and points out how they explain away difficulties which have arisen in the interpretation of certain fossil tracks, showing that some of the characters most relied upon to prove the vegetable origin of the fossil forms, such as branching, solid section, &c., could be produced by animals.

His observations were made on certain pits in the district about Cambridge which are filled with the fine mud produced in washing out the phosphatic nodules from the Cambridge greensand. As the water gradually dries up, a surface of extremely fine calcareous mud is exposed. This deposit is often very finely laminated, and occasionally among the laminæ old surfaces can be discovered, which, after having been exposed for some time to the air, had been covered up by a fresh inflow of watery mud into the pit. The author describes the character of the cracks made in the process of drying, and the results produced when these were filled up. He also describes the tracks made by various insects, indicating how these are modified by the degree of softness of the mud, and points out the differences in the tracks produced by insects with legs and elytra, and by annelids, such as earthworms. The marks made by various worms and larvæ which burrow in the mud are also described. Marks resembling those called *Nereites* and *Myrianites* are produced by a variety of animals. The groups of ice-spicules which are formed during a frosty night also leave their impress on the mud. The author expresses the opinion that *Cruziana*, *Nereites*, *Crossopodia*, and *Palæochorda* are mere tracks, not marine vegetation, as has been suggested in the case of the first, or, in the second, the impression of the actual body of ciliated worms.

Growth of Carapace of Crustacea and of Shell of Mollusca.†—A notice is here given of T. Tullberg's essay on this subject,‡ in which he states that the carapace of the lobster is formed by the subjacent cells, the outer part of which becomes directly converted into the hard covering; the striation is due to the fibres being imbedded in the fundamental substance; these fibres are formed by the cells at the time when the enveloping substance is deposited.

On the other hand, the shell of the Mollusca is, for the most part, a secretion from the cells of the mantle, but there is, in addition, a substance which in structure calls to mind the carapace of the lobster, where, too, the outer part of the cells gives rise to the shell-substance. The operculum of the whelk appears to be formed in the same way as its shell.

The researches have been carried on in too few species to justify any general conclusions, but if we take into consideration the great resemblance which obtains between all chitinous formations, it hardly seems rash to suppose that they are all formed like the carapace of

* Abstr. Proc. Geol. Soc. Lond., 1883, No. 443, pp. 10–11.
† Arch. Zool. Expér. et Gén., i. (1883) pp. xi.–xiv.
‡ In K. Svenska Vetens.-Akad. Handl., xix. (1882).

the lobster, while the great resemblance between the shells of Lamellibranchs and Gasteropods almost justifies the belief that their mode of formation is essentially the same.

Commensalism between a Fish and a Medusa.*—In a consignment from the Mauritius, G. Lunel found united *Caranx melampygus* and *Crambessa palmipes*. The fish stuck with the greater part of its body in the apertures which are formed by the four columns uniting the stomach with the nectocalyx, and traversed by the gastro-vascular canals. This union could not be explained by the hypothesis that the animal had sought out the other as its prey and means of nourishment. For the medusa belongs to a family which possesses no proper oral aperture, but only a series of microscopic pores, which can only take in very finely divided nourishment, and the fish had merely taken up his quarters in a natural hollow of the medusa, which was only enlarged, but in no way injured, by the long residence of the fish.

It was ascertained that the fisherman had taken the two animals together in that position; and that several years ago there had been seen on the coast, in a depth of about six inches below the surface, a fish of the same kind in conjunction with an anemone, and going in and out of it. The anemone into which the fish had entered was living, for it could be seen moving.

Lunel arrives at the conclusion that there are certain kinds of fish the fully grown individuals of which live at more or less considerable depths, whilst the young, either on account of an unknown peculiarity of their organization, or because they require a diet more congenial to their age, ascend with particular medusæ to the upper regions of the sea, to find there the countless small pelagic animals on which they and their hosts are nourished. It is noticeable that the fish, in order to enter the medusa, must swim upon its side, therefore in a very abnormal position.

Symbiosis of Algæ and Animals.†—K. Brandt states that the occurrence of yellow cells has now been observed in the following groups of animals:—Radiolaria, Anthozoa, Hydrozoa, Foraminifera, Flagellata, Ciliata, Spongiæ, Ctenophora, Echinoderma, Bryozoa, Turbellaria, and Annelida. He is able to add the following to the list of species in which they have been detected:—*Reniera cratera*, *Paralcyonium elegans*, *Aiptasia turgida*, *Echinocardium cordatum*, *Holothuria tubulosa* (larva), *Zoobothrium pellucidum*, and *Eunice gigantea*.

Besides yellow and brown algæ, others occur also in animals. Green algæ have been found in numerous rhizopods and infusoria, also in fresh-water sponges, hydrozoa, and turbellaria. Marine sponges also contain blue-green algæ, Oscillatorieæ, and red and red-violet Florideæ. Engelmann's researches on animal chlorophyll show that some modification must, however, be made of the conclusion at

* Fol's 'Recueil Zoologique Suisse,' i. (1883) pp. 65–74 (1 pl.).

† Pflüger's Arch. f. gesammt. Physiologie, 1883, pp. 445–54. Cf. this Journal, ii. (1882) pp. 241, 322.

which the author had previously arrived, that the occurrence of chlorophyll in animals is invariably due to the presence of inclosed algæ.

The yellow cells of different animals differ from one another very considerably in their structure; but all agree in possessing a chlorophyll-like pigment, a nucleus, and a starch-like product of assimilation. In almost all were found two different products of assimilation, viz. 1st, grains containing a vacuole, and therefore appearing like a ring in optical transverse section, never doubly refractive, always colourless or very pale blue, and coloured by pure iodine brown or violet, or, under certain circumstances, blue-violet; 2nd, compact granules, doubly refractive and of irregular form, of a reddish or violet colour, and not changed by treatment with iodine. The first of these is undoubtedly a substance allied to starch.

When large quantities of the green cells are carefully treated with filtered water, they usually assume the form of zoospores with two cilia at the anterior end; their pigments being still usually in the form of parietal plates, and having starch-grains in their interior.

Morphologically the yellow cells are very different from chlorophyll-bodies, and correspond to unicellular chlorophyllaceous algæ, while physiologically they behave altogether like chlorophyll-grains.

By a fresh series of experiments the author has confirmed the view previously held that the hosts or "phytozoa" make use, for their own nutrition, of the products of assimilation which the algæ obtain in excess through the influence of light.

Mollusca.

Skin of Cephalopoda.*—P. Girod regards the dermis of cephalopods as being essentially formed of connective tissue, the cells of which may become the centre for the formation of reticulated tissue, connective bundles, pigment-cells, or the so-called *iridocysts*. We find two strata, one formed of pigment-cells which are motile chromatophores, the other of iridocysts. The former is the most interesting, and has been very extensively studied. For its further comprehension it is well to distinguish the two constituent parts of the chromatophore: the *pigment-cell*, which is nothing else than the central spot, filled with coloured granulations, and the *radial bundles* which form a complete crown around the cell. The chromatophore, thus constituted, moves in a space which may be called the *peripheral space*.

The pigment-cell varies in size according to the degree of contraction or expansion of the chromatophore. The basal cell of the radial bundle is rounded during contraction, elongated and flattened during expansion. The fibres which make up the bundle approach one another during contraction, and separate on expansion. The interfascicular spaces are elongated during contraction, wider and flatter during expansion. Girod denies the contractile muscular nature of the radial bundles, and regards them simply as formed of connective tissue. It is clear, therefore, that, on this view, the

* Arch. Zool. Expér. et Gén., i. (1883) pp. 225–66 (1 pl.).

bundles cannot be regarded as taking any active part in the expansion of the chromatophores. Their importance lies in their being the agents for the fixation of the pigment-cells in the layers which they occupy. The contraction of the chromatophore is due rather to the elasticity of the capsule and the contraction of the basal cells; the expansion of the cell seems to be due to its protoplasm.

The layer of iridocysts is formed of a series of plates formed from the primitive connective-tissue-cells; they have a central nucleus, and are made up of a number of rods. Where the iridocysts are only arranged in one layer they are more closely packed.

In the developmental history of the layer of chromatophores the first point is the conversion of certain cells into pigment-cells; around these other cells become grouped; the intermediate cells then increase in number, or form fresh pigment-cells, and new "common cells," which, in their turn, are capable of proliferation. The pigment-cell, once constituted, grows rapidly, though the nucleus remains of the same size all through the period of growth. The limiting cells divide, and so increase in number till there are from twenty to thirty of them. The radial bundles are formed by the striation of the cells of the peripheral reticulum.

Development of Gills of Cephalopods.*—L. Joubin describes the gills of *Sepia officinalis* as commencing under the form of two small rods placed symmetrically in relation to the antero-posterior plane, and in the middle of what will become the posterior wall of the pallial cavity. The bud, which is primitively due to an outgrowth of the epithelial layer, soon elongates, becomes rounded at its tip, and attached by a wide base. The bud then flattens, and its hinder face becomes applied to the visceral mass, while the anterior is still covered by the mantle.

One and then a second fold, and afterwards others, appear on the bud, and these form depressions on one surface which correspond to elevations on the other. Although these folds increase in number they do not occupy the whole face of the young gill; along its edge there remains a space, and in the anterior of these an efferent vessel is developed, and in the posterior the special branchial gland.

Any one elevation may be regarded as a semicircle formed of three parallel arcs of cells. If these be fixed at their extremities, and if the arcs were to grow equally, we should soon have a large, deep, and more or less conical cul-de-sac. This is not, however, what happens. The cells of the median layer increase in number, and push forwards the epithelium of the convex surface, while that of the concave remains unaltered; the middle layer soon forms a stratum invested on either side by the convex epithelium; the cells of this stratum, which at first touched one another, soon become separate, and give rise to intermediate lacunæ and vessels.

Each of the layers thus formed gives rise, in its turn, to a series of transversely disposed elevations, which soon form hollow outgrowths, this time on either side. Finally, in the adult there is a

* Comptes Rendus, xcvii. (1883) pp. 1076–8.

third series of outgrowths, which do not appear till the embryo is about to leave the egg.

The efferent blood-vessel is early developed, occupies almost the centre of the organ, and is contained in the base of the layers and of the branchial gland. The efferent vessel is developed on the crest of the gill and on the outer edge of the layers just described; it has the same undulating course as the parts which carry it, and is, at the base of the gill, directly continuous with the auricle of its own side.

Further Researches on Nudibranchs.*—R. Bergh prints an important paper, illustrated by five plates, as a supplement to his monograph of the family of which *Polycera* Cuvier is the typical genus.

After a number of general notes on species and genera, among which is the description of *Ohola*, a new genus collected by the 'Challenger,' at Trapura, in the South Seas, the author considers the Doridida in general, with their divisions and probable phylogeny. The genus *Heterodoris* of Verrill and Emerson is considered as probably belonging to a different family. The Doridida are separated into two very well marked groups by the possession of a single large retractile crown of gills, or of numerous retractile branchia: Cryptobranchiata and Phanerobranchiata respectively. The latter, connected with the typical Doridida through *Staurodoris*, diverge in two lines, of which the more ancient forms are *Notodoris* and *Akiodoris*. The former culminates in *Placamophorus*, with *Ohola* as a lateral branchlet. The latter passes through *Acanthodoris*, *Goniodoris*, &c., towards *Ancula* and *Drepania*.

The phanerobranchiate, non-suctorial Doridida form the Polyceradæ (better Polyceratidæ) of Bergh, and the suctorial forms his Goniodoridida. A synopsis of the genera and species of these groups is given. They inhabit all seas, but are largest and most beautiful in the warmer regions.

Functions of the Renal Sac of Heteropoda.†—L. Joliet was able to notice on a living *Phyllirhoe* that the renal sac was folded, and that it opened slowly; this movement was clearly due to the action of the cilia of the pericardiac orifice. When the sac was full its own orifice opened slowly, remained visible for some seconds, and then disappeared. In the Firolidæ there is a system of external muscles, by means of which the renal organ may perform a true diastole. The author addressed himself to the problem whether the water taken in this diastole entered into the pericardium, or whether, on the contrary, water passed out from that cavity. The results of his observations of living forms were to convince him that the water which bathes the renal cavity does not enter into the pericardium, and that it is the function of the renal sac to extract liquid from the blood, to expel it to the exterior, but not to draw water from without to pass it into the blood. In fine, we must agree with the teaching of Lacaze-Duthiers, that an organ whose principal function is to secrete the products of

* Verh. Zool. Bot. Gesellsch. Wien, 1883. Cf. Science, ii. (1883) p. 748.
† Comptes Rendus, xcvii. (1883) pp. 1078–81.

excretion, cannot be well looked for in the course of currents which pass into the organism, but may be well sought for along a line of centrifugal currents.

Interstitial Connective Substance of Mollusca.*—J. Brock finds that the interstitial connective substance of molluscs is very ordinarily found in the region of the central nervous system, and of the great nerves and vessels lining the inner surface of the cœlom, and on and between the viscera; the amount present varies greatly in different species, being, for example, richly developed around the central nervous system of Opisthobranchs, though very sparsely so in Pulmonates; while the conditions are reversed when we come to examine the viscera. The author deals in detail with *Aplysia punctata*, *A. fasciata*, *A. depilans*, *Pleurobranchus* sp., *Pleurobranchæa meckeli*, *Helix pomatia*, *H. nemoralis*, *Limax agrestis*, and *Arion empiricorum*.

The observations of those who have studied the embryology of the Mollusca appear to make it certain that, in the later stages of their development, a large quantity of spindle-shaped or branched mesodermal cells are to be found in the cœlom; it is from them that, in all probability, the connective substance is derived. To connect the one with the other it is only necessary for a homogeneous intercellular substance to be secreted; by means of their processes the cells come into connection with one another, and so give rise to the network. Other cells increase in length and break up into fibrils, and thus the whole body becomes traversed by a connected network of nucleated bundles of fibrils, which are surrounded by a plexus of unaltered mesodermal cells. Yet other cells become altered in composition, and become filled with carbonate of lime or concretions of an indefinite character. If this be the mode of genesis of the interstitial substance the lowest conditions are to be found in the Opisthobranchs; the plasma-cells are exquisitely delicate bands in *Pleurobranchæa*, and large compact cells with sharp processes in *Aplysia punctata*.

With regard to the vexed question of the cellular lining of the cœlom Broch comes to the following conclusion: the Enterocœlia always have a peritoneal epithelium which is derived from the endoderm, and which, therefore, represents a true epithelium; the Pseudocœlia have either no (?) cœlomic epithelium, or a true endothelium (Mollusca) which is derived from the mesoblast and has the morphological value of cells of connective substance. This character may be distinctly retained, as in Opisthobranchs and Pulmonata, or may attain to a higher degree of differentiation, and taking on the form of a true epithelium obscure its original character, as in Prosobranchs (? all) and in Cephalopods.

Visual Organs in Solen.†—B. Sharp has been led to believe that *Solen ensis* and *S. vagina*, the common razor-shells, are possessed of visual organs, by observing that a number of these animals which were exposed in a large basin for sale in Naples retracted their siphons when his hand cast a shadow over them. Repeating the

* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 1–63 (4 pls.).

† Proc. Acad. Nat. Sci. Philad., 1883, pp. 248–9.

experiment at the Zoological Station, he became convinced that the retraction was due to the shadow, and not to a slight jar which might have been the cause.

Upon examining the siphon, he found as many as fifty-five blackish-brown lines or grooves between, and at the base of, the short tentacular processes of the external edge. When a vertical section of these pigmented grooves is made, the cells of which they are composed are found to be very different from the ordinary epithelial cells of the surrounding tissue. The pigment-cells are from one-third to one-half longer than the latter, and consist of three distinct parts. The upper ninth or tenth part of each cell is perfectly transparent, and is not at all affected by the colouring matter used in making the preparation; the second part is deeply pigmented and opaque, and forms about one-half the cell; while the remainder consists of a clear mass which takes a slight tinge when coloured. This portion contains a well-defined nucleus filled with granular matter, and is probably the most active part of the cell. These retinal cells, if so they may be called, resemble those of the very primitive eye of *Patella*. The value to the *Solen* of an organ which would enable it to detect the shadow of approaching objects as it lies imbedded in the sand, with the end of the siphon protruding, must be evident; and the structure of the cells described bears sufficient relation to those of the eyes in *Patella*, *Fissurella*, and *Haliotis*, to make it highly probable that they constitute true primitive visual organs.

Arthropoda.

a. Insecta.

Respiratory Centre of Insects.*—According to Dönhoff, the respiratory centre in the bee is situated in the anterior ganglia, and therefore the respiratory movements are put an end to by decapitation. Dr. O. Langendorff, from his investigations, finds that in the bee, wasp, and other insects, the respiratory movements are not destroyed by removal of the head, especially when by *tearing*, and not *cutting* it off, a great loss of blood is avoided; the respiratory movements show the same increased rapidity with a high temperature, slowing with a low temperature in the headless insect as in the uninjured insect.

A number of experiments were also made upon *Libellula depressa* and other insects belonging to the Pseudoneuroptera, in which group the segmentation of the body is very marked in correspondence with their ancestral type; in these insects the respiratory centre is not merely not localized in the head, but each segment is a complete centre in itself, being capable of respiratory movements when entirely isolated. "A better example to illustrate the physiological metamerism of the insect body can hardly be imagined; each segment with its ganglion is a physiological unity!" The results of a great number of observations are fully stated in the paper, and several diagrams are given of tracings obtained of the respiratory movements.

* Arch. f. Anat. u. Physiol., 1883, pp. 80-8.

Chordotonal Sense-organs and the Hearing of Insects.*—In a long and elaborate account of this subject, including numerous fresh observations, Prof. V. Graber describes under the above new designation the rod-like terminal secretory structures of the nerves of certain parts (chiefly legs or wings) of insects. The general type of rod is distinguished as *Scolopal*, or pencil-like, being pointed at the proximal end; this form is always hollow, and its walls are extraordinarily refractive. In general, an insect has but one form of these rods. Two subordinate forms are distinguished: (*a*) *Mononematic* and (*β*) *amphinematic*, according as the distal end is, or is not, pointed like the proximal; in the mononematic the distal end runs out into a slender filament. Mononematic rods may be either (*a*) *conocephalic*, with conical heads (larva of *Tabanus*, of *Tortrix* sp., Orthoptera and some *Formicidæ*); (*b*) *Apiocephalic* (a Phryganid-larva), head blunter; (*c*) *Conacocephalic*, truncate-conically headed (*Dytiscus*, some *Chironomus* larvæ, &c.); (*d*) *Cylindrocephalic*, head of equal diameter throughout (a saw-fly larva).

The amphinematic form of rod occurs in *Corethra*, larva of *Syrphus*, *Pediculidæ*. The fine distal process is to be regarded as the termination of the head of the rod, and not as a prolongation of the nerve-fibre. An essential difference between the amphinematic and mononematic rod is that, in the former, the nervous axial filament is firmly fixed or stretched within the cavity of the rod, while in the latter its distal end lies loose in the liquid which this cavity contains.

In the "scolopophors," or tubular end-organs of the chordotonal nerves, the "chord" of the rod is a prolongation of an axial process of the basal ganglion-cell. The usually compound masses of these organs vary greatly in the number of units contained in them; from occurring singly in *Tabanus* most *Chironomi*, they may number upwards of 100 (tympanal organ of *Acrididæ*) or 200 (some "poriferous" organs) in the same sense-organ; where they are few in number they are commonly very intimately connected, so that in some cases the contours of the different tubes are almost invisible (*Corethra*, *Ptychoptera*, *Tortrix*, *Syrphus*, &c.). In some genera (*Corethra*, &c.) the chordotonal organ of each segment is fastened to the integument by a special "ligament" consisting of a thin-walled tube in continuation with the sheath of the nerve, and filled with a homogeneous and slightly granular mass, and extending in a direction opposite to that of the chordotonal organ itself.

Of the general positions in which these organs occur, Graber states that the typical forms are always extended from one relatively immobile point of the integument to another; e. g. any one of the organs is wholly contained in one segment, and never invades the bands connecting the segments; they also show a tendency to have as great a length as the available space will admit of, and to maintain a relatively superficial position. They are as widely distributed among insects as the optic and tactile organs, in proof of which tables are given, deduced from observations (chiefly by Graber) made on upwards

* Arch. f. Mikr. Anat., xx. (1882) pp. 506-640 (6 pls.).

of sixty genera belonging to all the orders. These tables show further that their most usual seat is the hind-wings or halteres, the next the fore-wings; the legs are more often thus employed in the lower orders (*Hemiptera*, *Neuroptera*, and *Orthoptera*) than the wings.

As regards their phylogeny, Prof. Graber considers the serially arranged organs to have been derived from an original dispersed condition, and the simplest scolopoferous forms from nerve-endings devoid of rods.

The physiological division of Prof. Graber's work* leads up to the conclusion that the function of these organs is probably auditory. Sounding a loud note on a violin not far from a specimen of *Blatta germanica* engaged in walking across the floor, is followed by the immediate cessation of the movement; this may be repeated several times with a like result if the intervals between the notes are not too short. With specimens placed in a wide glass vessel the same thing occurs; a *Blatta* deprived of its eyes, and suspended by one leg and allowed to become quite motionless, manifested great excitement, jerking itself upwards, on a loud note being sounded on a violin at about a metre's distance. *Coccinella* behaves similarly, but in a less striking manner. Of water-insects, Graber finds that *Corixa* darts wildly about when the edge of the glass side of the aquarium is tapped with a glass rod; further experiments show that mere mechanical vibration is not the cause of the movement, but that it is due to pure sound. Important evidence was obtained as to the *quality* of sound audible to these insects; for neither did a loud but deep toned hand-bell sounded outside the aquarium, nor the lower notes of a violin, produce much result, but the notes E to D, &c., on the latter instrument always increased in the most striking manner the number of water-bugs aroused. The water-beetle *Laccophilus* is most readily excited, and in great numbers; *Dytiscus marginalis* and *Nepa cinerea* also reacts strongly to loud sounds. On the other hand many aquatic larvæ, especially *Ephemeridæ*, exhibit no distinct perception of sound, though remarkably sensitive to mechanical agitation of the surrounding medium. Variations in the intensity of sound may be demonstrated to be perceptible to insects.

Facts such as the great manifest sensitiveness of many insects to the grasshopper's chirp, too great to be explained as due to tactile sensation, militate against the hypothesis that the sense involved is merely tactile. Comparison of the structure of the tympanal chordotonal organs with that of the vertebrate ear leaves it probable that the former have acoustic properties; in the Gryllidæ the tympanum and auditory meatus are both represented (the latter by tracheal tubes, the former by a peculiar enlargement of the trachea), the organ of Corti is of course represented by the scolopoferous and other chordotonal nerve-endings already described; they exhibit a considerable variety in the amount of their sympathy with the movements of the tympanic organs in the different cases.

The primitive forms of chordotonal organ appear to have the

* Loc. cit., xxi. (1882) pp. 65–145.

same function as the more highly evolved. It is a fair inference from the nature of the materials composing these organs in insects that they are capable of transmitting vibrations of a high degree of rapidity. To certain objections to the acoustic theory of the functions of these organs it is replied that experiments show that this function in insects is not exclusively owned by the brain and the head, but that the perception of auditory sensations has its seat also in part in the ventral ganglia.

A. B. Lee * has also examined these organs in a number of Dipteran larvæ. He finds that, as a rule, there is one compound (polyscolopic) and one simple (monoscolopic) organ in each segment; they are always arranged in a bilaterally symmetrical manner; the number of elements in the compound organ is generally 3, but may be 2, 4, or 5. In opposition to the received view that the nerve-endings are rod-like bodies, consisting of body, head, and point of apex, the apex ending in a chord and the body being traversed by an axial fibre which is the termination of the axial fibre of a ganglion, Lee finds that there is no "apex" to the body, and that the "chord" of Graber's paper is a complex, not a simple termination of a ganglion-cell, that the axial fibre does not belong to the chord, and that the whole rod is to be regarded as a capsular investment of a swollen nerve-ending, and not as the nerve-ending itself. The appearances of "apex" and "chord," so often seen, are produced by certain conditions of the tubular wall, termed by Lee "apical tube," which is continued beyond the ends of the rods, hence the chord is made up of an axial fibre and an apical tube; this is the case with all the auditory rods examined. The axial fibre ends in a hollow bulb at the distal end of the head of the rod in the larva of *Simulium*. The head of the rod consists of two segments in all examples which were studied, the proximal division having the form of a truncate cone, the distal that of a perfect cone; the alleged cylindrical and conacoid forms appear from experiments to be due to imperfect resolving power in the Microscope employed; or, in the case of the conacocephalic form, to a delicate membrane which bridges over and conceals the angle between the body and its shoulder. Lee comes to the conclusion that what Graber describes as distal prolongations of the heads, from which the ideas implied in amphinematic and mononematic are derived, have no real existence, but that the appearance is produced by the lumen of a tube prolonged forwards from all around the head, and attached distally.

Number of Segments in the Head of Winged Insects.†—The statements concerning the number of segments which form the head of insects are very conflicting; thus, while Burmeister only recognizes two, Strauss-Durckheim allows as many as seven. Dr. A. S. Packard, jun., from the study of the embryos of a great many types, considers that four segments are always to be found, the appendages corresponding to these being the antennæ, mandibles, first maxillæ,

* Loc. cit., xxiii. (1883) pp. 133–9 (1 pl.).
† Amer. Natural., xvii. (1883) pp. 1134–8 (1 fig.).

second maxillæ (labium). The clypeus and labrum, however, remain to be accounted for, and probably represent the tergal portion of the antennary segment, the procephalic lobes forming its pleural portion; these latter become the epicranium of the adult; hence the head of an adult insect is chiefly made up of the first, or antennary segment. The so-called "occiput" is shown to be the tergal portion of the fourth or labial segment; it generally disappears in the adult, or becomes soldered to the epicranium, but remains in *Corydalus* (a Neuropterous insect) as the base of the head.

The remainder of the original segments are obsolete, and take no part in the formation of the epicranium in the adult.

Protective Device employed by a Glaucopid Caterpillar.*—It is well known that many caterpillars, e. g. those of the Arctiidæ, interweave their prickly hairs with their cocoons, thus not only rendering the latter stronger and thicker, but also furnishing a kind of protection in those species in which the hairs have an urticating power. A novel and ingenious method of utilizing its hair for the protection of the chrysalis is that employed by the larva of *Eupomia Eagrus*, as described and figured by Dr. Fritz Müller. Around the slender twig to which it intends to fasten its chrysalis, the larva constructs from its hairs, before and behind itself, a series of whorls, about six in number, the hairs in each whorl being vertically and very densely fastened to the twig. The inside whorls are so fastened that they incline over the head and tail ends of the pupa. Between these two formidable rows of palisades the pupa rests safe from the attacks of any small and unwinged enemy.

Formation of Honeycomb.†—It is well known that the cells of honeycomb afford the largest possible space and the greatest strength with the least possible expenditure of material; but the subject has not been properly investigated in a scientific manner. The earlier researches of Maraldi and others at the commencement of the eighteenth century showed that each cell in the honeycomb of bees consisted of a six-sided column bounded in the middle layer of the comb by a three-sided pyramid, and that the sides of the cells in the deepest portion form with each other angles of 120°, and the mathematical relations of the angles and sides of the cells to one another were investigated. The actual way in which the bees form the cells has been closely observed by Dr. K. Müllenhoff.

A number of the insects, at least a dozen on each side, commence to form the comb, and they are so arranged as to be exactly opposite one another; by mutual pressure therefore the lump of wax which each bee carries in its jaws becomes pressed out to form a plate; each bee, however, avoids coming into contact with the bee in front, and therefore the middle lamella of the honeycomb gets to be formed out of as many pairs of parallel trapezes as there are bees on each side. In a similar way the whole process of building the honeycomb was observed, and the observation showed clearly that the wonderful complexity and mathematical accuracy of the whole structure was not in

* Kosmos, xii. (1883) p. 449 (figs.). Cf. Amer. Natural., xvii. (1883) p. 1289.
† Pflüger's Arch. f. gesammt. Physiol., xxxii. (1883) pp. 589-618.

the least owing to the development of a high instinct in the bees, but simply to physical laws dependent upon the position assumed by the workers and to the shape of their body and the plasticity of the wax. The cells of the comb are in reality circular, and in those species of wasps and bees which form but a single cell remain circular; the prismatic shape of the cells of a complex honeycomb is simply owing to the mutual pressure of the adjacent cells and is strictly analogous to the formation of cylindrical prismatic soap-bubbles by mutual pressure.

We remember to have seen this explanation before, though we cannot now fix the reference.

Mouth-Organs of Rhynchota.*—O. Geise regards the flattened or more or less curved process of the clypeus of the Rhynchota as the homologue of the labrum of beetles; the jointed groove corresponds to the labium, the two separable setæ to the mandibles, and the two, only with difficulty separable, setæ to the maxillæ of biting insects. He next considers the structure which Savigny regarded as the ligula, but to which most authors have applied Burmeister's name of "Wanzenplatte"; he himself proposes to speak of it as the pharynx, and describes it as being endowed with great elasticity, and as acting as a pump, which is set in action by the contraction of muscles attached to the body-wall, whereby the space in the walls in which they are inserted is enlarged, and a vacuum thereby formed. The structure and relations of these parts are entered into in great detail, but a full abstract of the paper would be impossible without a republication of the figures to which constant reference is made. The essay should receive the careful study of students of the anatomy of insects.

Development of Genital Organs of Insects.†—A. Schneider is here reported as concluding that a muscular fibre from the heart serves as the point of origin of the genital organs of insects; this may be best demonstrated by the larva of *Coretha plumicornis*, where a fibre belonging to the *alæ cordis* gives off a branch which passes backwards and ends at the intestine; a little way from its origin this fibre swells out and becomes provided with a large number of nuclei; at a later stage these nuclei may be seen to belong to two sets differing in size; the largest are surrounded by a layer of protoplasm and become the independent cells of the "primitive ova."

In the viviparous *Cecidomyiæ* there are ova which, like those of other insects, segment and undergo further development; these are never found in the ovarian sacs. In the rest of the Diptera and in all other insects the primitive ova give rise to ovarian culs-de-sac. In the Culicidæ each primitive ovum gives rise to a sac in which only one definite egg is found.

When a primitive ovum is transformed into an ovarian sac, the nucleus divides, one half becomes much larger and goes to form the nucleus of the egg, while the smaller undergoes division and forms a kind of follicle; some of the small nuclei increase in size and become eggs, and in this way moniliform sacs are formed.

* Arch. f. Naturg., xlix. (1883) pp. 315–73 (1 pl.).
† Arch. Zool. Expér. et Gén., i. (1883) p. xlvii.

Genital Ducts of Insects.*—J. A. Palmen has here a preliminary note of his investigations into the comparative anatomy of the efferent ducts of the sexual organs in insects.

He commenced with the Ephemeridæ which are, among insects, remarkable for having the ducts paired, and that not only in all the larval but also in the imaginal stages, and in both sexes. In the males the two vasa deferentia extend, independently of one another, as far as the ventral side of the ninth segment, where there are placed the appended copulatory organs; these the ducts traverse and open at their tip or at the side. These appendages may be either almost separate, or be more or less fused at their base; in only one species examined was there any transverse connection between the ducts. In younger larvæ the vasa deferentia are delicate cords along which are placed the sperm-producing glands; in older larvæ the sperm is collected into the cavity of these cords, the walls of which become enlarged, while the ducts have here the function of vesiculæ seminales; the distal portion of the cord remains narrow and acts as an ejaculatory duct.

In the female the two oviducts are also independent and open between the seventh and eighth segments; the fold in which the orifices are placed has the chitinous layer of the body continued into it, and this extends as far as the orifices of the oviducts. At first delicate, the ducts become enlarged as the ova pass into them, and an organ of uterine appearance is developed proximally, and a vagina distally. On the whole it would seem to be clear that the Ephemeridæ represent, so far as their sexual organs are concerned, a very primitive type of organization.

An examination of the structure and descriptions given of the structure of the male organ in several species of Orthoptera and Trichoptera seem to show that the unpaired ductus ejaculatorius of these insects is morphologically an invagination of the integument of the body. In the larvæ of *Corethra* the two testes are attached to the integument by two cords, and in *Chironomus* there is much the same arrangement. During metamorphosis certain parts of the hindermost abdominal segments are reduced and others increased in size; in consequence of this the points of insertion of the cords —that is of the orifices of the vasa deferentia—pass inwards, and this part of the integument becomes unpaired. In the Forficulinæ the azygous condition of the terminal portion of the male sexual ducts is due to the development of an internal transverse connection between the vasa deferentia, and the consequent reduction of one of the two terminal portions, In this case, then, the unpaired ductus ejaculatorius and the vesicles arise from the primitive vasa deferentia and not from the integument.

In the Perlidæ, which stand close to the Ephemeridæ, we find that the oviducts open close to one another at the base of a median unpaired vagina. Chitin invades this last, and here we have an unpaired vagina which is, morphologically, a differentiated interseg-

* Morphol. Jahrb., ix. (1883) pp. 169–76.

mental fold, and, therefore, a derivate of the outer integument of the body. This process of differentiation in the Perlidæ may be regarded as typical of several groups of insects, complications notwithstanding.

The generative organs of insects may, therefore, be regarded as formed from two elements which are morphologically distinct—the primitively internal paired structures (testes and vasa deferentia, ovaries and oviducts) and tegumentary structures. In the least differentiated groups (as in lower animal forms) the latter are only represented by the genital orifices, and, consequently, the whole apparatus is paired. The paired parts may become secondarily unpaired in four different ways—there may be the invagination of a common tegumentary portion, or the internal ducts may anastomose and fuse proximally to their origin, or these two processes may take effect together, or, finally, one of the symmetrical parts may become superfluous and reduced.

Thoracic Musculature of Insects.*—C. Luks investigated the thoracic musculature of insects of every group, except, unfortunately, the Thysanura and Collembola. He finds that the wing-muscles appear to have developed along two lines; in one, the indirect flying muscles were almost completely aborted, while in the other they were developed at the expense of the direct muscles. In close connection with the development and modification of these muscles is the extent of concentration of the rings of the thorax and the size of the wings. In the Orthoptera all the three segments of the thorax are freely movable on one another, while in the Coleoptera only the prothorax is so movable. In the Lepidoptera the prothorax loses its mobility, though retaining its distinctness, while in the Diptera and Hymenoptera the whole region is converted into a firm thoracic apparatus, to which, in the latter, the first abdominal segment also becomes applied. As Graber has shown, we observe that in insects which, by other points in their organization intimate that they are more highly developed, one pair of wings tends to become aborted, as is seen in the Coleoptera, Diptera, and even Lepidoptera where the hinder pair of wings often become united with and share in the movement of the anterior pair.

Early Developmental Stages of Viviparous Aphides.†—L. Will, after noticing the results of earlier observers, comes to his own observations on the development of the ova; to examine the ovaries a fresh individual was opened on the slide in a weak salt solution, or in iodized serum; acetic acid was occasionally added, but this is a reagent which must be used with caution. Water at about 70° C. was found the best killing agent. Sections were largely made, and these were coloured with borax-carmine and hæmatoxylin.

The common oviduct opens on the ventral surface and in the median line, a little in front of the anus; as is well known, the seminal vesicle and cement-glands which are present in the oviparous are wanting in the viviparous forms. Connected with the oviduct by special canals are a number of ovarian tubes, the walls of which

* Jenaisch. Zeitschr. f. Med. u. Naturwiss., xvi. (1883) pp. 529–52 (2 pls.).
† Arbeit. Zool. Zoot. Inst. Würzb., vi. (1883) pp. 217–58 (1 pl.).

terminate in a filamentous process, which enters into connection with the similar filaments of the neighbouring tubes.

The tubes are camerated internally, and this cameration is obvious from without owing to the contraction of the outer walls; the wall of the tubes is formed by a distinct unilaminate epithelial layer; like Brass, the author was unable to detect any *tunica propria;* in the region of the oviduct the epithelial is invested by a muscular layer. At the other end, the terminal chamber of a mature ovary consists of two closely connected parts; in the inner one there is a homogeneous mass of protoplasm and then a number of cellular elements which fill up the space between the central protoplasm and the investing epithelium; both in position and structure these cells present the same appearance and relations as the yolk-forming or nutrient cells of oviparous Aphides; the central protoplasmic mass which they surround may be spoken of as the rachis. Like the young egg, these cells are without a membrane.

In the lower portions of the ovarian duct the flattened are replaced by cylindrical epithelial cells, and here large cells, which are young ova, are to be detected; the resemblances between these and the ova of oviparous forms is insisted on; we may indeed sum up the matter in saying the egg is attached to the central rachis by a stalk. The characters of the ova in succeeding chambers are pointed out, and attention is given to the fact that every two chambers are separated by a layer of cells formed by a thickening of the epithelium, and that there is in the centre only space sufficient for the passage of the connecting cord.

The function of the ovarian stalk is discussed, and the result is come to that the ova grow by their own power of assimilation as well as in consequence of the assimilative power of the stalked rudiments; it seems to be clear that there is a streaming of the protoplasm which passes from the young ova through their stalk into the rachis and then through the cord of connection to the egg; it follows from this that the stalked cells of the terminal chamber must be regarded as rudimentary ova; they are not as Ludwig thought, nutrient cells, but true "Eianlage."

The author next passes to an account of the formation of the blastoderm, and he finds that in the viviparous Aphides the germinal vesicle does not disappear, but is directly converted into the first cleavage-nucleus. The first two spheres are only incompletely separated from one another; after this, fissive processes take place with great rapidity, and there appear to be no stages of repose. While the earlier divisions are being effected the egg increases greatly in size, and gradually becomes altered in form, exchanging its spherical for an elongated appearance.

The views and accounts of Brandt, Leuckart, and Brass are carefully reviewed.

Chlorophyll in Aphides.*—L. Macchiati having noticed that certain Aphides when placed in a dark situation lost their colour in

* Bull. Soc. Entomol. Ital., 1883, pp. 163-4.

the same way that leaves do, investigated two species, *Siphonophora malvæ* and *S. rosæ*, with a view of ascertaining whether they contained chlorophyll; he discovered by applying the usual tests that chlorophyll was undoubtedly present; the objection that this substance is absorbed from plants by the insects and not elaborated in their own bodies, is met by the statement that it is also to be found in those species that live upon the coloured petals of flowers. The conclusion arrived at needs to be confirmed "by a more matured study," and M. Macchiati promises a fuller investigation of this interesting discovery.

γ. Arachnida.

Testis of Limulus.*—W. B. S. Benham describes the testis of *Limulus*. The organ consists of two lateral and a median network formed by ramifications and anastomoses of the vasa deferentia; on the walls of these ducts are situated the sperm-sacs, sometimes singly but more usually in groups; in the latter case the sacs communicate with each other and only one opens directly into the duct; the sacs contain groups of spermatozoa without tails, the latter being apparently developed within the ducts themselves; occasionally the sperm-sacs were situated at some distance from the ducts and no ductule could be traced from them; it is possible therefore that they are not formed as diverticula of the spermatic duct, but originate independently, and only acquire a secondary connection with it. The chief point that is dwelt upon in the paper is the branching and anastomoses of the spermatic duct; this fact lends strong support to Lankester's views concerning the close relationship between the Arachnida and *Limulus;* for in no crustacean is there any such network formed by the spermatic duct, whereas it is a constant character of the Arachnida.

Polymorphism of Sarcoptidæ.†—E. L. Trouessart and P. Mégnin have a note on the sexual and larval polymorphism of the plumicolous Sarcoptidæ. The species belong to the subfamily *Analgesinæ* which is divisible into the three groups of *Pterolycheæ*, *Analgeseæ*, and *Proctophyllodeæ;* in the two former the fecundated females, after their last ecdysis, have the abdomen entire and not lobed, but in the third the adult females have, at the end of the abdomen, two conical chitinous prolongations; a study of exotic forms shows that in nymphs and larvæ the abdomen is bifid. In one preparation, the male, even after the development of its generative organs, was seen inclosed in the transparent integument of the nymph with a forked abdomen; this, according to ordinarily received ideas, would lead us to think that the male emerged from the skin of a female.

The form, therefore, with a forked abdomen, is not sexual but larval, and we have here only another example of the law that female Sarcoptidæ retain more or less the form of the nymph, while the males take on a different appearance.

A still more remarkable polymorphism was observed in the males

* Trans. Linn. Soc.—Zool., ii. (1883) pp. 363–6.

† Comptes Rendus, xcvii. (1883) pp. 1319–21.

of a Pterolychid which may be distinguished as *Bdellorhynchus polymorphus*, which lives on such Anatidæ as *Erismatura*, *Querquedula*, and *Spatula:* while some of the males have the normal rostrum, others have the hooklets of their mandibles disproportionately elongated; in form these mandibles vary greatly; and indeed it is only the hinder part of the body which is normal and identical in these two sets. The genital organs are similar, but the copulatory cupules seem to be a little better developed in the normal males. Figures of the forms here noticed will be published.

δ. Crustacea.

Spermatogenesis of Podophthalmate Crustacea.*—G. Hermann finds that the testicular cells of podophthalmate Crustacea give rise to spermatoblasts, each of which becomes a spermatozoon. As in the Vertebrata, the formation of these commences by the appearance of a "cephalic nodule" in the spermatoblast, which becomes converted into a transparent vesicle, which gradually grows spherical. At the anterior pole of this vesicle there soon appears a kind of outgrowth of the wall which projects into the cavity; a short time afterwards a delicate rod appears at the opposite pole. These two outgrowths elongate, and, uniting, form a "central column" which extends from one to the other pole of the "cephalic vesicle." In the brachyurous Decapoda the vesicle generally becomes bell-shaped, the nuclear substance forms a kind of hemispherical cap, from the edges of which are emitted a number of filiform prolongations, varying in number and size. In this way the so-called radiate cell is produced. The body of the spermatoblastic cell seems to disappear very early.

In most of the *Macroura* the cephalic vesicle elongates, and a collar of opaque homogeneous substance is developed; this is at first circular, but soon becomes triangular, while the three angles are drawn out into filiform rigid prolongations. The fundamental phenomena appear to be constant, but the definitive form of the cephalic vesicle varies in various species. *Astacus fluviatilis* resembles the *Brachyura* by the possession of a number of prolongations.

It is to be noted that, in consequence of a kind of gradual condensation of their substance, the adult spermatozoa are smaller in size and often also simpler in structure than the transitory forms which appear in the course of their development.

It is possible that the great differences in the details of the structure of spermatozoa may throw some light on the zoological affinities of their possessors.

American Isopoda.†—O. Harger has a report on the Isopoda collected by the 'Blake'; though the number of species is small the collection was interesting for the large proportion of forms either new or not hitherto known from the American coast, while others have been only imperfectly described. *Cirolana impressa* and *Rocinela oculata* are the two new species.

* Comptes Rendus, xcvii. (1883) pp. 958–61.

† Bull. Mus. Comp. Zool. Camb., xi. (1883) pp. 91–104 (4 pls.).

New Host for Cirolana concharum Harger.*— S. Lockwood announces the discovery of this isopod in the interior of the edible crab, *Callinectes hastatus* Ordway. The crab was an adult female, and the parasites were crowded in the left side of the carapace. Incredible to say, there were twenty-three full-grown specimens, measuring 3/4 in. by about 1/4 in. each. The ovaries and the tissues on the left side were completely honeycombed. How long the animal could have lived, and what its real sufferance of pain was, are questions. But with these predaceous wolves, literally consuming its inner parts, it surely would soon succumb. It seemed to Mr. Lockwood that they must, when in the swimming larval state, have entered near the eye-stalks of the crab, which, with a large catch of others, was taken at the close of February in Raritan Bay, N.J. From the size of the parasites, it would seem that they had been in possession some three months. The determination of the isopods was due to Mr. O. Harger. The query how so large a number could have entered the same place, and at the same time, he thought was met by the supposition that the crab had found a nest of the larvæ, and was feeding on them, when a part of the batch entered the host, as conjectured above.

Copepoda Entoparasitic on Compound Ascidians.†—Prof. A. Della Valle finds three Copepoda in the compound ascidians of the Bay of Naples. The most abundant species are *Doroyxsis uncinata* and *Enterocola fulgens;* the first-named is found in the branchial sac, the second only in the stomach. For the third form is established a new genus, *Kossmecthrus*, distinguished by the form of the mouth-organs and by the dorsal position of the third pair of legs; the two legs of the fourth pair show a marked asymmetry; it occurs in the branchial sacs of the ascidians. Della Valle considers that *Enterocola* and the new genus should form types of two new families.

Anatomy and Physiology of Sacculina.‡— Y. Delage states that *Sacculina* is composed of two parts, one external and the other internal; the latter is made up of tubes and of a basilar membrane. This membrane forms a kind of flattened sac invested by a delicate chitinous layer, which is continued on to the tubes. Its walls are formed by a layer of large cells, which, in their deeper parts, separate into ramified filiform prolongations. The whole cavity of the sac is occupied by cavernous tissue, which is formed of cells converted into fibres; these ramify and anastomose abundantly.

The part which is external to the crab-host is enveloped in a sac which has been improperly called a mantle, and which serves to bound the incubatory pouch, and to protect the visceral mass. In its walls there is a close plexus of striated muscular and a layer of connective fibres; at the point of insertion of each of these latter there is a large nucleus—the nucleus of the cell which formed the fibre.

* New Jersey St. Micr. Soc., meeting March 19, 1883. Cf. Science, ii. (1883) p. 664.

† Atti R. Accad. Lincei, Trans., vii. (1883) p. 180.

‡ Comptes Rendus, xcvii. (1883) pp. 961–4.

From the extremity of its sucking tubes as far as the superficial boundary of the body the *Sacculina* is traversed by a system of lacunæ in which there circulate the liquids taken in by the tubes and which forms a rudimentary digestive and incubatory apparatus.

Some of the spaces between the muscles of the visceral mass are occupied by sinuous tubes which are filled with ova, and are invested by the general endothelial layer. The ovaries open into the incubatory pouch, not far from the cloaca. There are two testicles, one on each side of the middle line, which open into the bottom of the pouch.

The nervous system is formed by a single ganglion which is situated in the visceral mass, near the cloacal end; this end, therefore, is the cephalic or upper one, and not the lower, as has been ordinarily supposed. This ganglion has the form of a four-rayed star, whence four chief nerves are given off; the two upper ramify in the muscular layer, giving off an important branch to the cloacal sphincter. The two lower pass to the visceral mass, some dividing into two branches, one of which innervates the muscular layer of the envelope, and the other the transverse muscular layers.

Two or three days after a *Sacculina* has set free its *Nauplius* it gives off some more ova; the chitinous layer which clothes the incubatory pouch undergoes ecdysis and passes out by the cloacal orifice. A new layer is formed, a number of ramified chitinous tubes escape from the oviduct, to the base of which they remain attached. The ova are now driven into and fill these tubes, which later on become detached and remain in the incubatory pouch till the ova are matured. The eggs are fertilized in the ovary.

In a second note on *Sacculina*,* M. Delage has some observations on an internal stage in its development; he finds that an early period is passed by the parasite within and not without the body of the crab; it is there found in a completely developed state, having its generative organs and its nervous system completely developed; and it is only when it grows larger that it changes its position. At the moment when it does so the orifice of its cloaca is closed and completely surmounted by a delicate chitinous membrane; a little later this breaks, and young Cyprids make their way to the periphery of the cloaca, where they become attached. All young Sacculinæ have Cyprids fixed to their cloaca, and these, therefore, as Fritz Müller supposed, play the part of complemental males.

In a third note† M. Delage considers the development of the *Cypris*; he finds that the young leave the incubatory pouch of the Sacculina under the *Nauplius* form. During the five ecdyses that take place in the next four days the two pairs of biramose appendages are lost, and the *Cypris* with its six pairs of limbs, its fixing organ, antennæ, and internal spherical mass of small cells, becomes developed. For three days or more the *Cypris* swims about freely; it then, either during the night or at some dark spot, attaches itself to young and very small crabs; this fixation is always effected by one of its antennæ, is always on a hair of the body, and is never on the ventral

* Tom. cit., pp. 1012–4.
† Tom. cit., pp. 1145–8.

surface of the crab. After it has become fixed it undergoes a marvellous metamorphosis, becoming an elongated sac, in which little of the *Cypris* is left save the outer integument and the spherical mass of cells. A dart-shaped body is now developed at the antennary pole, which is driven into the tissues of the crab; to this dart the cellular mass is appended, and it, therefore, makes its way into the body of the host.

The author believes he has shown that all that forms the adult *Sacculina* arises from the nucleus of the internal *Sacculina*, and that the basal membrane with its tubes arises from the sac which contained it. The wall of this sac represents the integument of the *Nauplius* or *Cypris*, and the nucleus the cellular mass contained in its body. We find, then, that the portion of the parasite interior to the crab represents the skin of the larva, the external portion a genital nucleus, which pierces its own investment and the integument of its host.

It is proposed to use in place of the term *Rhizocephala* that of *Centrogonida*, in reference to the dart-like organ of reproduction, and to form of them an order distinct from the Cirripedia.

On this communication Professor Lacaze-Duthiers made some remarks:* he insisted on the observations as demonstrating the advantage and necessity of experiment in zoology. As to the infectivity of young as compared with older crabs, he reminds us of the differences between young and old human beings in their receptivity of the poison of typhoid fever. The idea that the *Sacculina* fixes itself to the interior of the crab must be given up, and the animal not regarded as an ectoparasite, like a tick for example, but as first entoparasitic and then forming a true hernia, developed within and only passing outside the body to allow of the growth of some of its organs.

He concludes as follows: "If, in the eyes of some naturalists, zoology is a purely descriptive science, it ought in many cases to be experimental, so as to avoid the errors which are inseparable from a study made at a limited point of time in the existence of organisms. Our knowledge of development, which has been revealed to us by experiment, will alone allow us to have an exact appreciation of relations which are obscure and difficult of detection. It is for such an object that we must distinguish between a zoology which is purely descriptive and one which is experimental."

Vermes.

Classification of the Phyllodoceidæ.†—G. Pruvot has especially devoted his attention to the nervous system of these annelids, and commences his note with an account of the arrangement found in *Phyllodoce laminosa*. One of the results of the investigation is the demonstration that the segment which carries the last tentacular cirrus does not differ essentially from the normal setigerous segments.

* Comptes Rendus, xcvii. (1883) pp. 1148-51.
† Ibid., pp. 1224-6.

Although authors do not agree in their views as to the anterior appendages of the body, it is always possible to distinguish dorsal from ventral tentacular cirri: the latter cannot be taken note of in the formation of generic divisions, inasmuch as they insensibly change in form from below upwards; on the other hand the anterior dorsal cirri are subulate, and differ sharply in form from those which succeed them.

The Phyllodoceidæ, then, are best divided into two groups, one with five, the other with four antennæ; in each group there are forms in which the first three dorsal cirri are subulate, and others in which two only have that form. In the second division is ranked a new genus *Nothis*, in which the third segment is remarkable for having no dorsal cirrus.

Anatomy of Polynoina.*—A. G. Bourne has recently studied the anatomy of *Polynoe cava* Mont., and has succeeded in discovering the nephridia. Ehlers had previously described in a *P. pellucida* a series of contractile sacs opening externally by several ciliated mouths, both upon the dorsal and ventral side of the parapodium, which he regarded as the segmental organs; but these are, according to Haswell, in reality intestinal cæca; the true nephridia open upon the ventral papillæ which are developed upon all the segments with the exception of the last and the eight anterior; these ventral papillæ are known by the descriptions of Huxley and Grube, and are figured by many other authors, but they were believed to have some connection with the generative functions, owing to the fact that they were found to be filled with ova or spermatozoa at the time of sexual maturity; the generative products, however, are never found within the lumen of the nephridium, but only in the section of the body-cavity inclosed in the papilla; they probably make their way to the exterior by a rupturing here and there of the body-wall. The nephridia are short straight tubes, never convoluted though the wall may be variously folded and plaited; they open internally by a ciliated rosette; the lumen is enlarged into a vesicle at the base of the papilla; there are no muscles developed in the walls. Several other anatomical details are given in the memoir; the elytra are shown to be connected with the "dorsal surface of the somite proper," and not with the parapodium; in *P. areolata*, as in *Sigalion*, rudiments of notopodial cirri may co-exist with the elytra, thus disproving any homology. No blood enters the elytra, but they contain a nervous network ending in small papillæ, which are no doubt tactile.

Spadella Marioni.†—P. Gourret has a further note ‡ on this new Chætognath, in which he gives some account of its body-cavity and generative apparatus. On each side of the pharynx there is a glandular organ which opens by a short canal to the exterior; its swollen ventral portion is lined by cylindrical or conical cells, the contents of which are sometimes found to be small polygonal bodies; anatomically, it is perhaps analogous to the segmental organs found

* Trans. Linn. Soc.—Zool., ii. (1883) pp. 347–56 (3 pls.).
† Comptes Rendus, xcvii. (1883) pp. 1017–9.
‡ Cf. this Journal, iii. (1883) p. 843.

by Claparède in the anterior somites of tubicolous annelids. The various orifices of communication between the oviduct and the female gland, which Grassi has described in other Chætognaths, do not appear to be present in this form. The products also escape to the exterior by a ventral, and not by lateral orifices.

The male gland has the nucleus of its epithelial cells very distinct; outside the epithelial there is a structureless layer, and beyond this are longitudinal muscular fibres. Some of the epithelial cells of the efferent duct are cylindrical, small, and nucleated, while others, which have no nucleus and are larger and more highly refractive, appear to be glandular in function.

New Forms of Thalassema.*—K. Lampert describes as new *Thalassema formulosum*, *caudex*, *sorbillans*, and *vegrande*. He separates the species of the genus into two groups, according as the longitudinal layer of muscles is or is not separated into bundles. The next point of distinction is to be found in the number of the segmental organs, which, as is well known, is not constant in this genus, some species in each division having two, and some three pairs; this, however, is not an invariable character as in some examples only one pair are developed; nor can the distinction be of much aid to the systematic zoologist, inasmuch as the condition of the organs varies much with the maturity of the genital products, for which these glands act as efferent ducts.

Spermatogenesis in the Nemertinea.†—A. Sabatier believes that the difficulties in the way of observation of the various stages in spermatogenesis are the cause of the different accounts given by various observers, equally well skilled. Many of these difficulties are avoided by the study of the small *Tetrastemma flavida*, which under the compressorium becomes so transparent that it is possible to study what is going on in its tissues and organs, even with the aid of high powers; no previous preparation, nor any reagents are necessary for the examination of its germinal sacs or pouches, which, moreover, are well adapted for the purpose, inasmuch as they are not all at the same stage in development.

The spermatic sacs of a young *Tetrastemma* have a pyriform shape, and later on become oval, owing to the pressure exerted on them by the adjoining organs; they are placed between the internal muscular layer and the cæcal diverticula of the intestine, and are formed by a special membrane which is attached by short tubes to the body-wall; and these open to the exterior by lateral pores. These sacs may be seen to be filled with a finely striated substance, made up of bundles set along various axes; these bundles vary greatly in size; they are fusiform in shape; the median portion forms a zone of varying width and has its contents more or less granular, while the two terminal cones are distinctly striated. If we compress the animal and force the contents out of the sac there escape bundles which are either compact, or, when more mature, are broken up into an innumerable quantity of spermatozoa. The head of the spermatozoon is cylindrical and

* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 334–42.

† Mém. Acad. Sci. Montpellier, x. (1882) pp. 385–400 (3 pls.).

highly refractive, the tail very fine and very delicate. This is what is seen in a mature sperm-sac.

In an immature one we find a very different arrangement: a young sac is small, and has finely granular colourless contents; the protoplasm is homogeneous. In other small sacs we may find at the centre of the protoplasm a transparent sphere, which clearly represents a nucleus. In fact, at this stage the contents of a male sac look exactly like those of the female. The surface of the protoplasm next becomes covered with bosses formed by grooves; soon several separate protoplasmic spheres become apparent, while the central mass is, of course, diminished in size; the spheres vary greatly in size; during this process of segmentation the nucleus remains intact. In other cases the protoplasm of the cell is seen to be broken up by the formation within it of clefts and spaces; but, as in the other, the result is the disintegration of the primitive mass, the superficial becoming distinct from the central portion. Yet in other cases, and especially in the autumn, cells in which no nucleus was apparent were observed to develope a stellate space within themselves; here no central protoplasmic mass was left. The nucleus, then, does not appear to be essential to spermatogenesis, and it is the peripheral and not the central portion of the cell that becomes converted into spermatozoa.

If we now fix our attention on the peripheral bodies, we find that in each there arise endogenously a number of large-sized granules, while at the same time the protoplasm of the spherule elongates, becomes fusiform and transversely striated. The filaments which correspond to the striæ become more and more independent, the intermediate zone atrophies, and the filaments take on the definite form of the spermatozoa.

To sum up: The seminal sac of the Nemertinea forms *spermatospores*, or male ovules, composed of a mass of finely granular protoplasm, in which a nucleus may or may not be developed. The central portion tends to atrophy, while the peripheral takes on the form of plates or spheres which become attached to the inner wall of the sac. The central portion is the *protoblastophor*, the peripheral spherules the *protospermoblasts*. From each of these we get *deutoblastophors*, and *deutospermoblasts* which become spermatozoa.

Development of Trematoda.*—H. Schauinsland, after an elaborate account of the views of his predecessors in this field of inquiry, gives the results of his own observations on eight species of *Distomum*, and on *Aspidogaster conchicola*. His general results may be thus summed up: The Trematode ovum is made up of the true egg-cell and of the yolk, which at first arises, more or less, from large, rounded, nucleated cells; the egg-shell is formed by a highly coloured chitinous membrane, in which a long and a transverse axis can be generally detected; at one end there is nearly always an operculum, and that end is also that of the head. Cleavage is complete though irregular, being of course more or less dependent on the amount of yolk; the result is a solid mass of cells, which in time absorbs the whole of the yolk;

* Jenaisch. Zeitschr. f. Med. u. Naturwiss., xvi. (1883) pp. 464–527 (3 pls.).

before this is effected one cell at the upper pole becomes constricted off, and gives rise to the "calotte-shaped" cells. In all the species examined there was found an investing membrane; at the periphery of the homogeneous cell-aggregate there is differentiated a layer of flattened cells, from which in *D. tereticolle* arises a structureless cuticle with eight plates beset with chitinous setæ; in all the other forms examined there is a ciliated membrane, in which it is not possible to demonstrate the presence of separate cells. The solid endoblast lying within the flattened ectoblastic cells is at first made up of similar cells, but in the course of development some of them become flattened out and form a kind of epithelial lining to the ectoblast; others, at the cephalic end, become fashioned into an enteron, the lumen of which is formed by the gradual degeneration of the inclosed cells. The great mass of the endoblast remains, however, unaltered, and gives rise to germinal cells.

Some young forms are provided with vessels in which ciliated infundibula are to be made out at certain points; in *Distomum cygnoides* and *D. tereticolle* these appear to be connected with the enteron.

The investing membrane is regarded by the author as a formation of the ectoblast which is developed in two successive layers: first there appear cells which may be called ectoblasts of the first order; these are replaced by the ectoblastic cells of the second order—the permanent embryonic ectoderm. It may be as well to remind the reader that Van Beneden has noted the same phenomenon in the Tæniadæ.

Further investigations are required to answer the question as to whether the muscles are truly of epithelial origin, or whether they have a mesenchymatous character; and the first point to be settled is the relation of the young stages of Trematodes to the Enterocœlia.

The author does not share the opinion of Leuckart as to the mesodermal character of the germinal cells; it is perhaps best to regard them as cleavage-elements which have not been used up, and which, being such, do not require any further fertilization. The germinal cells found in the first set of *Rédiæ* may similarly be looked upon as cleavage elements which have remained over from the first generation.

The resemblances between the developmental histories of the Trematoda and of *Malacobdella* are perhaps superficial. There is, again, a close resemblance between the Trematodes and the Mesozoa, and the only difference between the embryos of *Rhopolura* and of *Distomum* is that the former remains at a lower grade of development. The existence of the former in a highly nutrient fluid makes the development of any other organs than those of reproduction altogether superfluous: the organs which are developed in the Trematoda are such as are necessary to enable it to find a new and suitable host. The Distomidæ and the Orthonectidæ are therefore, in all probability, closely allied, though the direct origin of the former group is a more difficult question.

There are many very striking and important resemblances in the developmental history of the Tæniadæ and the Trematoda:

both are formed from two distinctly separated cell-layers; in the outer there appear chitinous hooks or setigerous plates or a large number of cilia. The chitinogenous layer and the investing membrane are formed in very much the same way.

Striking as the resemblances are, it is not impossible that it is merely accidental, and that the outer cell-layer of the Tænioid embryo is not comparable to the ectoderm of the young Trematode, but only to the underlying layer of epithelial cells. Further investigations on tæniæ are necessary to the resolution of this problem; if it should be shown that they do lose their ectoderm we should have, in these two groups, the only known examples of the complete loss of a germinal layer, inasmuch as Kleinenberg's observations on a similar phenomenon in *Hydra* appear to stand in want of revision.

Simondsia paradoxa.*—This remarkable parasite was briefly described by Dr. Cobbold in his 'Entozoa,' from some specimens discovered by Professor Simonds in the stomach of a German hog that had died in the Zoological Society's Gardens. The drawings and specimens were temporarily lost, but, having been fortunately recovered, Dr. Cobbold has been enabled to add considerably to his former description of the parasite. The most striking feature in the organization of the worm is a large rosette-shaped organ which represents a prolapsed uterus entirely comparable to the prolapsed uterus of *Sphærularia bombi*. The male, which is slightly smaller than the female, presents no specially interesting points of structure. In the female all the ovarian tubules and the uterine branches are contained within the rosette, but the position of the external opening could not be made out with certainty, though it is apparently situated at the base of the rosette in the ventral line. Each female is inclosed in a single cyst, the head alone projecting; the interior of the cyst shows a perfect cast of the rosette-shaped organ; the males are free.

Monograph of the Melicertidæ.†—L. Joliet finds that of all rotifers the Melicertidæ are those which are best adapted for the investigation of the processes of development, inasmuch as after the eggs are laid they are protected by the tube, and eggs are laid every day, and development is completed in three days.

To the three species, *M. ringens*, *M. pilula* Collins, and *M. tyro* Hudson, the author adds a fourth, *M. pedunculata*, which most nearly resembles the first, but is distinguished from it by being not free in its tube, but attached to it by a seta which is fixed to the end of its tail; the new species would seem to be rare, having as yet been found only at Nogent-la-Phaye, near Chartres. The pond in which it was found was for several years preceding the last two completely dried up; the so-called winter eggs are not formed in the winter only, but throughout the season of activity.

After a description of the general form, Joliet deals with the

* Trans. Linn. Soc.—Zool., ii. (1883) pp. 357–61 (1 pl.).

† Arch. Zool. Expér. et Gén., i. (1883) pp. 131–224 (3 pls.).

digestive tract, the mastax of which is incapable of such protrusion as is seen in *Notommata;* the author is of opinion that this capacity for protrusion shows that the organ in question is analogous to the armed proboscis of an annelid, and he adds, "nous donnons le nom d'œsophage à la portion suivante du tube digestif," but this is a procedure long since adopted by at least English writers on the anatomy of rotifers. The excretory apparatus is described as being very similar to that of *Lacinularia socialis.* The contractile vesicle found in most rotifers is absent, and its function seems to be taken on by the spacious cloaca. After some notes on the nervous system, the author passes to the processes of reproduction, to which the largest part of the essay is devoted.

His more important conclusions may be thus summed up :—

1. There is no difference in the position of the nervous system and tactile organs of the Melicertidæ and other rotifers. As in them, *Melicerta* has the central nervous system dorsal, that is to say, on the surface which corresponds to the cloacal orifice, and the unpaired tactile organ. Like all rotifers, *Melicerta* has three tactile organs, an unpaired dorsal, and two lateral pairs.

2. The organ regarded by Huxley as the ganglion is a gland which is set apart for providing the mucus by means of which the elements of the protective tube are held together. The formation of this tube has been described in a satisfactory manner by Gosse, Bedwell, and Grube. The motile "languette" placed beneath the vibratile pit takes the part of the axis of a wheel.

3. In the Melicertidæ the females may be divided into those which lay male, those that lay summer female, and those that lay winter female eggs. Each appears to have its speciality.

4. All ova are equally fit for fecundation, but all are not fecundated.

5. The male resembles that of *Lacinularia socialis.* The spermatozoa are ribbon-shaped, have an undulatory movement, and an elongated head. In the body of the female they become immobile, and collect on the surface of the ovary.

6. Save that perhaps the fecundated egg expels the polar globules, there is no difference in the development of ova coming from a fecundated or a virgin female.

7. The theory of Cohn, according to which only fecundated females lay winter eggs, while the summer ova are developed parthenogenetically, is not in accordance with the facts.

8. There are reasons for believing that the female fecundated summer egg gives rise to one which lays winter eggs, while a non-fecundated summer egg will only develope into one which lays male or female summer eggs.

9. There is certainly a relation between the number of males existing at a given time, and the number of winter eggs existing at about the same time.

10. The winter ought rather to be called durable eggs, for they are destined to resist dryness as much as cold.

11. The winter have the same early history as the summer eggs,

and are, at the time they are laid, distinguishable only by their size and colour. They undergo segmentation in the same way. At a certain time, the embryo is encysted in a cellular membrane lying internally to the vitelline membrane. Later on this becomes chitinized and ornamented, while the outer vitelline membrane disappears.

12. As far as the closure of the blastopore the male egg has the same history as the female.

13. The summer egg, if not fecundated, does not give off polar globules.

14. When the egg is laid it divides into two unequal segments, which divide regularly and symmetically up to the 16th stage. After this the derivates of the small segment predominate and inclose the others. When the blastoderm is formed the embryo consists of—

a. An internal layer entirely derived from the last and largest segmentation-sphere; this forms the intestine.

b. An outer layer which forms the ectoderm and is in great part, probably altogether, derived from the smaller primitive segment, and from the first sphere detached from the large segment.

c. A median layer which, if it does not form a continuous layer, at least does form groups of cells which are arranged between the outer and inner layers; this is derived from the two median spheres of the large primitive segment, and probably serves to form the genital organs and muscles.

This arrangement is a striking example of the way in which the order of the succession of the layers corresponds to the order of segmentation, the sphere the furthest from the animal pole serving exclusively to form the intestine, the two median spheres the genital organs and muscles, and, lastly, the three lower clear spheres the ectoderm.

15. When the blastoderm has been formed the embryological phenomena take place in the following order: formation of the tail; appearance of the vibratile pit, of the short cilia that cover it; development of the ocular pigment, of the large cilia of the wheel-organ; formation of the buccal cavity and of the cloaca by the invagination of the ectoderm; appearance of the meconium, of the mastax, of the vibratile cilia. The larva then escapes, leads for some time a wandering life, and then settles down to construct its tube.

Echinodermata.

Histology of Echinodermata.*—In his second communication † O. Hamann commences with an account of the nervous system of *Holothuria polii*, and of the structure of the "feet" of this form. In each of the so-called pyramidal feet we find a strong nerve-cord placed in the connective tissue, and composed of epithelial supporting cells, between the processes of which run the nerve-fibrils; below the apical disk they form a plate, and here the processes of the epithelial sensory cells pass into the layer of nerve-fibrils. Among the nerve-

* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 309–33 (3 pls.).

† See this Journal, iii. (1883) p. 847.

fibrils ganglionic cells are scattered irregularly, and they are remarkable for the small quantity of protoplasm which surrounds the nucleus. While the pyramidal feet have not, the sucking feet have a sucking plate, the epidermis of which consists of elongated cells of palisade-like form; these pass into the circular ridge, the cells of which are much shorter and of two kinds; some are cylindrical and connected by fine fibrils with a layer which appears to be nervous, while others have stout processes, which pass perpendicularly through the nervous layer and become united with the subjacent connective tissue.

In each of the shield-shaped tentacles around the mouth we find that the stalk has a canal which gives off branches to each of the "capitula" which form the free end. The epithelial layer of these capitula is worth study; the cells are filamentous and give off processes which are of two kinds, some being stronger than the others and not forming a plexus. In longitudinal sections we see a layer underlying the epithelium, which is in parts finely granulated, and in parts striated; the epithelial supporting cells terminate beneath the fibrillar layer, while the separate fibrils of the epithelial sensory cells are continued into the nerve-cord of the epithelium, which again is a branch from the large nerve-trunk in the stalk of the tentacle.

The Cuvierian organs are next dealt with, and are described as tubular structures, beneath the ciliated epithelial layer of which is a peculiar striation; this consists of strongly projecting bands arranged circularly and parallel to one another, and have glandular cells, in rows, among them. Longitudinal and circular muscles are also to be observed. In the centre of ejected tubes there appears to be a canal, but this may be due to the breaking up of those structures, and fresh material must be examined before any certain conclusion as to its normal presence can be arrived at.

The circular nerve-cord of *Synapta* presents the following histological characters: the greater part of it is formed by circular fibrils, the nerve-fibres, among which cells are irregularly scattered; this nerve-layer proper is traversed by processes, which arise from the cells that form the superficial layer, and which, with their processes, may be regarded as supporting epithelial cells; they are homologous with the similarly named structures found in the epidermis of Asterids.

From the nerve-ring there are given off five radial nerves; these are set in the layer of connective substance, below them there is a vessel, then the circular, and then the radial muscles. The nerve-trunk is divided into two parts and probably also supported by a thin cord derived from the connective tissue. The radial nerve gives off fibrous bands, which supply the circular muscles, and others which pass to the periphery of the body and end in the tactile papillæ. These latter appear to be developed in consequence of the loss of the suckers or feet; they present the following structures: the epithelium is greatly thickened, and its cells are cylindrical and two or three times the length of an ordinary epithelial cell; nerve-fibres pass into them. In addition to these ordinary papillæ, there are others which inclose calcareous bodies, and especially those anchor-like structures which are so characteristic of the group; in these no nerve-fibres

would seem to be found. Yet again, two kinds of glandular cells are developed in the integument. In addition to the ectodermal nerve-supply, there is an endodermal system of enteric nerves; the œsophageal portion supplies only the musculature of the œsophagus, but this is primitively endodermal in origin; the true ectodermal portion is found in the stomach and intestine, and its fibrils are richly supplied with ganglionic cells, and distinctly separated from the connective-tissue fibres.

The four regions of the digestive tract—œsophagus, stomach, intestine, and rectum—of *Synapta*, are both histologically and morphologically sharply separated from one another; and the whole tract is distinguished from that of the pedate Holothurians by the facts that the longitudinal layer of muscles lies externally and not internally to the circular, that there is a special gastric epithelium, and that the internal layer of connective tissue is strongly, while the outer layer is feebly developed.

The muscles of the body-wall appear to attain a remarkable strength in the Synaptidæ.

Nervous System of Holothurians.*—R. Semon agrees with Johannes Müller in regarding the radial nerves as the primary, and the œosophageal ring as the secondary portion of the Holothurian nervous system; the histological characters of the former are more complicated, and they appear to be developed before the latter. In the young Synaptæ from which careful transverse sections were made, the radial nerves were seen to be completely developed and to have at either pole a relatively large swelling, but there was no indication of any commissure. The author disagrees with the ordinarily received doctrine that the nerves end in a point near the anus, for in that region he has been able to detect a considerable thickening in the nervous band, and he inclines to believe that a secondary anal commissure is developed; on the other hand, in the Aspido- and Dendrochirota there is certainly no such commissure, the appearance of which is really due to the elastic connective-tissue-fibres there developed. At either end of the digestive tract special sensory regions appear to be present, and Holothurians are notoriously sensitive at their mouth and anus, possibly to protect themselves from the parasites by which they are often infested.

After some observations on the topographical relations of the nervous system, the author passes to the histology; the difficulty of the investigation is even greater than in other groups of animals, owing to the small size of the elements, and our slight knowledge of the minute structure of the other organs. After the animal has been killed in boiled sea water, whereby it dies in an extended condition, and the elements have been isolated, it is as well to wash them several times in distilled water, as they have always a quantity of by-products associated with them. Staining reagents must be very carefully applied to the fresh tissues, as, unless they are very dilute, they will soon blacken the whole tissue. The author found his greatest difficulty in

* Jenaisch. Zeitschr. f. Med. u. Naturwiss., xvi. (1883) pp. 578–600 (2 pls.).

the absolute impossibility of completely separating the nervous from the surrounding tissues, and consequently, of being always certain as to the truly nervous character of the fibres and cells which he had under examination.

A transverse section of a radial nerve showed that the periphery was surrounded by cells, several layers thick, and that in the Aspidochirotæ, there were distinct aggregations of cells right and left of the middle line; these bands were not seen in the Dendrochirotæ or in the Synaptidæ. Internally one sees here and there cells, which in the Aspidochirotæ exhibit a certain arrangement, and which may be distinguished as internal and marginal; histologically, these cells have the same structure—a relatively large nucleus and a small quantity of protoplasm. The nervous band is provided with a membranous sheath which extends along its whole length and divides it into two halves; it is traversed by a system of transverse as well as of longitudinal fibres. The former may be certainly believed to enter into connection with the nerve-cells, but the relations, and indeed the essential nature, of the latter require further investigation.

Some remarks are made on the sensory organs, but no close examination has yet been made of the structures at the base of the tentacles of *Synapta*, which Müller regarded as eye-spots, or the auditory organ of Baur. The author has discovered at the end of the ambulacral pedicels and of the tentacles, plates which appear to have a fine tactile sensibility.

Vascular System of Echinoderms.*—In No. VI. of his 'Notes on Echinoderm Morphology,' P. H. Carpenter discusses the recent utterances of various French anatomists on the anatomical relations of the vascular system.

Attention is first directed to the researches of Koehler, who finds, in addition to the one vascular ring round the mouth of an *Echinus* which has been acknowledged by Hoffmann and by Perrier, another oval ring which can be injected by inserting the cannula into the lower end of the "heart" or "ovoid gland" through the intermediation of a vessel which lies beside but is quite distinct from the water-tube. The injection will pass also into ramifications within the Polian vesicles, and, if pressure be used, into these organs, while the water-tube and radial vessels will also be injected. In Spatangids either of the two oral rings may be injected from the corresponding radial vessel, and each ring sends branches into the ambulacra. "This," Mr. Carpenter says, "leads to the suspicion that each radial vessel of an *Echinus* communicates directly with a corresponding vascular ring, just as was described by Teuscher, and that the water-vascular and blood-vascular systems are distinct, at any rate in the peristome and ambulacra." And it is further pointed out that Koehler's results would have had a still higher value if they had been more fully compared with the results of other anatomists, who have, in Asterids, Ophiurids, and Crinoids, already described independent blood-vascular and water-vascular systems.

* Quart. Journ. Micr. Sci., xxiii. (1883) pp. 597–616.

Koehler's studies give evidence of the connection between the "heart" and the blood-vascular system, which, while affirmed by Ludwig, Carpenter, and others, has been denied by Perrier and Apostolides. The organ in question is described as "a reticulum of connective tissue, supporting cellular elements that undergo a peculiar degeneration, the final result of which is the formation of numerous pigment-masses;" it might, perhaps, be convenient to speak of this body as the "plexiform gland"; it is most certainly not a heart, and may probably have something to do with the production of the common brown pigment-bodies.

After noting and criticizing some of Koehler's statements as to the fusion of the two vascular systems and other points in the anatomy of Spatangids, Perrier's recent note on the organization of Crinoids is taken up, and it is pointed out that, for the investigation of certain anatomical points, *Antedon eschrichti* affords more satisfactory material than *A. rosacea*. The blindness of the vessels connected with the "ovoid gland" is apparent only, and is due to the study of single thin sections; on the whole, Mr. Carpenter agrees rather with Ludwig than with Perrier in his views on the vascular system; the latter, however, is the first continental naturalist who has supported publicly the Carpenters' doctrine of the nervous nature of the fibrillar envelope of the chambered organ.* Mr. Carpenter reports the presence of bipolar cells in the branches of the axial cord in *Pentacrinus*, *Bathycrinus*, and *A. eschrichti;* and, in the last-named he has found that there is in the disk a fibrillar plexus which forms an annular network around the lip. Extensions of this plexus are, in all probability, connected with the fibrils of the sub-epithelial band, which by many anatomists is regarded as the sole nervous apparatus of the Crinoidea.

Cœlenterata.

Nervous System of Porpita.†—After a short account of the literature of the nervous system in the Cœlenterata, H. W. Conn and H. G. Beyer give a sketch of the general anatomy of *Porpita* before describing in detail the nervous and sensory structures of the animal. The nervous system consists entirely of scattered ganglion-cells, generally tripolar, but frequently also bipolar and sometimes multipolar; the fibres may be traced for some distance, dividing and subdividing, until they are finally lost in the muscular layer; in some cases the processes of several ganglion-cells unite. Transverse sections show that these cells are invariably ectodermic, and never endodermic as is the case in certain other Cœlenterata; the nerve-cells are most abundant in those parts of the body, e. g. the velum, where the muscular system is well developed, and appear to be entirely absent from the nutritive zooids which are unprovided with muscles. There is no trace of any central nervous system: no nerve-ring exists such as has been demonstrated in Medusæ.

* Cf. this Journal, iii. (1883) p. 661.

† Studies Biol. Laboratory Johns Hopkins University, ii. (1883) pp. 433–45 (1 pl.).

Round the edge of the velum are a number of organs believed to be sensory; each consists of a small "ectodermal pocket," containing a number of large cells which are of two kinds; those on the outside are more slender and less granular than those in the interior, with which, however, as well as with the ordinary ectodermic cells, they are connected by insensible gradations. No connection was observed between these and the ganglion-cells, and not a single ganglionic corpuscle could be detected among them. Seeing, however, that the ganglionic cells are only developed in connection with the muscles, it is not to be wondered at that they are absent from these marginal sense-organs.

When the animals are kept in an aquarium for some time, the marginal bodies rapidly degenerate, the cells becoming fused together and the whole organ presenting the appearance of a fused granular mass, which causes them to resemble glandular organs.

Bermudan Medusæ.*—J. Walter Fewkes gives a list and some account of the free jelly-fishes found in Castle Harbour, Bermuda, in May and June 1882. Among them is the representative of a new genus, *Oceanopsis*, which differ from other Oceanidæ by possessing four otocysts, from the neighbourhood of each of which, on the bell margin, there arise small tentacular filaments. One specimen of *Rhizophysa filiformis* was observed to be more than three feet in length.

Porifera.

Alleged new Type of Sponge.†—Under the name *Camaraphysema obscura* J. A. Ryder describes and figures (from a single dead specimen) a lobate mass, chiefly made up of chambers lined by nucleated columnar cells resting on a basement membrane. The chambers contained ova in different stages of development; no collar-cells, sponge-mesoderm, fibres, or spicules were observed. From these points it will be sufficiently evident that the author has been mistaken in assigning the organism to this group. He mentions eversible funnels as lying in the mouths of the superficial chambers, and possibly the *Bryozoa* would more fitly receive this form, which, however, to be properly determined, should be studied in the living state.

Biology and Anatomy of Clione.‡—The first question propounded by N. Nassonow is, "How does the sponge make its way into the hard calcareous structures, and how does it complete its destructive work?" To answer this question he cultivated young sponges on thin transparent calcareous lamellæ; the larvæ, after a free stage, settled on the plates, and soon a rosette-shaped mark appeared; the sponge gave off thin processes which passed into the substance of the plate, and followed the contour lines of the rosette; about a day after the sponge settled a rosette-shaped particle was taken out of the plate; the body of the sponge entered the depression thus

* Bull. Mus. Comp. Zool. Camb., xi. (1883) pp. 79–90 (1 pl.).
† Proc. U. S. National Mus., iii. (1881) pp. 269–70 (7 figs.).
‡ Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 295–308 (2 pls.).

formed, took the particles into, and then cast them out of its body. Towards the evening of the day of observation the rosette-shaped marking had totally disappeared, and its place was taken by a small pit; into this the sponge contracted the greater part of its body. Chemical as well as mechanical agencies appeared to be at work, but the demonstration of the presence of the acid was prevented by the strong alkaline reaction of the sea water. Contrary to the view of Hancock, Nassonow thinks that the spicules of the sponge take no part in the boring operation; indeed, the young sponge began before it had developed any skeletal structures, not to say before it had completely taken on the other characters of the adult.

The second question deals with the influence of the parasitic mode of life on the organization of the sponge; of these results the most striking is perhaps the fact that *Clione* appears to pass its eggs into the water where, and not, as in all other sponges, in the body of the animal, they become fertilized.

Some information is given as to the structural characters of this sponge, and the author states that the best sections were obtained from specimens which had been treated with osmic acid, and hardened in alcohol; good results were also obtained by colouring with hæmatoxylin; sections should, on account of the spicules, be mounted in glycerine. On account of the closeness with which the mesodermal cells are packed the sections must, as in *Aplysina* (Schulze) be very thin. These closely-packed cell-layers fill, in parts, the whole of the inner body-mass, and among them foreign bodies—either food-remnants or calcareous particles—were not unfrequently observed. Various forms of cells are to be noticed, but between them all there are a large number of intermediate stages.

New Siliceous Sponges from the Congo.*—W. Marshall introduces his description of these new sponges from fresh water by some general observations on the relation of fluviatile to marine sponges. Every one agrees that the former are genetically derived from the latter, and most think that the origin was a monophyletic one. The three general resemblances which lead to this view are: (1) they are monactinellids; (2) they inhabit fresh water; (3) they exhibit an asexual as well as a sexual method of reproduction. The first two points appear to be of no importance, when we consider that three-fourths of the marine Silicispongiæ appear to be monactinellid; and as against the third we have Dybowski's observation that there are no gemmules in the *Lubomirskia* of Lake Baikal, and that a number of marine forms reproduce by gemmation; yet again, we must bear in mind that gemmules are not confined to sponges, witness only the analogous case of the Bryozoa. Gemmules, then, no more than stinging cells, are to be used as criteria of genetic affinities. A careful discussion of all the facts of the case leads to the conclusion that fresh-water sponges are most closely allied to the Renierinæ, but that they have been developed independently of one another in

* Jenaisch. Zeitschr. f. Med. u. Naturwiss., xvi. (1883) pp. 553–79 (1 pl.).

different regions of the earth's surface, and that their resemblances to one another are due to the similar conditions of their new and altered mode of life. Some of these modifications have been acquired (e. g. gemmules) and may be said to be of a positive character, while others are negative, and are due to the disappearance of some of the characters of their marine allies; such is the loss of colour, owing no doubt to the disappearance of the conditions for self-protection which called it into existence. The fresh-water sponges may form the group Potamospongiæ among the Renierinæ.

Three species of the new genus *Potamolepis* are described: *P. leubnitziæ*, *P. chartaria*, and *P. pechuëlii*; they have no resemblance to *Spongilla*, or indeed to any Renierine sponge. The last species calls to mind a *Farrea*, owing to the macroscopic structure of its skeleton, and the arrangement of its fibres. The differences appear to be due to their surroundings, for the currents of water in the rainy season being of great force, it is necessary for *Potamolepis* to develope structures which are not necessary to the *Spongilla* of stagnant or gently flowing water.

Protozoa.

Parasitic Infusoria.* — *Trichomonas vaginalis* is described by G. Künstler as extremely protean in external form; it may develope pseudopodia over the general surface or localized at the posterior extremity; at the anterior end are four flagella united by their bases, from which point an undulating membrane extends to the posterior extremity of the body. At the base of the flagella also the mouth opens; the nucleus, which varies in form, lies at the side of the œsophagus; the general protoplasm has a vacuolated structure. In the intestine of a certain Chelonian occurs a parasite apparently allied to *Giardia agilis*. The body is divided into two regions: the anterior is the larger, is vacuolated, and invested by a loose plicated and embossed sheath; the base of the flagellum has almost the same diameter as the body, is very long, and is readily shown to be striated; it reproduces by buds from the anterior extremity. Other organisms are mentioned as parasites, but not described, from the same host. *Heteromita*—or *Boda* (*Bodo ?*)—*Lacertæ* is described as a new species from the *intestine of Lacerta viridis;* the mouth is surrounded by a circular cushion, the nucleus often has a very complicated structure, presenting much variation, the body is areolar; reproduction takes place by transverse fission. A pyriform Flagellate, with four long locomotor flagella, with a lobule at their base, leading into the œsophagus, and a longitudinal costa on the left side, also occurs here. A quadri-flagellate organism with a large posterior vacuole is described from *Hydrophilus*, also an *Amœba*, which is truly amœbiform only in the young state, afterwards it maintains a finger-like shape and produces pseudopodia only from the anterior region. *Flagellata* are also indicated from various insects, from *Toxopneustes* and the blood of *Cuvia*, a *Nyctotherus* from *Oryctes* and a Planarian from *Solen*, but with no, or but the briefest descriptions.

* Comptes Rendus, xcvii. (1883) pp. 755–7.

New Infusoria.—O. E. Imhof * states the discovery in the Lac du Bourget in Savoy of *Dinobryon cylindricum* n. sp.

A. C. Stokes (of Trenton, N. J.) also records † a *Vorticella*, which, on account of its peculiar and well-developed external investment, he has named *Vorticella vestita*.

"Body soft and plastic, broadly campanulate, widest at the anterior margin, constricted beneath peristome border and posteriorly rounded at its junction with the pedicle; when contracted, subspheroidal. The whole cuticular surface is covered by a conspicuous cellular coating which gives the superficial aspect a minutely reticulated appearance, and the external margin a finely crenated outline when seen in optical section. This investment is formed of a single layer of cells arranged in equatorial series, the upper and lower cell-walls being equidistant in each row throughout the whole length of the body. The cells themselves are as colourless as the animalcule and as transparent, their contents being invisible liquid usually containing many dark-bordered, actively moving granules. When the creature is in a weakened or dying condition the cell-contents are so increased in quantity that the cells become extended and bubble-like, the zooid then resembling a mass of froth.

The peristome border is but slightly everted. The vestibular bristle is well-developed and conspicuous. The contractile vesicle pulsates at intervals of twelve seconds. The nucleus is band-like, curved, and remarkably long, one arm extended across the body anteriorly for almost its entire width, then bending and curving for nearly an equal distance along the ventral side of the zooid.

The pedicle is from six to seven times the length of the body, and when retracted forms about seven coils which exhibit transverse striations or wrinkles, particularly noticeable as it is extending. The muscular thread is roughened at irregular intervals by clusters of minute rounded elevations. Body 1/500 in. in height."

W. Milne also records ‡ one new genus and four new species from brackish water: *Tetramitus gyrans* n. sp.; *Hexamita Kentii* n. sp.; *Longicilium flexicuneus* n. gen. and sp.; and *Tillina barbata* n. sp.

Relationship of the Flagellata to Algæ and Infusoria.§—G. Klebs proposes to limit the term Flagellata to the Euglenaceæ and Peranemeæ, which are again divided into the Euglenida, Astasieæ, Chloropeltida, and Scytomonadina Stein; and discusses their structure, vital phenomena, and systematic position. The treatise is divided into three sections: (1) monograph of the Euglenaceæ; (2) some Flagellata in the older sense of the term, belonging to the lower chlorophyllaceous algæ; and (3) the fresh-water Peridineæ.

The Euglenaceæ are made up of the genera *Euglena*, *Trachelomonas*, *Colacium*, *Ascoglena* (Stein's *Euglenida*), *Eutreptia*, *Phacus*, *Astasia*, *Rhabdomonas* (two species of Stein's Astasieæ), and *Menoidium*

* Zool. Anzeig., vi. (1883) pp. 655–7.
† Amer. Mon. Micr. Journ., iv. (1883) p. 208.
‡ Proc. Phil. Soc. Glasgow, xiv. (1883) pp. 32–6 (1 pl.).
§ Sep. repr. from Unters. Bot. Inst. Tübingen, i. (1883) 130 pp. (2 pls.). See Bot. Ztg., xli. (1883) p. 595.

Stein. The chlorophyllaceous are separated from the non-chlorophyllaceous hyaline Euglenaceæ. The author describes their general structure, system of vacuoles, contents, and investing structures, and then proceeds to their mode of division, resting condition, and the question of sexuality, as to which he obtained simply negative results, and the general biological phenomena of the green Euglenaceæ. He considers the colourless as direct descendants of the green forms, and as the link of relationship of the latter with other Flagellata. No systematic separation of the hyaline from the green forms is possible. Notwithstanding the numerous transitional forms between the different species of Euglenaceæ, the author establishes two groups with nine genera, the characters dependent on the delicate internal structure, the mode of movement, behaviour towards external influences, &c. The author then discusses the relationship of the Euglenaceæ to the Peranemeæ and Algæ. The Peranemeæ resemble the Euglenaceæ in essential points, but differ in the possession of a mouth-opening and special mouth-apparatus.

Among the Flagellata of Stein, the author regards, in addition to the Volvocineæ, *Chlorogonium euchlorum* Ehbg. as a typical Chlamydomonad, as also *Chlorangium stentorinum* from the family of Hydromorina. As is the case with the other Chlamydomonads, hyaline forms of both occur. A new classification of the unicellular Chlorophyceæ is proposed, associating under the name Protococcoideæ the groups Pleurococcæ, Chlorosphæraceæ, Tetrasporeæ, Chlamydomonadæ, Volvocineæ, Endosphæraceæ, Characieæ, and Hydrodictyeæ. The Endosphæraceæ, Tetrasporeæ, and Chlorosphæraceæ lead to the Siphoneæ, Ulvaceæ, and Confervaceæ.

The fresh-water forms of the Peridineæ, on the vegetable nature of which the author agrees with Leuckart, are treated of in detail, and the following are the general results at which the author has arrived.

The Euglenaceæ and Peranemeæ must be separated from the Ciliata and placed among the Infusoria, forming a separate division, the Flagellata, distinguished by a different mode of ciliation, and other differences in structure. The Volvocineæ, Chlamydomonadæ, and *Hydromorina* Stein remain partly among the Chlorophyceæ. From both the Ciliata and the Flagellata must also be separated the Peridineæ, termed by Claparède and Lachmann Cilioflagellata, and regarded by Bergh and Stein as a connecting link between these two groups; they form a well-marked family of Thallophytes.

Klebs' group of Flagellata remains, even if associated with the Infusoria, an intermediate group, connected on one hand, through the Cryptomonadæ, with the Algæ, on the other hand with the Vampyrellæ, rhizopod-like organisms, Noctilucæ, &c. Their general character connects them partly with the Protozoa, partly with the lower Thallophytes.

Transformation of Flagellata into Alga-like Organisms.*— A paper intended to show some relations between animals and plants at their lowest degrees of development is contributed by M. Shmankevitch.

* Mem. Novorossian Soc. Natural., vii. Cf. Nature, xxix. (1884) p. 274.

When the Flagellate *Anisonema acinus*—having a relatively high organization—is cultivated for many generations in a medium which is slowly modified, for instance in fresh water to which a certain amount of sea-salt is added, its structure is modified in proportion as the concentration of the solution of salt is increased. The individuals become less developed, their size diminishes, and the feeding-canal loses its former development. Numberless intermediate forms between *Anisonema acinus* and its new, less developed representatives, make their appearance, as well as between these and the still lower *Anisonema sulcatum*, which would thus be but a lower organized variety of the former. When the concentration of the medium in which the *Anisonema* lives is carried on side by side with a change of temperature of the medium, the transformation goes further on, and the lowest *Anisonema* are transformed on the one side into alga-like organisms, and in another direction into organisms which seem to belong to the category of fungi. The individuals not only become smaller, but they give rise also to a progeny long before reaching their full size. Under the influence of the sun's rays the uncoloured Flagellata acquire a new physiological function, and develope chlorophyll.

"We see thus," the author says, "the beginnings of two kingdoms, animal and vegetable, radiating from one common stem. We see the transformation of one of them into the other, not only in its morphological features, but also in its physiological functions, under the direct influence of physical and chemical agencies. The saline solutions, as compared with fresh water, diminish the size of the lower organisms, and at the same time they contribute towards the development of chlorophyll in the fresh-water algæ, thus giving them, so to say, a more vegetable character, together with an increased productiveness." And further: "Whilst descending from *Anisonema sulcatum* to a unicellular alga, we see the retrogressive development, a simplification of organization; we descend towards the plants containing chlorophyll. . . . While descending from the same *Anisonema* by another branch, we enter into the region of those lower organisms which, under the influence of another medium, do not develope chlorophyll, and, having no nutrition from the air, derive their food from the substratum; they might be described as parasitic Rhizopoda, and this the more, as from the fungoid form we can ascend, under some circumstances, not only towards the amœba-like uncoloured Flagellata, but also towards the moving monad. On the contrary, by reversing the physical agencies, we can arrive, from the unicellular alga, as well as from the fungoid form, to an uncoloured form having the structure of *Anisonema*." The researches of A. Giard, Cienkowsky, and Famintzin, and some observations by E. Ray Lankester, seem to be, in the author's opinion, in accordance with the above.

Stein's 'Infusionsthiere.'*—The second half of Part III. of Dr. F. Ritter v. Stein's well-known work on the Infusoria, has just been

* Stein, F. Ritter v., 'Der Organismus der Infusionsthiere. III. Abth. II. Hälfte. Der Organismus der Arthrodelen Flagellaten.' fol., Leipzig, 1883, 30 pp. and 25 pls.

published. It does not contain the expected characters of the genera and description of the species figured in the first part, which are still further deferred, but deals with the forms most of which are more usually known under the name of Cilio-flagellata.

After a descriptive account of the course of his researches since the publication of the first half in 1878, the author gives a summary (in 23 pages) of the results at which he has arrived. The forms now treated of he considers to be a sub-order of the Flagellata, the simpler forms of Flagellates described by the first part forming the other sub-order. The latter he terms Monero-flagellata and the former Arthrodelo-flagellata. He objects to the name of Cilio-flagellata, as it supposes that the organisms besides a flagellum are provided with cilia, whilst *Prorocentrum* and *Noctiluca* are without such cilia. They all, however, have a distinctly articulated body, whence the designation Arthrodelo.

The division into five families is founded upon the modifications of the articulation, and the 30 genera upon the absence or presence of a secondary articulation of the body-covering as well as on their arrangement, number, form, and size. The following are the families and genera:—

Prorocentrinæ (*Prorocentrum*, *Dinopyxis*, and *Cenchridium*), Cladopyxidæ (*Cladopyxis*), Peridinidæ (*Gymnodinium*, *Hemidinium*, *Glenodinium*, *Clathrocysta*, *Heterocapsa*, *Amphidoma*, *Oxytoxum*, *Pyrgidium*, *Ceratocorys*, *Goniodoma*, *Gonyaulax*, *Blepharocysta*, *Podolampas*, *Diplopsalis*, *Peridinium*, and *Ceratium*).

Dinophysidæ (*Amphidinium*, *Phalacroma*, *Dinophysis*, *Amphisolenia*, *Citharistes*, *Histioneis*, and *Ornithocercus*).

Noctilucidæ (*Ptychodiscus*, *Pyrophacus*, and *Noctiluca*).

Being prevented by unfavourable weather from going to the sea, Dr. Stein bethought himself of trying the contents of the stomachs of marine animals preserved in spirit, and in this line of research he was completely successful, by far the most numerous and important of his discoveries being obtained from the stomachs of various Tunicates (*Ascidia*, *Salpa*, and *Cynthia*), Vermes (*Sabella*, *Serpula*, and *Sipunculus*), and Echinoderms (*Synapta*, *Ophiothrix*, '*Comatula*,' and *Actinometra*). Hundreds of individuals were obtained from one species of *Salpa*, and the author was occupied from November 1880 to the end of 1882 in the examination of the organisms he thus found.

A general description is given of the principal forms, with references to the 25 plates, which are also accompanied by brief "explanations." It was not found possible to engrave all these on copper as was done in the case of the plates of the preceding Parts, and 11 are accordingly lithographs.

It will be observed that Stein includes *Noctiluca* in his order of Arthrodelo-flagellata. His justification for this we propose to deal with later, but here may be mentioned that it is based on the discovery of the forms placed in the two genera *Ptychodiscus* and *Pyrophacus*, which on the one hand are closely related to *Noctiluca* while on the other they are unmistakably Arthrodelo-flagellates.

Among other novelties introduced by Stein are the following:—

The genus *Cenchridium* Ehrbg., hitherto placed with the Foraminifera and forming Williamson's *Entosolenia*, is referred to the Prorocentrinæ from its similarity to *Dinopyxis*, and particularly *D. compressa*. Examination of living individuals is desirable before this classification can be accepted.

Dinopyxis compressa has hitherto been, Stein thinks, erroneously classed as a diatom (=*Pyxidicola compressa* Baily, *P. prisca* Ehrbg. ?).

The problematical organisms which Ehrenberg obtained from flints and described as species of *Xanthidium* (distinct from the true species of *Xanthidium*, which are unicellular algæ of fresh water) Stein places in the genus *Cladopyxis*—the sole genus of the Cladopyxidæ—on account of peculiarities of form which he considers show them to belong to the Flagellata. A species of *Cladopyxis* from the stomach of a *Salpa* is evidently very nearly allied to *X. ramosum* and *X. furcatum* Ehrbg.

Cilio-Flagellata.*—G. Pouchet has made some observations on Cilio-flagellates, supplementing those of Bergh.†

A number of new forms are described, most of which the author hesitates to designate as new species on account of the very rudimentary state of our knowledge, ranging them as varieties in "specific groups." Of *Protoperidinium* two new species are described, of *Peridinium* one, *Glenodinium* three, and *Gymnodinium* one. No new light (the author says) is thrown on the mode of evolution and reproduction, and the facts observed in regard to the conjugation of *Ceratium*, the gemination of *Dinophysis*, and the segmentation of *Amphidinium* "do not seem to agree precisely with one another, and would suggest very great differences in the group which seems, however, to be so homogeneous and so natural."

Some species may present themselves in chains which break up to set at liberty the individuals which have arrived at their full development. The origin of these chains remains completely unknown. It seems scarcely probable that they are formed by epigenesis. They seem rather to result from the simultaneous development of a certain number of cells originally conjugated.

Other Cilio-flagellates (*Dinophysis*) are found in groups of two individuals, which are destined to separate later on; others (*Amphidinium*) divide and multiply after the manner of diatoms.

The mucous cyst, observed by Stein and Bergh, within which fission is said to take place, was never seen, but in some Cilio-flagellates provided with a test (*Peridinium divergens*) the body retracted within it was seen to give rise by fission to two new individuals.

The Cilio-flagellates appear to be directly allied to the *Noctilucæ*, which latter are perhaps directly derived from *P. divergens*. "Everything indicates the closest relationship between these organisms, and if the evolutionary chains pointed out here should come to be directly demonstrated, or if, on the other hand, the peridinian chains should

* Journ. Anat. et Physiol., xix. (1883) pp. 399–455 (12 figs. and 4 pls.).

† Cf. this Journal, ii. (1882) p. 351.

arise, as there is every reason to believe, from cellular chains closely related to algæ (just as *Amphidinium* with the diatoms) then these peculiarities added to the organic complication of the genus *Polykrikos* furnished with an integument and nematocysts, would contribute to render still more indistinct the otherwise entirely artificial line between Plants and Animals."

New Choano-Flagellata.*—A. C. Stokes describes some new species of W. Saville Kent's order of Choano-Flagellata, viz. *Monosiga robusta*, *M. Woodiœ*, *M. longipes*, *Codosiga dichotoma*, *C. longipes*, *Salpingœca acuminata*.

Anatomy of Sticholonche zanclea.†—H. Fol gives a detailed account of the anatomy of this Protozoon, which was originally discovered and shortly described by R. Hertwig. He regards it as forming a special order of Rhizopods — Taxopoda. The main features of its organization are as follows:—The oval body is covered externally by a firm envelope, to which are attached a number of hollow spicules, probably chitinous, with a slight deposition of calcareous salts; these are arranged in radiately disposed groups; the membrane itself appears to be permeated by a system of fine tubules. The body is composed of a fine granular substance in which are imbedded a vast number of clear spherical globules; in the interior is a large "reniform body," covered with a closely set array of rods, and containing in its interior a spherical highly refracting body. There are no true pseudopodia, but a series of "arms," somewhat like the suckers of *Acinetæ*, attached in four longitudinal rows to the rods of the reniform body. Thus far the observations are mainly confirmatory of those of Hertwig. The most important addition to the anatomy of this protozoon is the description of a large mass situated on the concave surface of the reniform body. This mass shows two distinct forms, always seen in different individuals, (1) a number of small globules which pass gradually into the sarcode globules of the body, (2) a single large corpuscle increasing in size with the growth of the animal, and which, when it has arrived at complete maturity, is liberated in the form of an holotrichous Infusorian. This body was observed and figured by Hertwig in certain Radiolarians but erroneously described as a nucleus, and since the "nucleus" is inclosed within the central capsule in these Radiolarians, it seems to be proved that the latter cannot correspond to the reniform body of *Sticholonche*. The further development of this infusoriform body was watched, and it appeared finally to break up into a number of minute spores, the subsequent fate of which could not be traced. The hypothesis at once suggests itself that the two kinds of individuals, one with the mass of globules, the other with the infusoriform body, are of different sexes, but all attempts at fertilization failed. Nothing therefore can be said with certainty concerning the relations and functions of these different structures, though it is evident that the latter at any rate are connected with

* Amer. Mon. Micr. Journ., iv. (1883) pp. 204–8 (6 figs.).
† Mém. Instit. Nat. Genevois, xv. (1883) pp. 3–35 (2 pls.).

the reproductive process; if merely parasites their constant presence and in the same spot is inexplicable. A comparison with other Rhizopods affords no satisfactory explanation of the problematical infusoriform body, though it possibly corresponds to the gemmules arising within the central capsule by which many Radiolarians are propagated.

The following is M. Fol's diagnosis of this genus :—

"Pseudopodia in four rows. Nucleiform body curved in the form of a bean. Membranous envelope of intercrossed tubular fibres. Spines in the form of pins and sabres, arranged in divergent groups."

Studies on the Foraminifera.*—G. Shacko has studied some Orbulinæ from Cape Verde, in which he noticed the large spheres which Moseley regarded as parasitic algæ, and Lankester as cell-nuclei; he is himself inclined to regard them as embryonic chambers, but he did not test them with acids. In some Orbulinæ from the miocene strata of Lapugy he found the shells closely covered by Globigerinæ, but he is not able to understand exactly what their relations to one another were.

A study of the embryos of *Peneroplis proteus* leads him to think that there must be here a very regular constriction of the protoplasm with the formation of nuclei, or else a very regular breaking-up of the whole of the sarcode, such as is seen in the central capsule of the Radiolaria.

The perforation of the shell of *Peneroplis* has also been studied, and the impression arrived at is that the upper layer of the shell was at first really perforated, and that later on this perforation disappeared, when the septal surfaces and their large tubes became firmer.

Development of Stylorhynchus.†—A. Schneider finds that *Stylorhynchus* passes through the greater number of its developmental stages, and often even acquires its adult structure in the interior of an epithelial cell of its host. The same epithelial cell contains several developing parasites. The young is at first similar to a coccidium; this coccidium buds off the segment which will answer to the deutomerite of the adult, then the protomerite, and finally the neck. The primitive body, therefore, minus the nucleus, corresponds to the fixation apparatus of the adult. The nucleus retains its original position till the formation of the protomerite, when it descends into the deutomerite; and the cavity of the rostrum corresponds to the position originally occupied by the nucleus.

* Arch. f. Naturgesch., xlix. (1883) pp. 428-53 (2 pls.).

† Comptes Rendus, xcvii. (1883) p. 1151.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Relations of Protoplasm and Cell-wall in the Vegetable Cell.*— F. O. Bower considers that it has now been demonstrated with as much certainty as is possible, by the use of microchemical and staining reagents, that in certain cases, the number of which is now constantly being increased, there is a direct connection between the protoplasmic bodies on opposite sides of cell-walls, and that this connection is established by means of fine strings of protoplasm which, in the cases observed, run nearly transversely through the walls. The question remains whether this is the only mode of permeation of the cell-wall by protoplasm. The author cannot accept it as proved as yet that any further permeation of the cell-wall by protoplasm really exists, but he brings forward certain grounds for regarding such a permeation as possible or even probable, taking into account chiefly those phenomena observed in free cell-walls, in order thereby to avoid any confusion with connecting strings, such as those already proved to exist:—

1. The strings already observed vary greatly in thickness, from the well-marked to the undistinguishable; thus we have evidence of the existence of strings which would probably not have been recognized were it not for comparison with other examples. Further, it has been shown, in the author's paper on plasmolysis, that protoplasm may be drawn out into strings so fine as to defy definition, even by high powers of the Microscope; thus there can be no objection on the ground of the small size of the hypothetical strings or reticulum.

2. Those cases in which a perforation of cell-walls has been demonstrated are those very cases in which a most efficient physiological connection is required. There is no reason why a less obvious permeation should be denied where the requirements are less, but by no means absent.

3. There is *a priori* probability of some form of permeation of cell-wall by protoplasm, if Strasburger's account of the growth of cell-walls be correct.

4. A strong argument in favour of such general permeation of walls by protoplasm is found in the existence of important chemical changes in the substance of certain cell-walls at points at a considerable distance from the main protoplasmic body, e. g. formation of cuticular substance, wax, &c., which differ fundamentally from cellulose, are insoluble in water, and are apparently formed in the wall itself. The tendency of recent observations is to show more and more clearly how close the connection of protoplasm with the important chemical changes in the plant is; thus it appears probable that protoplasm is present in some form or other in the cell-wall.

* Proc. Brit. Assoc. Adv. Sci., 1883, p. 581. Cf. this Journal, iii. (1883) pp. 225, 524, 677.

Reasons are also given for thinking that the exposure to air is not an important factor in the above changes. These and other considerations show that though this permeation of the wall cannot be accepted as proved as yet in any one case, still the subject deserves more close attention than it has yet received, while it may be expected that the application of new methods may produce definite results bearing on this very important question.

Intercellular Connection of Protoplasts.*—W. Hillhouse gives the results of a large number of observations to prove the intercellular connection of protoplasm. Out of twenty-two plants examined, these connections were only found in the cortical tissue of *Ilex Aquifolium* and *Æsculus hippocastanum*, the pulvinus of *Prunus laurocerasus*, and the winter bud pith of *Acer pseudoplatanus;* he, however, points out that these connections are easily broken in preparation, and that a single connection between a number of cells would be sufficient to produce a perfect unity of action. His conclusions are:—

1. That protoplasmic threads connecting neighbouring protoplasts are present in such widely different and diffused structures as sieve-tubes, cortical parenchyma, leaf-pulvinus, pith of resting leaf-bud, and endosperm of seeds.

2. That in the contraction of the protoplast in natural plasmolysis these threads would normally remain unbroken.

3. That they may serve to transmit impulses from one cell to another, acting in this way somewhat like a nervous system.

4. That besides the perforating threads, equally widely spread and much more numerous, are threads which attach the protoplast to the cell-wall, whether at the base of pits or otherwise, and that these threads are often opposite each other.

5. That the closing membrane separating two threads often shows differentiation, which suggests permeability, if not "sieve-perforation."

6. That in the contraction of the protoplast in natural plasmolysis these threads would naturally be unbroken.

7. That these threads may, when in extension, act upon the cell-wall and put it in a state of slight positive tension.

8. That the presence of minute perforations communicating from cavity to cavity of living cells would not, and when communicating with the intercellular spaces need not, be a hindrance to the turgidity of the cells.

Polyembryony of Trifolium pratense.†—B. Jönsson describes a case of polyembryony in the common red clover. He regards it as arising, not from the presence of several embryo-sacs, but from the formation of more than one ovum-cell in the embryo-sac.

Mechanical Structure of Pollen-grains.‡—J. Vesque states that pollen-grains shrink from evaporation of water; those of a spherical

* Proc. Brit. Assoc. Adv. Sci., 1883. Cf. Nature, xxix. (1883) p. 582. Cf. this Journal, iii. (1883) p. 524.

† Bot. Notiser, 1883, pp. 135–7. See Bot. Centralbl., xvi. (1883) p. 171.

‡ Comptes Rendus, xcvi. (1883) pp. 1684–6.

form sometimes assuming a convexo-concave shape. If the original form is maintained, this is effected by longitudinal ribs. The number of pores has no systematic value; the development of spines and other emergences depends on the law of the greatest economy of space. The pores are so arranged that at least one always comes into contact with the stigmatic fluid. When there is only one pore, this is a compensation to the abundant development of pollen as a protection against self-fertilization.

Fertilization of Philodendron.*—E. Warming describes the phenomena connected with the fertilization of *Philodendron bipinnatifidum*, belonging to the Araceæ. The period of blossoming extends over from 34 to 36 hours; about 7 P.M. on the first day a great increase in temperature takes place in the staminodes and male flowers, to the extent of 18·5° C. excess over that of the surrounding air; no increase of temperature takes place in the female flowers; between 9 and 10 A.M. the next morning a second rise takes place to the extent of from 5° to 7°. About noon of the first day an aromatic odour is perceptible, and towards noon of the second day there is an abundant exudation of an aromatic sap. The anthers open between 4 and 5 P.M., and about 7 the blossoming is at an end. The author considers that fertilization is effected by pollen from the same spike, carried by small black bees, not by snails, as has been supposed.

Fertilization of the Prickly Pear.†—Dr. R. E. Kunzé sees in the irritable stamens of *Opuntia vulgaris*, a provision for securing cross fertilization by insect aid. In fair weather each flower opens on two successive days. Hive-bees, flies, and humble-bees were seen to visit the flowers for nectar, in obtaining which they grasp clusters of stamens, which, when released, fly up against the pistil, from which they slowly recede to their former position. Although the legs of the insects were covered with masses of pollen after visiting a flower, they were not seen to creep over the stigmas. The pollen-grains are therefore supposed to be thrown between the stigmas after the sudden movement of the stamens following the retreat of an insect. It is hardly necessary to add, however, that crossing is well effected by the insects in question, the motion of the stamens insuring a thorough dusting of their bodies with pollen.

Annual Development of Bast.‡—C. Hielscher has examined twenty-six different dicotyledonous and coniferous trees with respect to the amount of fresh bast formed each year. He finds that it does not consist of such well-marked regularly recurring zones as the wood in its annual rings. The primary bast always consists of both hard and soft bast; the secondary bast, formed every year, has usually the same composition, though in some cases, as *Alnus* and *Fagus*, after the second year soft bast only is developed. The amount of bast produced annually consists of three or more tangential rows of soft bast-cells.

* Engler's Bot. Jahrb., iv. (1883) pp. 328–40. See Bot. Centralbl., xv. (1883) p. 372.

† Bull. Torrey Bot. Club, x. (1883) pp. 79–81. Cf. Science, ii. (1883) p. 381.

‡ Abhandl. Naturf. Gesell. Halle, xvi. pp. 113–39.

Independently of the layers, probably functionless, which lie above the cork, the number of zones of active bast is only small. The increase amounts at most to 1/5, usually to not more than from 1/10 to 1/20 of the total increase of the wood.

In order to distinguish between hard and soft bast the author employs anilin sulphate, which stains yellow the elements of the hard bast only. The hard bast appears to be formed first out of the cambium. On each ring of wood, two zones of bast are often formed annually, but one only, or more than two, are not uncommon. In the older stems of many plants the formation of groups of sclerenchymatous cells in addition to bast-fibres is frequent.

Lenticels and the mode of their replacement in some woody tissues.*—H. Klebahn adopts Stahl's classification of the lenticels of dicotyledons and conifers under two types, viz :—(1) those composed of loose cork-cells with denser intermediate striæ, and (2) those with closely packed cork-cells without intermediate striæ. The former kind occur in *Sophora*, *Robinia*, *Alnus*, *Betula*, *Cratægus*, *Sorbus*, *Prunus*, and *Æsculus*; the latter in *Gingko* (*Salisburia*), *Sambucus*, *Lonicera*, *Euonymus*, *Cornus*, *Salix*, *Myrica*, and *Ampelopsis*. In both cases he regards the function of the lenticels to be as organs of aeration, to promote both the interchange of gases and transpiration.

The author then investigates by what means this function is performed in those climbing shrubs which are destitute of lenticels, and finds, in all cases, in the medullary rays, a number of parallel intercellular spaces running in a radial direction through the wood, cambium, and cortex. They are in communication with the intercellular spaces of the wood on the one hand and of the primary cortex on the other hand, and form a very efficient system of aeration for the wood.

Gum-cells of Cereals.†—Johannsen objects to the term "gum-cells" (*Kleberzellen*), applied by Hartig to certain cells in the grains of cereals. On examining thin sections which had been preserved for years in alcohol, he found in these cells a very evident protoplasmic network or system of chambers, the contents of which, probably drops of oil, were soluble in alcohol. Sections of dry grains of wheat, rye, and barley examined in water show in these cells numerous round strongly refringent bodies of nearly uniform size, and larger drops, clearly of oil. Both are stained brown by osmic acid, but only slowly yellow by iodine-water. They consist of oil.

Separate portions of the protoplasmic network were also examined, the meshes of which were nearly as large as the smallest drops of oil. Sometimes they are also stained by osmic acid, and therefore contain oil. The sections were heated for a day or longer with absolute alcohol containing 2 per cent. of corrosive sublimate, when nothing but a protoplasmic network was always left behind, coloured by iodine or anilin-blue.

Since even the most soluble proteinaceous substances become

* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 113–21 (1 pl.).

† Meddel. Bot. Foren. Kjöbenhavn, 1883. See Bot. Centralbl., xv. (1883) p. 305.

insoluble on treatment with alcohol and corrosive sublimate, the author considers it probable that the "gum-cells" do not contain albuminoids, but drops of oil imbedded in a protoplasmic network, and proposes for them the preferable term "oil-cells" (*Fettzellen*).

Nucleus in Amylaceous Wood-cells.*—B. Schorler has investigated the structure of the nucleus in the starch-containing cells of a large number of trees and shrubs belonging to different natural orders. He finds a nucleus universally present in living cells, although of so delicate a nature that it is often not visible except by hardening and staining. Its form is originally spherical or ellipsoidal; but external forces subsequently bring about a great variety of changes. The size also varies very greatly; it is on the average larger in Coniferæ than in dicotyledons. The measurements are given of the nuclei in a great number of species, the length varying from 3 to 25·5 μ; the breadth from 1·5 to 13·5 μ; while some are nearly as broad as long, in others the length is ten times the breadth. The internal differences are but comparatively small, as shown by the different degrees in which pigments are taken up. One or more nucleoli may be present, and a nuclear membrane can usually be detected.

Even in mature wood-cells the nuclei are often not only in a living condition, but are even capable of division. The nucleus may remain unchanged so long as starch is still stored up in the cells. In the older rings of wood they may even retain their vitality for a period of eighty-six years (*Sorbus torminalis*), or even longer. When dead the nucleus does not necessarily disappear, it may become disorganized by a complete change in its internal structure, exhibited by its losing its granular character and becoming rigid, frequently in consequence of becoming permeated by resin. Such nuclei, of a dark brown colour, have been found in the 110th annual ring of the yew.

Peculiar Stomata in Coniferæ.†—K. Wilhelm describes a peculiar structure of the stomata in the leaves of *Abies pectinata*, the outermost cavity of the stoma containing, at all times of the year, a number of nearly black patches composed of a great quantity of minute granules. The particles are nearly insoluble in cold, but very soluble in hot alcohol, and are of the nature of wax, apparently identical with that which covers the surface of the leaves. Their purpose is apparently to hinder transpiration. This peculiar substance appears to be invariably present in the stomata of *Abies pectinata*, and in many other Abietineæ and Cupressineæ, but was not found in the yew.

Root-hairs.‡—F. Schwarz publishes an exhaustive account of the root-hairs of plants in their morphological and physiological relations. Although it is possible in certain cases for roots to absorb nourishment from the soil when destitute of root-hairs, yet the latter are unquestionably the most important organs for this purpose. The

* Jenaisch. Zeitschr. f. Naturw., xvi. (1883) pp. 329–57.

† Ber. Deutsch. Bot. Gesell., i. (1883) pp. 325–30.

‡ Unters. Bot. Inst. Tübingen, i. (1883) pp. 135–88 (1 pl.). See Bot. Centralbl., xv. (1883) p. 337.

increase of surface brought about by root-hairs as compared with that of naked roots at from 5·5 to 18·7.

The root-hair has a constant tendency to grow in a downward vertical direction; when this is interfered with by any solid body, it grows along this body until it can again resume its original direction. A close attachment to the particles of soil is increased by the mucilaginous character of the outermost cell-wall. They are formed only at a certain distance from the apex of the root, in order not to interfere with the hydrotropic and geotropic movement of the latter. The external condition which affects more than any other the formation of root-hairs is the degree of moisture; too little and too much moisture are equally unfavourable. A retardation of growth from too much moisture goes along with a reduction of the amount of root-hairs; a retardation of growth from too little moisture causes a local increase of root-hairs, though the total quantity may be diminished.

The suppression of root-hairs in many water-plants is not due to the smaller supply of oxygen, but to other causes not altogether known at present; some water-plants form root-hairs abundantly when their roots penetrate into mud or soil.

Entire suppression of the root-hairs occurs in only comparatively few plants, not connected genetically, but related only in their mode of life. They are nearly or altogether purposeless in such as have a very abundant supply of water, as many bog- and water-plants, like *Butomus*, *Caltha*, *Euryale*, *Lemna*, *Nymphæa*, &c., and in those which, owing to their very small power of transpiration, require but very little water, as many Coniferæ, *Agave*, *Phœnix*, &c., from which they are altogether absent. They occur, however, in some succulent plants, as Crassulaceæ and Cactaceæ; in the bulbous and tuberous Liliaceæ they are present or absent according to their habit. Parasites usually have root-hairs when they also have the power of growing independently, as *Euphrasia* and *Melampyrum*; *Rhinanthus*, parasitic on the roots of grass, is destitute of them; many saprophytes, as *Monotropa*, *Neottia*, and *Orobanche*, are entirely wanting in root-hairs.

A great increase in the quantity of root-hairs may take place for a specific purpose, and organs of different value morphologically may become covered with them. They occur, for example, on the coleorhiza of Myrtaceæ, *Scabiosa atropurpurea*, and some grasses, for the purpose of fixing the seedling firmly in the soil. In *Psilotum triquetrum*, *Corallorhiza innata*, and *Epipogon Gmelini*, they are produced on the cauline organs, which perform the function of roots.

The root-hair is almost always simply an outgrowth of an epidermal cell. In exceptional cases the mother-cell subsequently forms a sheath round it, as in the prothallium of *Alsophila australis* and *Aspidium molle*. They are developed acropetally without any definite arrangement; rarely, as in *Nuphar*, *Elodea*, &c., they arise out of cells already formed. Their form does not vary greatly, though they are to a certain extent affected by external circumstances, contact, food-supply, &c. They may occasionally branch, and even twine. The longest root-hairs observed by the author were those of the Marchantiaceæ, 18 mm., *Trianea*, 8 mm., *Potamogeton*, 5 mm., and *Elodea*, 4 mm.

Sieve-tubes of Cucurbita.*—According to A. Fischer, a transverse section of an internode of *Cucurbita* shows two systems of sieve-tubes, one belonging to the vascular bundles, and the other situated within the sclerenchymatous ring so characteristic of the Cucurbitaceæ, which lies beneath the strongly developed collenchymatous tissue. This occurrence of sieve-tubes in the cortex is, as far as is at present known, entirely confined to this order. The sieve-tubes of the separate vascular bundles are united into one system with one another and with those of the cortex for the conveyance of nitrogenous formative materials, by fine transverse uniting strings which press through the fundamental tissue. On the other hand the peripheral sieve-tubes can only be in communication with this system through the nodes, as no uniting strings have been observed to pass through the sclerenchymatous ring, which is closed on all sides.

Spines of the Aurantiaceæ.†—J. Urban has investigated the morphological value of the spines, which occur singly or in pairs, in the axils of the leaves of many but not all Aurantiaceæ, and which have been generally regarded as metamorphosed axillary shoots. From comparison with unarmed species, and from the history of development, Urban regards them, on the contrary, as the metamorphosed lowermost leaves of the primary axillary shoot. Intermediate forms are exhibited by some species of *Citrus*.

Tubers of Myrmecodia echinata.‡—M. Treub describes the remarkable tuberous stem of the epiphytal Rubiaceous genera *Myrmecodia* and *Hydnophytum*, which are permeated by passages inhabited by immense numbers of ants. He states that the passages are not burrowed by the ants, but are formed by the disappearance of cells which become entirely enveloped in layers of cork. Their object is not to protect the colonies of ants, or to supply them with food, but rather to facilitate communication between the inclosed air-spaces and the external atmosphere.

Chlorophyll-grains, their Chemical, Morphological, and Biological Nature.§—A. Meyer continues his previous investigations on this subject.‖

He expresses a strong opinion against the chlorophyll-grains being surrounded by a membrane. Where a denser portion becomes separated on contact with water, this must not be regarded as originally present; for if so, it would become thinner by the swelling of the surrounding protoplasm, or by tensions resulting from endosmotic action, which is not the case. Pringsheim's lipochlor and hypochlorin he regards as still hypothetical.

Observations on *Acanthephippium* and *Asphodelus* show that the

* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 276–9.

† Ibid., pp. 313–9 (1 pl.).

‡ Ann. Jard. Bot. Buitenzorg, iii. pp. 129–60 (5 pls.). See Bot. Centralbl., xvi. (1883) p. 103.

§ Meyer, A., 'Das Chlorophyll-korn, in chemischer, morphologischer, u. biologischer Beziehung' (3 pls.). Leipzig, 1883. See Bot. Centralbl., xv. (1883) p. 332.

‖ See this Journal, iii. (1883) p. 239.

autoplast of the chlorophyll-grains consists of a light-coloured matrix in which are imbedded green grains. The phenomena of swelling and other reactions are explained by the following hypothesis:—Every grain contains an invisible inclosed substance soluble in water; the solution of this stretches the framework, which swells at the same time, and which forms a relatively dense envelope around the inclosed substance. The oily substances inclosed, he determined not to consist of a fixed (fatty) oil.

In the passage of autoplasts into anaplasts and chromoplasts, chemical and morphological differences are observable. The former are shown by the different behaviour towards reagents; the latter consist of a change in the structure, size, and mass of the trophoplast.

The form of the trophoplast is altered first of all by foreign bodies which grow in or on it. The autoplasts of many plants also undergo a change of form under the influence of rays of light. The position of the trophoplasts within the cells is also not fixed, light and gravitation causing variations in this respect.

From the investigation of starch-grains in parenchyma-cells of colourless stems, petals, fruits, seeds, and scales, the author draws the conclusion that wherever starch-grains occur, trophoplasts are also present, in or on which the starch-grains grow. The viridescence of ordinarily colourless parts of plants always depends on the transformation into autoplasts of anaplasts already present in the colourless cells. Wherever looked for, in parenchyma-cells, epidermal cells, sclerenchymatous cells, and sieve-tubes, the author always found trophoplasts.

In all cases where chlorophyll-grains are formed by the investment of starch-grains with viridescent protoplasm, the first stage is always the formation of trophoplasts. Observations on the development of the autoplasts of *Allium Cepa* and *Elodea* led to the conclusion that trophoplasts never arise from a differentiation of the protoplasm; but that they always multiply by division, and, with the protoplasm in which they are imbedded, always pass in a young and small condition into the daughter-cells on the division of a meristem-cell; there they increase further by division, grow with the cell either into anaplasts or into autoplasts and chromoplasts, and usually disappear with the death of the cell.

Mechanism of the Splitting of Legumes.*—According to C. Steinbrinck, the splitting of legumes is chiefly the result of hygroscopic tensions between the ligneous layer and the outer epidermis, alone or together with the hypoderm. These tensions are caused not only by the greater capacity of the ligneous layer for swelling, but depend essentially on the cross position of the cells of both tissues, which contract more in the transverse than in the longitudinal direction. This difference of contraction being greatest in the direction of the tangential transverse diameter of the ligneous fibres, these bring about a spiral curving inwards of both valves of the legume, which causes them eventually to spring asunder. In the different

* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 270–5.

genera and species this curvature is more or less strengthened by the capacity for swelling of the masses of cellulose in the ligneous layer increasing more or less from the outside inwards.

Aerial Vegetative Organs of Orchideæ in relation to their Habitat and Climate.*—An examination of the structure of a large number of both native and tropical Orchideæ leads P. Krüger to the following general conclusions on this subject:—Starting from the native species, there may be seen, both in the foliar and axial organs, a series of gradual variations, which increase in importance as the climatic conditions of the species vary from ours. In one group of tropical orchids the original herbaceous habit is still maintained; while contrivances to suit other conditions are perfected in changes in the parenchyma, having for their purpose the absorption of the water necessary for the plant, and protection from transpiration. In a further stage the herbaceous form is abandoned as unsuitable, and the succulent form assumed; while in a third type the development of a mechanically firm and resistant system strengthens the epidermal tissue, or assists in the formation of special receptacles for water, or a combination of the two means. All these changes are accompanied by corresponding changes in the cuticle, having for their object the diminution of transpiration in tropical orchids.

Assimilation of Carbonic Acid by Protoplasm which does not contain Chlorophyll.†—By experiments on *Penicillium glaucum*, J. Reinke finds that all the carbon-acids tested, with the exception of carbonic, formic, and oxalic acids, are of equal value for its nutrition, but are useful only when in combination with bases. The methyl-group can in many cases supply the fungus with carbon; as also can the group $C_6 H_5$. Before it becomes serviceable to the plant, the carbon of the acids must apparently enter into combination with hydrogen, in consequence of a process of reduction brought about by the assistance of water, and by means of protoplasm.

Artificial Influences on Internal Causes of Growth.‡—E. Wollny points out that the reason why the secondary shoots of woody plants grow more rapidly when the main stem is decapitated, is not merely that they receive a better supply of nourishment, but that the conditions of the soil are altered through greater access of moisture and warmth. The popular idea that vegetation keeps the ground moist is exactly the reverse of the truth.

Absorption of Food by the Leaves of Drosera.§—By a series of experiments, M. Büsgen has confirmed in a very striking manner the observations of Rees and Darwin as to the capacity of *Drosera rotundifolia* for absorbing nutriment through the leaf. The number of inflorescences and capsules was found to average very much higher (from three to five times as many), when the leaves were fed with

* Flora, lxvi. (1883) pp. 435–43, 451–9, 467–77, 499–510, 515–24 (2 pls.).
† Reinke's Unters. Lab. Göttingen, Heft 3. See Bot. Ztg., xli. (1883) p. 551.
‡ Wollny's Forsch. Geb. Agrikulturphysik, vi. (1883) pp. 97–134. See Biol. Centralbl., iii. (1883) p. 385.
§ Bot. Ztg., xli. (1883) pp. 569–77, 585–94.

insects, compared with those not so fed under similar circumstances, even when an abundant supply of a nutrient fluid was furnished to their roots.

Mechanical Action of Light on Plants.*—F. Cohn has investigated not so much the cause of the apparently spontaneous movements of the lower plants and of animals, as the forces which induce those movements to assume certain definite directions.

Non-chlorophyllaceous organisms, such as monads and the zoospores of fungi, move freely in every direction indifferently in reference to the incidence of the rays of light.† Diatoms and Oscillarieæ, coloured respectively by phæophyll and phycochrome, always prefer light to darkness, and accumulate therefore on the surface of the water. When the field is equally illuminated in all directions, diatoms are distributed uniformly through the water, and Oscillarieæ radiate equally in all directions. Green microscopic organisms which contain chlorophyll, such as Eugleneæ, Volvocineæ, and the zoospores of most algæ, always display a certain polarity, one end being destitute of chlorophyll and usually provided with cilia and a red "eye-spot," and being also more pointed in comparison to the other end, which is coloured a deep green. The pointed end is always the anterior end in the "swarming" motion; and this advancing motion is always accompanied by a rotating movement round the longitudinal axis which passes through the two ends; the direction of this rotation varies in different organisms. A number of experiments undertaken by Cohn show that when the direction of the incidence of the light on the field of view is made to vary, the direction of the motion of these green organisms varies with it; they always seek light and avoid darkness. But it is a remarkable fact in connection with this, that it is the direction rather than the intensity of the light that seems to influence them; as is seen when the light is reflected on to the field of view from a mirror. Reflected light appears to have no more effect in influencing the direction of their movements than absolute darkness. Experiments with coloured glasses show that it is only the more refrangible actinic rays which have this effect on the movements of minute organisms; the less refrangible, which have no chemical action, have also no effect of this kind. A few exceptional organisms display a power of motion in the opposite to the ordinary direction.

A comparison of these movements with those of artificial euglenas which are made to evolve carbon dioxide from one end, shows that the direction of the movement is dependent on the decomposition of carbon dioxide by the aid of the organism which contains chlorophyll, and hence on its polarity.

These movements of green swarm-spores and similar bodies are compared by the author with the phototonic movements of the organs of plants, on which many observations have recently been made, especially by Stahl.‡

* JB. Schles. Gesell. Vaterl. Cult., 1883, pp. 179–86.

† With the exception, however, of bacteria, as shown by Engelmann. See this Journal, ii. (1882) pp. 380, 656; iii. (1883) p. 256.

‡ See this Journal, ii. (1882) p. 373.

Action of the Amount of Heat and of Maximum Temperature on the Opening of Flowers.*—W. von Vogel states, as the results of a series of experiments, that the maximum temperature of the day has seven times greater influence on the opening of flowers than the average daily temperature. The mode of obtaining this result is detailed in the paper.

Behaviour of Vegetable Tissues towards Gases.†—J. Boehm describes an apparatus which he has contrived for the purpose of testing the variations, under different conditions, in the absorption of gases by vegetable tissues, by starch, and by coal. One of the most interesting of his conclusions is that the cell-wall is more permeable for oxygen than for nitrogen. Dry filings of wood and of starch-grains absorb four or five times their weight of carbonic acid, while cork absorbs comparatively little. Carbonic acid, oxygen, and hydrogen all become compressed in closed cells, owing to their greater diffusibility as compared to nitrogen.

Influence of External Pressure on the Absorption of Water by Roots.‡—J. Vesque has carried out a series of experiments on this subject, chiefly on two plants, one woody, the oleander, and the other herbaceous, the garden bean. The following is a summary of the results arrived at:—

1. The absorption of water by the roots of the oleander depends on external pressure; it seems to augment in proportion to the difference between the external pressure and that of the air contained in the woody mass of the root.

2. Osmose does not appear to be always very active; for, in diminishing the atmospheric pressure to about 60 cm. of water, absorption is arrested.

3. In the conditions of the experiments the pressure of the internal air is not very different from that of the atmosphere. It is mostly less from zero to 9 cm. of mercury; in one instance only did the internal pressure exceed that of the atmosphere by 1 cm. of mercury.

4. The effect of pressure on the oleander is sufficient for a sudden change of barometric pressure to cause a sensible disturbance in the absorption of water by the roots.

5. The garden bean was much less influenced by external pressure, as respects the absorption of water by the roots, than the oleander. There certainly is some influence, but it is ordinarily imperceptible among fluctuations resulting from changes of transpiration or from other secondary causes.

Contrivances for the Erect Habit of Plants, and Influences of Transpiration on the Absorption of Water.§—V. Meschayeff does not agree with Schwendener's view that there is a special tissue-system for the purpose of maintaining organs in an erect condition; he considers,

* Bull. Soc. Imp. Nat. Moscou, lviii. (1883) pp. 1-13. See Bot. Centralbl., xvi. (1883) p. 145.

† Bot. Ztg., xli. (1883) pp. 521–6, 537–50, 553–9.

‡ Comptes Rendus, xcvii. (1883) pp. 718–20.

§ Bull. Soc. Imp. Nat. Moscou, 1883, pp. 299–322.

on the contrary, that all the different tissues may be adapted to this special purpose.

The process of the absorption of water he explains as follows:—Transpiration attracts, so to speak, upwards the osmotic force, which is met by the flow of sap from all the neighbouring parts of the stem, especially in the elongated elements. The diminution of pressure which results brings into play from below the turgidity of the stem and the elasticity of the cortex; this causes increased activity in the root, which brings about an accumulation of water in the lower parts of the plant and an increased elevation of the sap. Capillarity and air-pressure play only a secondary part.

Sap.*—J. Attfield gives an account of observations made on sap exuding from a wounded silver birch tree. A branch 7 inches in diameter, had been lopped off a tree 39 ft. high, about 10 ft. from the ground, before the leaves had expanded, leaving a wound about an inch in diameter, from which sap dropped. A bottle was suspended so as to catch the sap, and from observations it was found that the flow was apparently faster in sunshine than in the shade, and by day than by night, and altogether amounted to about 5 litres a day; this had been running for 15 days, but how long it would continue is uncertain. The sap was clear and bright, sp. gr. 1·005, had a faintly sweet taste and a slightly aromatic odour. After 12 hours it deposited a trace of a sediment, which, when examined microscopically, was found to consist of parenchymatous cells and a few so-called sphere-crystals. The liquid contained 99 per cent. water and 1 per cent. solid matter, which was composed mainly of sugar, 91 per cent., the other constituents being ammonium salts, albuminoids, nitrates, phosphates, and organic salts of calcium and magnesium, mucilage, and traces of nitrites and potassium salts. It had calcium and magnesium salts in solution equal to 25 degrees of total permanent hardness. It contained a ferment capable of converting starch into sugar, and when exposed to the air, it soon teemed with bacteria, the sugar being changed into alcohol.

Solid Pigments in the Cell-sap.†—The petals of flowers are far more often coloured by a pigment soluble in the cell-sap than by one in a solid granular form. Of 200 species examined by P. Fritsch, only 30 contained solid pigments in the cells either of the petals or of the fruits.

Far the most common of these solid pigments is yellow, much the greater number of yellow flowers, including nearly all yellow Compositæ, being indebted for their colour to substances of this nature. Exceptional instances of soluble yellow pigments occur in the petals of *Dahlia variabilis*, *Althæa Sieberi*, and *Tagetes*, and in the hairs of a good many species. Solid yellow pigments are described in *Impatiens longicornu*, where they vary greatly in size and form, *Tropæolum majus*, where the various shades of colour in the flower are due to a

* Pharm. J. Trans., xiii. (1883) pp. 819–20. Cf. Journ. Chem. Soc.—Abstr., xliv. (1883) pp. 1164–5.

† Pringsheim's Jahrb. Wiss. Bot., xiv. (1883) pp. 185–231 (3 pls.).

substance of this description imbedded in a brown cell-sap, *Œnothera biennis*, *Cerinthe aspera*, *Calendula officinalis*, *Tagetes glandulifera*, *Viola tricolor*, *Rudbeckia laciniata*, *Digitalis ambigua*, and *Salpiglossis variabilis*. The particles of the pigment are often in a state of active molecular movement; they are always coloured green by iodine, and are soluble in concentrated sulphuric acid with a deep blue colour. In some other chemical reactions they vary. The pigment appears to be always imbedded in a matrix of protoplasm.

A solid red pigment was observed in the fruits of *Rosa canina*, *Pyrus aucuparia* and *Hostii*, *Convallaria majalis*, *Bryonia dioica*, and in the aril of *Euonymus latifolius* and *europœus*, *Celastrus candens* and *Taxus baccata*.

The red pigment in the cortical portion of the root of the carrot is of a very peculiar kind, resembling long pointed crystals. The cells of the scarlet berry of *Arum maculatum* contain a great quantity of minute brownish-red granules.

Insoluble violet pigments are rare, but occur in *Thunbergia alata* and *Delphinium bicolor*; while blue granules are found in the fruit of *Viburnum Tinus*. Brown insoluble pigments were found only in sea-weeds, *Fucus vesiculosus* and *Furcellaria fastigiata*.

The development of the coloured granules does not end with their acting as pigments; after this period they go through a variety of changes of development or degradation.

Movement of Sap in Plants in the Tropics.*—Observations made in Europe show that the activity of the circulation of the sap has two periods of maximum in the 24 hours, one in the morning, the other, less pronounced, in the afternoon. V. Marcano has carried on a series of experiments to determine whether the same is the case in the tropics. They were made at Caracas in Venezuela, about 10½° N. lat., at a height of 869 metres above the sea-level, where the barometric pressure scarcely varies from 1 to 2 mm., and the thermometer not more than 3° in the 24 hours. The plants observed were *Carica Papaya* and a liane. By means of a manometer, two very well marked maxima in the rapidity of the movement of the sap were detected, the first between 8 and 10·15 A.M., after which the curve rapidly sinks to zero, remains there for a time, and then rises, between 1 and 3 P.M., to a much smaller height than in the morning, sinking then again gradually to zero, the activity commencing again after sunrise.

Exudation from Flowers in Relation to Honey-dew.†—T. Meehan refers to the fact that standard literature continues to teach that the sweet varnish-like covering often found over every leaf on large trees, as well as on comparatively small bushes, was the work of insects, notably Aphidæ. Dr. Hoffman, of Giessen, who in 1876 published a paper on the subject, is the only scientific man of note who takes ground against this view. He met with a camellia, without blossoms, and wholly free from insects, and yet the leaves were coated with "honey-dew." He found this substance to consist of a sticky colour-

* Comptes Rendus, xcvii. (1883) p. 340.
† Proc. Acad. Nat. Sci. Philad., 1883, p. 190.

less liquid, having a sweetish taste, and principally gum, and Mr. Meehan has often met with cases where no insects could be found, as well as others where insects were numerous, and where in the latter case, the attending circumstances were strongly in favour of the conclusion that the liquid covering was the work of insects. He considers that few scientific men have any knowledge of the enormous amount of liquid exuded by flowers at the time of opening, and he has seen cases where the leaves were as completely covered by the liquid from the flowers, as if it had exuded from the leaves, as he considers Dr. Hoffman had good grounds for believing is often the case.

What is the object of this abundant exudation of sweet liquid and liquid of other character from leaves and flowers? We are so accustomed to read of nectar and nectaries in connection with the cross-fertilization of flowers, that there might seem to be no room for any other suggestion. But plants like *Thuja* and *Abies* are anemophilous, and, having their pollen carried freely by the wind, have no need for these extraordinary exudations, from any point of view connected with the visits of insects to flowers. In the case of *Thuja*, Sachs has suggested another use: "The pollen-grains which happen to fall on the opening of the micropyle of the ovules are retained by an exuding drop of fluid, which about this time fills the canal of the micropyle, but afterwards dries up, and thus draws the captured pollen-grains to the nucellus, where they immediately emit their pollen-tubes into its spongy tissue. In the Cupressineæ, Taxineæ, and Podocarpeæ, this contrivance is sufficient, since the micropyles project outwardly; in the Abietineæ, where they are more concealed among the scales and bracts, these themselves form, at the time of pollination, canals and channels for this purpose, through which the pollen-grains arrive at the micropyles filled with fluid."*

In his former observations on liquid exudation in *Thuja* and other plants, Mr. Meehan was inclined to adopt the suggestion of Sachs as to the purpose of the liquid supply; but as it was present in *Abies* so long after fertilization must have taken place, and as it was held up in the deep recesses of the scales of the pendent cone, where it could hardly be possible the wind could draw up the pollen, we must look for other reasons, which, however, do not yet seem to be apparent.

Latex of the Euphorbiaceæ.†—S. Dietz has studied the composition of the latex of various plants, especially of the Euphorbiaceæ. He finds almost invariably crystalline substances to be present which crystallize out when the latex is made to coagulate under the cover-glass. In the Euphorbiaceæ he distinguishes three kinds of crystallizable substances, as follows:—

1. Sphærocrystals. These differ in their mode of development from any hitherto known. In the coagulated latex of the Euphorbiaceæ

* Sachs' 'Text-book of Botany,' 2nd Engl. ed., 1882, p. 513.

† M. Tud. Akad. Ertek., xii. (1882) 23 pp. (2 pls.). See Bot. Centralbl., xvi. (1883) p. 132.

there arise separate dense spherical groups, becoming gradually denser as the solvent evaporates, in consequence of which, when crystallization commences, an empty space is formed in the interior of the sphærocrystal. The sphærocrystals of the Euphorbiaceæ are organic in their nature, and all belong to the inulin type. They occur in especially large numbers in the coagulated latex of *Euphorbia splendens*, *heptagona*, and *erosa*, in the last species with a diameter of 0·8–1·0 mm.; also, less developed, in axial organs of the two first-named species. The latter differ from other sphærocrystals in dissolving in glycerine after from four to eight weeks' immersion.

2. Resin-crystals were found in the latex of all species of Euphorbiaceæ examined, belonging to the cubical system. They are of three kinds:—viz. (1) forming angular dendritic groups; (2) groups consisting evidently of closely packed separate crystals; (3) those which occur only isolated.

3. Crystals consisting especially of potassium and calcium malate. These belong mostly to the rhombic and to the bi- and uniaxial systems. True crystals of salts of malic acid also occur, to which he gives the name of stellate crystals.

Crystalloids in Trophoplasts, and Chromoplasts of Angiosperms.*—Pursuing his previous investigations of starch-generators or trophoplasts,† A. Meyer has come to the conclusion that the bodies described by Schmitz in algæ under the name of pyrenoids ‡ are identical with the crystalloids of proteinaceous substances which frequently occur in the fusiform trophoplasts of many flowering plants. They differ from the protoplasm in having no framework or plastin. The crystalloids of *Phajus* swell and dissolve with greater or less readiness in water; they are completely soluble in solution of chloral hydrate; when hardened by alcohol they are soluble in cold potash-lye, but not when hardened by mercuric-chloride; they are colourless, homogeneous, and doubly refractive; when hardened by picric acid they are distinctly stained red by alum-carmine, but less easily than the nucleus. In most of these characters they agree altogether with Schmitz's pyrenoids.

The autoplasts of foliage-leaves are usually formed as follows:—The comparatively small trophoplast of a meristem-cell, which is at first colourless and globular, or more or less regularly stretched by the surrounding protoplasm, begins to grow slowly with the protoplasm of its mother-cell. The framework or plastin thus increases in mass, and grains of chlorophyll are formed within it, and possibly other at present unknown substances soluble in alcohol. The mature autoplast appears to have changed its structure before it exhibits any change in colour. The trophoplasts of the petals of angiosperms are usually smaller than those of the foliage-leaves, but do not differ from them in any essential respect. The trophoplasts of foliage-leaves may be classed under the four following types:—(1) colourless

* Bot. Ztg., xli. (1883) pp. 489–98, 505–14, 526–31.
† See this Journal, ii. (1882) p. 368.
‡ Ibid., iii. (1883) p. 405.

during the whole of their existence; (2) at first colourless, then forming chlorophyll, which remains till the death of the cell; (3) colourless and forming chlorophyll, which afterwards passes over into xanthophyll; (4) colourless, producing xanthophyll directly sooner or later; (5) coloured by xanthophyll during the whole of their existence.

The chromoplasts of flowers may be classified as follows:—A. In the last stage of development round, or (in the epidermis) more or less angular from mutual pressure, never fusiform. (*a*) They produce comparatively little xanthophyll, and appear at last more or less flat and irregularly filled with vacuoles; xanthophyll light yellow. (*b*) They produce comparatively little xanthophyll, and contain till the end a great quantity of starch; xanthophyll light yellow. (*c*) They produce a comparatively large quantity of xanthophyll, and are finally more spherical: *α*. with none or very few vacuoles, and xanthophyll reddish yellow; *β*. xanthophyll light yellow. (*d*) They produce a comparatively large quantity of xanthophyll, which finally lies within the protoplasm in a granular form. B. They finally become fusiform from the tendency of the xanthophyll to crystallize; xanthophyll usually dark or reddish yellow. C. They produce crystalloids in or on them, by which they are more or less stretched. Of each of these types, between which there are transitional forms, the author cites examples.

Formation and Resorption of Cystoliths.*—According to J. Chareyre, the reserve-materials of the Urticineæ and Acanthaceæ consist of aleurone-grains, each of which contains a globoid; *Acanthus* and *Hexacentris* also contain starch. The globoids which constitute the calcareous reserve-materials of the seed disappear more completely if the plant is cultivated in pure sand than in limestone or ordinary soil; but they do not contribute to the formation of cystoliths. In pure silica the pedicel only of the cystoliths is formed. In darkness only rudimentary cystoliths are produced.

In the Acanthaceæ etiolation and death produce no effect on the cystoliths; but in *Ficus elastica* the calcium disappears in darkness after about fourteen days. The resorption of the calcium carbonate does not result from its passing over into the alkaline carbonate. Under normal conditions, the cystoliths are formed again in a month or six weeks. Calcium oxalate behaves in the same way. In etiolated leaves of *Ficus*, sulphuric acid produces a larger quantity of crystals of gypsum than in normal leaves.

Function of Organic Acids in Plants.†—W. Detmer regards the organic acids as having a very important function as the chief promoters of osmose, and consequently of the turgidity of the cell. The conversion of starch into sugar is also greatly dependent on the presence or absence of free acids; the presence of carbonic acid and of small quantities of hydrochloric, nitric, phosphoric, citric, and oxalic

* Comptes Rendus, xcvi. (1883) pp. 1594–6. Cf. this Journal, iii. (1883) p. 389.

† SB. Jenaisch. Gesell. Med. u. Naturw., 1883, pp. 47–9.

acids promoting this conversion by means of starch in a remarkable manner. Absence of these acids not only decreases the transformation of starch but also the turgidity of the cells; but this conversion can only be effected by the combined action of the acid and of the ferment.

Formation of Ferments in the Cells of Higher Plants.*—A series of experiments by W. Detmer leads him to the conclusion that in the cells of higher plants no transforming ferment can be produced in the absence of oxygen. Access of free oxygen is an essential condition for the formation of diastase, and the ferment is unquestionably formed by means of oxygen out of the albuminoids or proteids of the protoplasm.

Poulsen's Botanical Micro-Chemistry.†—This book, after having been translated from the original Danish into German, French, and Italian, at last appears in English, having been translated, with the assistance of the author, and considerably enlarged by Professor W. Trelease, of Wisconsin, U.S.A.

We referred to the original work (i. 1881, p. 772) but we may quote the following paragraphs from the introduction as showing its scope:—

"Physics has thus striven to bring the Microscope to as great a degree of perfection as possible; it remains for chemistry to find means of recognizing and rightly understanding the composition of the objects we investigate. In other words, if we employ a thorough system of chemical analysis with the optical apparatus, we shall be able to answer all questions lying within the range of possibility. It is this analysis applied to objects under the Microscope that we designate by the word *micro-chemistry*.

I have endeavoured to successively make the reader acquainted with the most valuable reagents used in micro-chemistry, i.e., with those substances whose action on the bodies to be studied allows their chemical composition and nature and sometimes their physical structure to be recognized. In the first section I have considered the chemicals used in the laboratory; in the second, the vegetable substances to be tested for, and the reactions by which they are known . . . At the close of the first section I have introduced a short chapter on media for the preservation of permanent preparations, to which are added a few words on the cements used in mounting."

The book ought to be in every microscopist's library.

* Bot. Ztg., xli. (1883) pp. 601–6.

† See *infra*, Bibliography *a*.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Classification of Ophioglossaceæ.*—K. Prantl gives the following characters of the primary subdivisions of the genera belonging to this family:—

I. *Botrychium.*

Sectio 1. *Eubotrychium.* Folia semper glaberrima, stomata in utraque pagina obvia; lamina oblonga vel deltoidea, ad summum bipinnata; petioli fasciculi bini præter binos in pedunculum exeuntes; xylema rhizomatis indistincte seriatum. 5 sp.

Sectio 2. *Phyllotrichum.* Folia juvenilia sæpe et adulta pilosa, stomata infera; lamina deltoidea, bi- ad quinquepinnata; xylema rhizomatis distincte seriatum. 10 sp.

II. *Helminthostachys.* 1 sp. (*H. zeylanicum*).

III. *Ophioglossum.*

Sectio 1. *Euophioglossum.* Rhizoma hypogæum, præter involucri margines glabrum, pedunculus solitarius e petiolo vel basi laminæ oriundus, petioli fasciculi basi tres, intra laminam plus minus ramosi, stomata utrinque obvia, rarius supra parca vel nulla, radicis fasciculus monarchus. 27 sp.

Sectio 2. *Ophioderma.* Rhizoma epidendrum papillosum; pedunculus solitarius e lamina oriundus; lamina fasciæformis integra vel dichotome lobata, basi sensim in petiolum teretem angustato, nervo mediano hinc inde laterales emittente, petioli fasciculi numerosi, stomata utrinque obvia, radicis fasciculus tri- ad tetrarchus. 1 sp. (*O. pendulum*).

Sectio 3. *Cheiroglossa.* Rhizoma epidendrum longepilosum; pedunculi plures, anteriores e margine basali laminæ dichotome lobatæ oriundi, nervis dichotomis; petioli fasciculi numerosi; stomata infera; radicis fasciculus diarchus. 1 sp. (*O. palmatum*).

Structure of Helminthostachys.†—From an examination of *Helminthostachys zeylanica* from Borneo, K. Prantl discusses the relationship between this and the two remaining genera of Ophioglossaceæ.

It is distinguished from both *Ophioglossum* and *Botrychium* by its dorsiventral horizontal rhizome, bearing two rows of leaves on its dorsal and several rows of roots on the lateral and ventral sides. Only a single leaf unfolds each year. The course of the fibrovascular bundles resembles that in *Botrychium* rather than in *Ophioglossum;* there is no median bundle; but, on the contrary, there are four placed diagonally to the base of the leaf-stalk. In the absence of any sclerenchyma in the collateral structure of the bundles in the stem and leaf, in the absence of palisade-parenchyma, and in other points, *Helminthostachys* presents a complete agreement with the other two genera.

* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 348–53.

† Ibid., pp. 155–61.

The most striking peculiarity of *Helminthostachys* is the fertile portion of the leaf, which is densely covered with sporangia, between which are still green portions of the mesophyll. Each of these green portions is the sterile apex of a branchlet.

Muscineæ.

Structure and Development of certain Spores.*—H. Leitgeb describes a number of examples of departure from the ordinary structure of the spores of cryptogams, viz. where the membrane is composed of two distinctly differentiated coats like the cell-wall of pollen-grains, mostly in the case of Hepaticæ. With Strasburger he retains the same terminology for the two coats, as for those of pollen-grains, viz. extine and intine; but restricts the latter term to an inner layer consisting of pure cellulose. In *Osmunda*, *Ceratopteris*, and *Gleichenia*, for example, there is no true intine or endospore, the inner layer of the spore-membrane being completely cuticularized, and showing none of the reactions of cellulose. Again, in many thin-walled spores which germinate immediately after maturity without any period of rest, as in those of many Jungermanniaceæ, *Jungermannia*, *Lophocolea*, *Lepidozia*, *Blasia*, &c., there is only one membrane with cuticularized outer layer, the whole of which is used up in the formation of the germinating filament. This is exactly comparable to certain pollen-grains, as those of *Naias* and *Orchis*, and in a certain sense also those of *Allium fistulosum*, where there is only one membrane, the whole of which goes to the formation of the pollen-tube. In other cases again, an inner layer of cellulose employed, in the formation of the germinating filaments, is formed only immediately before the period of germination.

In many thick-walled spores of Hepaticæ, the wall always consists of more than two distinctly differentiated layers; the exospore, extine, or sporoderm being composed of two separable layers, similar to the well-known case of *Equisetum*.

One type of this structure is furnished by *Preissia*, *Duvallia*, *Reboulia*, *Fimbriaria*, and *Plagiochasma*. The intine, which turns blue and swells strongly with chloriodide of zinc, is inclosed in a cuticularized layer, which is entirely structureless, and may be termed the extine. This is again inclosed in a third layer with folded protuberances, and elevated like a bladder on one side. But slightly different are the spores of *Grimmaldia* and *Boschia*.

Corsinia resembles these genera in the structure of the intine and extine, but that of the outermost layer is very different. It is of uniform thickness (as much as 20 μ), and is composed on the dorsal side of polygonal (usually hexagonal) plates, while on the ventral side it is a continuous perfectly smooth shell. Where the dorsal and ventral sides meet, is a projecting seam.

In *Sphærocarpus*, the spores remain united into tetrahedra; but this is not, as in *Lycopodium*, the result of a simple attachment of the adjacent walls; they are inclosed in a common membrane which is

* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 246–56.

closely connected with the walls which separate the spores from one another, and consists in fact of layers of the mother-cells of the spores. This membrane is beautifully sculptured on the outside by projecting reticulate bands; and the outer surface of the extine is also similarly sculptured. The history of development of these spores and of the sculpture is gone into in detail; and the author shows that in *Corsinia* also, and probably also in the other thick-walled spores, the outermost layer is developed, as in *Sphærocarpus*, from the membrane of the mother-cell, and from its innermost layers, the special mother-cell; its formation beginning only after the formation of the true extine, and before the peripheral layers disappear.

Fungi.

Alkaloids and other Substances extracted from Fungi.*—C. J. Stewart considers that the chemistry of fungi is by no means in a satisfactory state. Many of the existing statements are rendered doubtful by a bad identification of the species. It is also difficult to obtain a sufficient amount of raw material, and its perishable nature interposes another obstacle. Beyond this, the research itself is so difficult and expensive, and the question of profitable result is so remote to ordinary minds, that few qualified chemists have even ventured upon the task. He has accordingly endeavoured to collect together such facts as were scattered in chemical literature, and to explain them as untechnically as was possible with due regard to exactness and truth. The paper is not capable of being usefully abstracted, but it deals with the sugars found in fungi, oils and fats, vegetable acids, resins, colouring matters, trimethylamine, betaine, muscarine, and amanitine ($C_5\ H_{15}\ NO_2$). This is identical with the animal bases choline and neurine, and is another link between fungi and the animal kingdom. The production of these bodies artificially, which has been accomplished, is of great interest, as very few natural alkaloids have yet been artificially made; and the success leads us to hope that we may some day produce such medicinal alkaloids as quinine and morphia by chemical means at a cheaper rate.

Development of Ascomycetes.†—E. Eidam describes a new genus of fungi, *Eremascus*, which he regards as, with the exception of *Saccharomyces*, the simplest type of the Ascomycetes, the entire fructification being reduced to a single naked ascus. It occurs as a white pellicle on the surface of extract of malt. On the much-branched mycelium there appear, directly on the septa, and on both sides, two precisely similar protuberances, which grow into hyphæ, and coil spirally round one another even in their youngest stages. The spiral consists of several coils; the apices of the two hyphæ touch one another, and the septum becomes absorbed and their contents completely coalesce. The point of coalescence, which is at first small, increases into a spherical body, which becomes at length separated by septa from the rest of the spiral hyphæ. The remainder

* Grevillea, xii. (1883) pp. 44–9.
† JB. Schles. Gesell. vaterl. Cult., 1883, pp. 175–7.

of these hyphæ perform the function of conducting cells, and the spherical body becomes an ascus, in which eight ascospores with double cell-walls are formed. The ascus is either quite solitary, or as many as four, with their conducting cells, stand at the same height on the mycelial filaments. The author classes *Eremascus* among the Gymnoascaceæ.

A new species of *Gymnoascus* is described, *G. setosus*, found in quantities on a wasp's nest.

The author next gives a full description of the history of development of a species of *Sterigmatocystis*, which forms both conidiophores and asci in a very peculiar way. The perithecia are buried in a large hollow envelope formed of branched filaments, the ends of which swell up into colourless or slightly yellow thick-walled vesicles. Within this cushion are produced the asci. Two very fine hyphæ swell up at their apices, coil, one forming the "nucleus," the other branching and forming the wall of the perithecium. The young fructification has the remarkable property of its colourless contents turning a beautiful blue on addition of ammonia or potash, which changes to red when an acid is added. This colouring substance occurs only in the wall of the perithecium, which, when ripe, is nearly black, and in the ascospores, which are purple. These latter ripen very slowly, and, on germination, produce again the conidiophores of *Sterigmatocystis*.

In *Chætomium* (*C. Kunzeanum* Zopf) the origin of the fructification is a single thickish hypha which developes into a distinctly segmented spiral. In the further development Eidam agrees with Van Tieghem rather than with Zopf. A pseudo-parenchymatous ball is formed by the branching of a single spiral filament which is clearly distinguishable from the rest of the mycelium.

Conidia of Peronospora.*—M. Cornu gives a more exact description than any previous observer of the mode of abstriction of the conidia of *Peronospora*. In the middle of the septum which separates the conidium from its hypha is formed a soluble gelatinous layer. This accounts for the rapid development of *Peronospora* after rainy weather. Cornu disputes the possibility of the oospore directly producing zoospores on germination like the conidia, or rather the sporangium, as de Bary has described in the case of *Cystopus*. Each oospore, on the contrary, developes into a mycelial filament bearing a sporangium. Their germination depends greatly on moisture and temperature, as also on the depth at which they are buried in the soil. When at a considerable depth they may retain their power of germination for from two to five years.

Pleospora herbarum.†—Great confusion has resulted from authors having described under this name different organisms which have no genetic connection with one another. F. G. Kohl has carefully investigated its life-history, having sown the ascospores obtained from

* Cornu, M., 'Etudes sur les Peronosporées. II. Le Peronospora des vignes.' 91 pp., 5 pls., Paris, 1882. See Bot. Centralbl., xv. (1883) p. 274.

† Bot. Centralbl., xvi. (1883) pp. 26–31.

perithecia growing on the stems of *Levisticum officinale*. On the same host was found also the conidial form known as *Alternaria tenuis* Nees et Cord. The ascospores of the first form agreed precisely with those of *Pleospora Sarcinulæ* Gib. et Griff. Their cultivation gave rise to an abundant mycelium producing *Sarcinula*-conidia and subsequently perithecia, which again produced ascospores. The second form also gave rise to a mycelium indistinguishable from that of the first, producing immense quantities of green *Alternaria*-conidia, but no perithecia. The stylospores from pycnidia found on the same host gave rise to a mycelium which produced both pycnidia and *Alternaria*-conidia; but no proof was obtained of any genetic connection between the *Sarcinula*-conidia and perithecia on the one hand, and the *Alternaria*-conidia and pycnidia on the other hand.

Cladosporium herbarum, though frequently accompanying all these forms in nature, does not belong to the same cycle of development. It has two conidial forms; firstly, an elongated ellipse, unseptated, which are abstricted in clusters, and have a punctated membrane; secondly, also elliptical but shorter, divided into from one to three chambers, with smooth membrane, not constricted, or very slightly so, at the septa, and abstricted singly from the mycelial branches aggregated in tufts.

Epicoccum herbarum has also no genetic connection with *Pleospora*.

Chytridiaceæ.*—J. Schaarschmidt describes a new species of Chytridiaceæ, *Phlyctidium Haynaldii*, and proposes a fresh classification of the species living in water, according to the development of the mycelium. The mycelium appears to be wanting in *Olpidiopsis* and its allies; the naked plasmodium passes over immediately (*Olpidiopsis*) or indirectly (*Woronina*, *Rozella*, and perhaps *Achlyogeton*) into several zoosporangia. In *Chytridium* and *Phlyctidium* the mycelium is a simple filiform structure; it attains greater development in the genera *Rhizidium*, *Polyphagus*, *Cladochytrium*, *Obelidium*, *Zygochytrium*, and *Tetrachytrium*; it is septated and multicellular in *Catenaria*, *Polyrrhina*, and *Saccopodium*. The author found *Chytridium globosum* and *oblongum* parasitic on *Ulothrix zonata*.

Phoma Gentianæ, a new Parasitic Fungus.†—J. Kühn describes a newly discovered fungus, having its habitat on the stems, leaves, and buds of *Gentiana ciliata*, and takes the opportunity of denying that plants grown in mountainous districts are freer from such parasites than those of the lowlands.

Chrysomyxa albida.‡—Under this name J. Kühn describes a new species of parasitic fungus observed on the bramble (*Rubus fruticosus*) in the Black Forest. It forms small roundish white or yellowish white patches on the under side of the leaves, from 0·25 to 0·5 mm. in diameter. From these project threads which are the unbranched

* Magyar Növen. Lapok, vii. (1883) pp. 58–63 (1 pl.) (Magyar and Latin). See Bot. Centralbl., xv. (1883) p. 370.

† Landw. Versuchs.-Stat., xxviii. (1883) pp. 455–6. Cf. Journ. Chem. Soc. Abstr., xliv. (1883) p. 1025.

‡ Bot. Centralbl., xvi. (1883) pp. 154–7.

or the more or less branched spores, composed of a varying number of cells. Excluding the pedicel-cell, the number of cells of which the spores are composed is usually five or six, though there may be a larger or smaller number. The separate spore-cells are often very beautiful in form, bearing a distant resemblance to the teleutospores of *Puccinia coronata*. The walls of the cells are usually more or less thickened, and often with considerable projections; though the thickening is often entirely wanting. They are cylindrical or ovoid in form, but with considerable variations, the length varying from 17 to 47 μ and the breadth from 15 to 21 μ; the terminal cell frequently differing very considerably from all the rest. A nucleus is present, but disappears before the commencement of germination. The spores germinate with great readiness, frequently even under the cover-glass.

In larger patches the teleutospores are often accompanied also by the uredo-form. The uredospores also vary greatly in form, having perhaps an average diameter of about 26 μ. They differ from those of species of *Phragmidium* which are often also found on the bramble, in the entire absence of paraphyses. They are probably identical with the bodies described by Fuckel as the æcidial fruit of *Phragmidium asperum*. The uredo-form occurs abundantly on other parts of the plant besides the leaves.

Physoderma.*—J. Schröter describes this genus of parasitic fungi as characterized by being altogether destitute of a mycelium; the spores forming directly abundant masses of spores within the parenchymatous cells of the host. Small colourless lumps of protoplasm gradually swell up into a spherical form, and become invested first with a simple, afterwards with a thick coat. This process resembles the formation of the resting-spores of *Synchytrium;* but *Physoderma* differs from *Synchytrium* by the spores being formed in the parenchymatous and not in the epidermal cells of the host, and by the resting-spores of *Synchytrium* having a firmer inner layer of the cell-wall, so that the outer layer bursts easily.

The author has observed for some years in the neighbourhood of Breslau a very remarkable species of *Physoderma* on *Chenopodium glaucum*, and apparently confined to this species, completely deforming it, and causing the stem and leaves to assume a reddish or yellow colour. In the coloured pustules which appear in the summer are found very large zoosporangia with orange-coloured contents. From the base of the zoosporangium a dense tuft of very fine branched hyphæ penetrates into a parenchymatous cell of the host. Within this cell are formed very large zoospores endowed with very active motion, which pierce the tissue of the host and form new sporangia.

In the autumn are formed black pustules which contain the resting-spores, which are formed by a process of conjugation. The zoospores attach themselves to a cell-wall; from this spot proceed very long and delicate threads of protoplasm bearing at their apices small spherical vesicles. On the summit of these vesicles is a tuft of delicate,

* JB. Schles. Gesell. Vaterl. Cult., 1883, pp. 198–200.

short, but often branched threads of protoplasm. Two of these cells appear to conjugate (though it would seem as if the act of conjugation has not been actually observed), the protoplasm passing from one into the other, which swells up greatly, being filled with protoplasm and drops of oil, and invested with a firm coat. The two conjugating cells place themselves one on the top of the other, and an open tubular communication is formed between them. The process presents the greatest resemblance to the formation of the spiny spores of Chytridiaceæ. *Physoderma* appears to be an intermediate form between the Chytridiaceæ and *Pythium* and the Peronosporeæ; and may also be related on the other hand to *Cladochytrium*.

Bacilli of Tubercle.*—According to Prof. Rindfleisch, tubercular bacilli are best stained by fuchsin soluble in alcohol, but not in water. Two or three drops of a concentrated solution in 2–3 cm. of anilin-oil water are sufficient. The staining is especially good at 40° C. The bacilli are uniformly stained if a few drops of fuchsin are added to a mixture of equal parts of alcohol, water, and nitric acid.

Microbia of Marine Fish.†—In pursuance of their researches on this subject, L. Olivier and C. Richet have ascertained beyond doubt the spontaneous motility of the microbes obtained from living fish, as distinguished from mere passive or brownian movements. Motile organisms were found in living specimens of *Gadus luscus*, which had been only twenty-four hours in an aquarium, in the cephalo-rachidean and peritoneal fluids; in the peritoneal fluid of a *Blennius;* in the blood of the heart of *Gadus luscus*, and in the peritoneal fluid of a whiting.

The absence of putrefaction in the lymph or blood of a fish does not prove the absence of living microbes; some of the examples named above remained for months without alteration. A good nutrient fluid for their culture was found to be infusion of beef. The cephalo-rachidian fluid of a mud-fish was mixed with sterilized infusion of beef in one part of an exhausted tube. After three months no clouding appeared in it, but at the bottom was a minute whitish deposit. This contained mobile, short, flexuous bacilli, which were stained by methyl-violet.

Physiology and Morphology of Alcoholic Ferments.‡—C. E. Hansen describes the mode of formation of the ascospores of *Saccharomyces*, his description of which differs in several points from that of previous observers, especially Engel and Brefeld. He also contests van Tieghem's view that the formation of ascospores is a pathological phenomenon due to bacteria. He gives a detailed description

* SB. Phys.-med. Gesell. Würzburg, 1882. See Bot. Centralbl., xvi. (1883) p. 18.

† Comptes Rendus, xcvii. (1883). Cf. this Journal, iii. (1883) pp. 402, 884.

‡ Meddel. Carlsberg Lab., ii. (1883) 3 pls. (Danish with French resumé). See Bot. Centralbl., xv. (1883) p. 257. Cf. this Journal, ii. (1882) p. 234; iii. (1883) p. 232.

of the characters by which the various species of *Saccharomyces* may be distinguished from one another. In all the species examined the ascospores were never developed below a minimum temperature of from 0·5° to 3° C., or above a temperature of about 37·5° C.

Hansen finds that some forms of *Torula* as well as of *Saccharomyces* can invert and also cause alcoholic fermentation; while others show the latter phenomenon only.

Alcoholic Ferments.*—L. Bontroux employs as diagnostics of the species of fungus that induce fermentation the form of the vegetative cells, whether elongated or oval, whether they occur singly or in colonies, their fermenting activity, and their power of resisting acids and high temperatures. He describes as many as nineteen species of *Saccharomyces*, but some of them are forms of other fungi, as *Oidium lactis*, *Dematium*, &c.

Magnin's 'Bacteria.'†—The second edition of this book contains not only Cohn's accepted provisional classification of the Bacteria, but a general *resumé* of the latest labours in this difficult study, largely supplemented by the experimental observations of Dr. G. M. Sternberg, the translator. Scarcely any subject since the time of Jenner has attracted so much attention as the question of the proof of the infectiveness of certain of the bacteria. Opinions have fluctuated not only in connection with the difficulty of proof required, but also from the differences in the methods of experimenting. In some cases pure cultures have not been made use of, and in others the series of observations have not been of a sufficiently extended nature to determine correctness in the results. Dr. Sternberg is very critical in accepting some of the conclusions and statements made by others; and hence he has taken the precaution to lessen any objections that may be made against his own observations, which are therefore the more valuable and trustworthy. At the same time he avoids accepting the evidence where the subject is still under serious discussion. When the experiments are of a positive nature, as in the virulence of his own saliva when injected into rabbits, he does not hesitate to join the ranks of those who insist upon the *bacteria*, *bacilli*, or *micrococci* being the cause of the malady induced, and not the sepsin or septic product produced by the microrganism, as has been insisted upon by some.

The fuller our knowledge of the *rôle* these invisible organisms play, the greater the facility of establishing the laws of hygiene and the means, if not of eradicating our common enemies, yet of lessening the virulence. Whether we are to accept Zopf's views of all forms being originated by development from the same organism; whether the common forms by transmission through various living organisms, or certain media, in themselves harmless or hurtful, obtain, increase, or lose their virulence; whether by the slow progress of evolution gathered

* Bull. Soc. Linn. Normandie, iii. (1883) 42 pp. See Bot. Centralbl., xv. (1883) p. 329.

† Magnin, Dr. A., 'Bacteria. Translated with additions by Dr. G. M. Sternberg, F.R.M.S.' 487 pp., 12 pls., and figs. 2nd ed., 8vo., New York, 1883.

in their course and transmission through different species of living bodies, modified properties have been acquired either in a single or several species, and whether by a selected reversal of the mode of life a reversion to harmlessness can be induced in the virulent forms, are questions of serious import that lie in the future. To those interested in the question of germicides (sporocides) and antiseptics, we may refer to an article by Dr. Miquel,* the able observer at the Montsouris Observatory, Paris, who has largely extended the list, which is headed by biniodide of mercury.

Those who are in want of a subject for investigation may be strongly advised to cultivate an acquaintance with the pages of this valuable work, and add their own independent observations to the list of original articles of which there is a very copious bibliography brought down to a very late period. Dr. Sternberg can be congratulated on giving us a well illustrated and most readable addition to the literature of the bacteria with valuable information derived from his own careful experiments.

Lichenes.

Cephalodia of Lichens.†—K. B. J. Forssell proposes to confine the term Cephalodia to those structures which contain one or more algæ, the type of which differs from the normal gonidia of lichens, and which have been formed by the mutual action of hyphæ and algæ. Cephalodia have been at present observed in one hundred species of algæ, but belonging to only a few genera. They appear to occur chiefly in the Archilichenes. Those described in other families have mostly not been properly cephalodia, where the hyphæ always obtain a stronger development from contact with the algæ; as *Peltigera canina*, where the hyphæ serve to nourish the algæ, or *Solorinella asteriscus*, where they are indifferent to one another.

The position of the cephalodia varies; they occur sometimes in the under, sometimes in the upper side of the thallus, sometimes on or in it; occasionally also in the protothallus. They usually form protuberances of a dark yellowish-red or dark red colour in the upper side of the thallus. When the cells of the algæ which form cephalodia come into contact with the hyphæ the hyphæ develope rapidly, involve the algal colony, and become copiously branched. The cells of the algæ divide at the same time, thus increasing the size of the cephalodium by mutual symbiosis. Most cephalodia are formed by the mutual action of algæ and of hyphæ which belong to an already developed lichen-thallus (cephalodia vera). Among these the author distinguishes between cephalodia epigena or perigena, formed on the upper side of, or upon, the thallus, as in *Peltidea aphtosa*, *Sphærophorus stereocauloides*, and *Stereocaulon ramulosum;* and cephalodia hypogena, formed on the under side of the thallus. There are differences again among these. Sometimes (*Solorina octospora*) the cephalodium lies at the base of the medullary layer; sometimes

* 'La Semaine Médicale,' 30 Août, 1883.

† Bihang till K. Svenska Vet. Akad. Handl., viii. (1883) 112 pp. (2 pls.). See Bot. Centralbl., xv. (1883) p. 330.

(*S. saccata* and *Lobaria*) the alga penetrates into the medullary layer; or sometimes (*S. crocea* and *bispora*) it penetrates still higher into the thallus, and spreads into the yellowish-green gonidial layer, which is often replaced by it; or finally (*Lobaria amplissima*, *Lecanora gelida*, and *Lecidea pancœola*) the gonidial and cortical layers are broken through, and the cephalodium emerges on the upper side of the thallus.

Under the name Pseudocephalodia (as distinguished from cephalodia vera) the author describes such as are formed in the protothallus by the germinating hyphæ investing algal colonies of some other type than the normal gonidia of the lichen. They are but slightly united with the other parts of the thallus, and exhibit a tendency towards independent development. At present they have been observed in only a few lichens:—*Solorina saccata* var. *spongiosa*, *Lecidea pallida*, and probably in *Lecanora hypnorum* and *Lecidea pancœola*. Intermediate forms also occur between the various kinds of cephalodia.

In some of the above-named species the author states that the pseudocephalodia develope in the same way as is described by Schwendener from the thallus of lichens, a point of considerable importance with regard to the Schwendenerian theory of the origin of lichens. In the true cephalodia we have in fact a double parasitism, or mutual symbiosis of algæ and fungal hyphæ.

Lichens from the Philippines.*—B. Stein describes a number of lichens forwarded by Dr. Schadenberg from Mindanao in the Philippines. Among them is a new genus, *Dumoulinia*, belonging to the Lecanoreæ, of which he gives the following diagnosis:—"Thallus crustaceus uniformis; apothecia lecanorina, superficialia, excipulo crasso cupulari; sporæ quaternæ, maximæ, hyalinæ, tetrablastæ."

Algæ.

Protoplasmic Continuity in the Florideæ.†—T. Hick has made an extensive series of observations on a large number of species belonging to the more important genera of Florideæ, with special reference to the question of protoplasmic continuity. He finds in all the species examined that there is such a continuity, and that of the clearest and most definite character. In the simpler filamentous types, such as *Petrocelis cruenta* and *Callithamnion Rothii*, the protoplasm of each cell is united with the protoplasm of contiguous cells by means of a fine protoplasmic thread. This occurs throughout the whole plant. In the more complex types, such as *Callithamnion roseum*, *arbuscula*, and *tetragonum*, the arrangements for continuity are of a more elaborate character. The contents of the axial cells are not only united with one another, but also with those of the cortical cells, however numerous these may be. The cortical cells also display continuity *inter se*. *Ptilota elegans* is a most instructive form, as here the connective threads may be easily traced from the tips of the ultimate branchlets to the base of the stipes of the frond. As the

* JB. Schles. Gesell. Vaterl. Cult., 1883, pp. 227–34.

† Proc. Brit. Assoc. Adv. Sci., 1883. Cf. Nature, xxix. (1883) p. 581.

threads become older, they increase in thickness, thus showing that they are not merely temporary or effete structures. On the stouter connecting-cords a sort of ring or collar is developed at about the middle point, and over this is stretched, in some cases, a delicate diaphragm. The behaviour of both rings and diaphragm, when treated with microchemical reagents, is similar to that of ordinary protoplasm.

Distribution of Algæ in the Bay of Naples.*—G. Berthold finds that if, in the algæ growing in the Bay of Naples, those species are separated the habitat of which is above low-water mark, and those which require strong currents, the great majority of the 180 to 200 species which remain are not confined to particular zones of depth. The species found in the zone between ebb and flow are usually peculiar to that habitat, or at all events do not thrive in greater depths. To this class belong *Bangia*, *Nemaleon*, and *Gelidium crinale*. Some species thrive best in strong currents; *Corallina* is especially partial to the zone of breakers. Stagnation of the water greatly diminishes the number of species; and some, in consequence, are entirely wanting at considerable depths. The presence of diffused light in the water is extremely important for the life of algæ; the minimum intensity at which they can thrive lies at but a small depth below the surface. Those species which grow in shady places, like marine grottoes, are in general found only near their entrances. The Florideæ are found especially where the light is diffused, the greater number of brown algæ, with a few Florideæ and Chlorosporeæ, in localities exposed to the direct light of the sun.

Algæ of Bohemia.†—A. Hansgirg gives a detailed account of the algæ of Bohemia, with reference both to their classification and their biology. The mode of life of *Leptothrix rigidula* Kütz. is especially described in detail.

Fossil Alga.‡—Under the name *Bythotrephis devonica*, C. J. Andrä describes a new alga, the remains of which he finds in the "Hunsrückschiefer," belonging to the Devonian formation.

New Genera of Algæ.§—A. Borzì describes several new genera of algæ, as under, viz.:—

Leptosira.—The only species, *L. Mediciana*, occurs among cultures of fresh-water algæ from bogs on Etna. It forms minute rounded green tufts composed of a number of dichotomously branched arms. The cells are oblong, and with very delicate cell-wall. All the cells can become zoosporangia. They swell into a spherical form, and the numerous zoospores escape through a hole in the side of the mother-cell. They are at first all inclosed in a common envelope, which

* MT. Zool. Station Neapel, iii. (1882) pp. 393–536 (3 pls.).

† SB. Böhm. Gesell. Wissensch., 1883. See Bot. Centralbl., xvi. (1883) p. 33.

‡ Verhandl. Naturh. Ver. Preuss. Rheinlande u. Westfalen, ix. (1882) pp. 110–3.

§ Borzì, A., 'Studi Algologici,' 117 pp. (9 pls.) Messina, 1883. See Bot. Centralbl., xvi. (1883) pp. 66–75.

soon dissolves in water. They are small, biciliated, and provided with an eye-spot. They conjugate, but in a manner different from other algæ, uniting by the end which does not bear the cilia. The zygospore becomes invested, in the course of a few days, with a cell-wall; the further development of the resting-spore was not observed. Those zoospores which do not conjugate, develope asexually in the ordinary way. After a time the terminal cell of the filament breaks up into from four to eight cells, which become detached, and present a protococcoid appearance. They develope, on germinating, into the original tufts, each cell putting out from two to four germinating filaments. He proposes to place this genus in his new class of Chroolepidaceæ (see p. 106).

Ctenocladus.—The only species, C. *circinnatus*, forms green incrustations in brackish marshes, composed of densely crowded tufts. The prostrate, curved, and segmented filaments put out a number of short segmented branches, which are all beautifully curved. These branches again branch, but the branches are borne on one side only. The cells contain homogeneous chlorophyll, a starch-grain, and a true nucleus; the wall is divided into three layers, the outermost of which presents the reactions of cuticle. Asexual reproduction takes place by means of macrozoospores and microzoospores. The macrosporangia are very elongated cells in the branches, or sometimes cells which put out a long lateral protuberance. The zoospores, from four to thirty-two in number, are forced out through a narrow opening in the wall of the mother-cell. They have the ordinary form of biciliated zoospores, and germinate into the new tufts after swarming for about twelve hours. After the discharge of the macrospores the thallus assumes a hibernating condition. The cells become rounded off, many of them divide, and the common cell-wall is gradually absorbed, so that the tuft becomes changed into an irregular aggregation of cells imbedded in mucilage, a protococcoid colony resembling a *Palmella* or *Glœocystis*. These palmelloid cells produce the microzoospores, from four to sixteen in a cell. They resemble the macrozoospores, except in size; their behaviour on germination was not observed. Sometimes the hibernating cells which do not give birth to microzoospores enter on a new condition; they develope into filaments closely resembling a *Ulothrix*, which form a kind of hypothallus. In these, shorter dark green cells are formed which develope into the typical tufts of *Ctenocladus*. But while these tufts mostly pass over in autumn into the hibernating condition already described, some cells, which Borzì calls "zoogonangia," enlarge greatly, assume a pear-like form, and hibernate in this condition. From these are produced in the spring biciliated zoospores, which conjugate; but conjugation takes place only between zoospores from different zoogonangia. The author considers the genus as probably a highly specialized form of the Chroolepidaceæ.

Physocytium.—The only species, *P. confervicola*, was found growing on *Œdogonium* and *Cladophora*. It forms small colonies attached to the substratum by a delicate filament. Each colony is composed of from 1 to 32 ciliated cells inclosed in a vesicle of very fluid mucilage,

in which they swarm actively; each vesicle is attached to the substratum by two very delicate threads. Each cell has two cilia, abundant cellulose, a starch-grain, red eye-spot, and two alternately pulsating vacuoles. After a time the vesicle bursts; the cells swarm free, then become immotile, and enter into a palmella-condition, a number being inclosed in a common gelatinous envelope. They divide, like *Palmella*, and each cell ultimately developes into a microzoospore, closely resembling one of the original cells. Several alternate generations of zoospores and palmella-cells are produced in the autumn and winter, and in the spring commences the sexual reproduction. Some of the palmella-cells are transformed into zoogonangia; out of the contents of each of these are formed from 4 to 16 zoogonidia, scarcely differing from the zoospores, but possessing sexual properties, since some of them conjugate, the rest soon perishing. The zygospores contain a red endochrome, and remain dormant for a time. In the latter part of the summer they germinate, and each produces one or less often two macrozoospores, which ultimately attach themselves to another alga, become invested with an envelope of mucilage, and develope, by the division of their contents, the original colonies. The author considers the genus nearly allied to the Volvocineæ.

Kentrosphæra.—Two species of this genus form green gelatinous lumps in the midst of filaments of Oscillarieæ. These colonies are composed of zoosporangia; each sporangium is unicellular, about 200 μ in diameter, with a very thick concentrically stratified wall of cellulose, and often possessing on one side a protruding spur. The cell contains bands of chlorophyll and a red pigment; the bands disappear, the cell becomes uniformly green, and the contents break up into a great number (about 400) of zoospores; they are minute and biciliated, but possess no vacuole or eye-spot. After swarming they become fixed, and develope into spherical cells, which divide internally into the protococcoid colony. Many of these colonies may follow one another in succession. No sexual mode of propagation is known. *Kentrosphæra* probably belongs to the Palmellaceæ.

Hormotila.—*H. mucigena*, the only species, covers with a thick green incrustation the walls of water-basins and damp rocks round Messina. Its vegetative form is scarcely distinguishable from a *Glœocystis;* the cells, very unequal in form and size, are imbedded in mucilage. Reproduction takes place only by means of zoospores, and apparently at all times of the year. To form zoosporangia, certain of the cells separate from the rest, and lose their mucilaginous envelope. These divide repeatedly by bipartition, and thus form small branched tufts bearing an external resemblance to *Cladophora*. In each of these cells are formed from 8 to 64 minute biciliated zoospores, which escape through the lateral protuberance in the wall of the mother-cell. After swarming they either develope directly similar tufts of sporangia, or, more often, pass through the glœocystis-condition first. The genus must be regarded as belonging to the Palmellaceæ.

Polymorphism of the Phycochromaceæ.*—W. Zopf details the structure and development of a low algal form which he calls *Tolypothrix amphibia*, and which he regards as confirming his view already published as to the genetic connection of low forms of fungi. It was found among the protonema of a moss, and had two forms, an aquatic form, and an aerial form growing on the surface of water. The aquatic form is filiform, and closely allied to the organisms which make up the genus *Tolypothrix*. It consists of an unbranched filament of cells inclosed in an evident sheath; within this sheath it breaks up into fragments or hormogonia. The aerial or chroococcus form developes from hormogonia, consisting of three or more cells which reach the surface of the water. Here a number collect together, and their extremely thin gelatinous envelope coalesces together into a continuous oily membrane. The blue-green colour of the hormogonia has now passed over into a greener tint. In this condition the cells divide in all three directions, and not in one only, as had previously been thought to be exclusively the case with the Scytonemeæ.

Reproduction of Ulva.†—A. Borzì thus describes the development and conjugation of the zoospores of *Ulva Lactuca*, which takes place freely in cultivation. The zoospores are oval, and are provided on the anterior beak with two colourless cilia, and, attaching themselves to one another by their anterior ends, coalesce in the course of about five minutes into a swarm-spore twice as large with four cilia. Occasionally the position of one of the conjugating swarm-spores is reversed. Compared with the great number of swarm-spores, conjugation takes place very rarely, which may be the result of a sexual differentiation, although none is visible externally; there is no difference in their motility. Warmth influences favourably their emission and motility. But it is interesting that while the ordinary zoospores display distinct positive heliotropism, the zygospores acquire an opposite heliophobic tendency, in consequence of which they seek dark spots, where their further development may proceed.

The zygospores lose their cilia and coalesce completely into an oval body, in which the anterior end is still distinguished by the absence of endochrome, while the other end has a great quantity of chlorophyll and the two pigment-spots and starch-grains of the two original zoospores. The zygospore attaches itself by its anterior end, and, after growing rapidly, divides transversely. The basal and apical cells finally become completely separated, this being preceded by the apical cell becoming narrowed and prolonged at the base into a beak-like colourless appendage. Similar transverse divisions follow, and thus a small colony is formed of unicellular individuals closely associated together, and constituting an asexual generation. Each of these individuals developes into a new frond; first of all becoming attached by its colourless end, and then dividing first into a filament and then into a plate of cells.

* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 319-24 (1 pl.). Cf. this Journal, iii. (1883) p. 688.

† Borzì, A., 'Studi Algologici,' 117 pp. (9 pls.) Messina, 1883.

Relationship between Cladophora and Rhizoclonium.*—A. Borzì considers that many algæ hitherto considered as belonging to the Confervaceæ are not independent forms, but stages of development of species of *Cladophora*. This applies especially to several species of *Rhizoclonium*, which he has, in cultivation, developed into filaments of *Cladophora*; thus confirming the previous hypothesis of Schmitz. *Gongrosira pygmæa* he also shows to be a form of *Cladophora fracta*.

The multinucleated condition of the cells, so common in the Siphonocladiaceæ, Borzì regards as simply the result of imperfect septation.

Classification of Confervoideæ.†—A. Borzì proposes the new family Chroolepidaceæ, to include his new genus *Leptosira* (see p. 102) along with *Trentepohlia*, *Acroblaste*, *Chlorotylium*, *Microthamnion*, and *Pilinia*; which he separates from the Confervaceæ, and gives the following classification of the Isogamous Confervoideæ:—

Segment-cells with several nuclei.	
Thallus unicellular.	Fam. 1. Siphonaceæ.
Thallus multicellular.	Fam. 2. Siphonocladiaceæ.
Segment-cells with a single nucleus.	
Thallus of a single lamella.	Fam. 3. Ulvaceæ.
Thallus filamentous.	
Chlorophyll parietal; zoosporangia not distinguishable from the vegetative cells.	Fam. 4. Ulotrichaceæ (incl. Chætophoraceæ).
Chlorophyll diffuse; zoosporangia distinguishable from the vegetative cells.	Fam. 5. Chroolepidaceæ.

Action of Tannin on Fresh-water Algæ.‡—J. B. Schnetzler had previously demonstrated the presence of an appreciable amount of tannin in fresh-water algæ, *Vaucheria*, *Spirogyra*, *Conferva*, &c. If the alcoholic solution of the chlorophyll of these algæ is treated with sulphate of sesquioxide of iron, an abundant blue precipitate takes place. If the entire fresh vigorous algæ are immersed in a solution of this salt of iron, they remain green for a considerable time, the cells becoming a dark blue only after the death of the protoplasm. The cells of *Spirogyra* seem to display great variation in their tenacity for life. In a green filament certain cells, either adjoining or separated, may be seen to become dark blue under the influence of the iron-salt. The position of these cells shows that their taking this colour cannot be due to external causes, but to their individual peculiarities, to the degree of resistance which the living protoplasm offers to the action of the iron-salt. After a time, when the protoplasm of all the cells is dead, the whole filament is coloured dark blue. Tannin appears therefore to be here an essential ingredient of living protoplasm.

* Loc. cit. † Loc. cit.
‡ Bot. Centralbl., xvi. (1883) pp. 157–8.

New Species of Bulbochæte.*—O. Nordstedt describes two new species of this genus. The first, from Brazil, was sterile; but is distinguished from all known species by a whorl of spines in the middle of each cell except the basal and all the hair-cells. The other species is from Australia, where it grows attached to Characeæ. It is allied to *B. minor*, but is characterized by peculiar dwarf males. The terminal cells of these dwarf males bear a bristle; and the antheridium is also sometimes divided into two branches. It constitutes therefore an intermediate form between those with unbranched dwarf males destitute of bristle, and the ordinary large branched, bristle-bearing plants, the antheridium of which is never branched.

New Genus of Oscillarieæ.†—Under the name *Borzia trilocularis* F. Cohn describes a new oscillarian alga exhibiting a structure altogether parallel to *Bacterium*. It forms olive-brown masses in fresh water inhabited by *Œdogonium* and other algæ. It consists of short oblong rods which oscillate slowly and with difficulty, each composed of three cells filled with granular phycochrome, the two terminal cells being rounded off. By cell-division the number of cells increases to six, and each rod then divides into two. In the neighbourhood of Breslau it shows no disposition to assume a filamentous or any other condition.

Vaucheriæ of Montevideo.‡—J. Arechavaleta has studied the species of *Vaucheria* found near Montevideo, of which he gives a detailed description, with diagnosis of eight new species. Some of these appear, however, to be identical with well-known European species; and of others the description given is deficient in some points necessary to determine whether they must be regarded as good species.

Gongrosira.§—N. Wille, who has found *Gongrosira de Baryana* Rab., growing on *Planorbis* and *Paludina*, has proved, by cultivation, that it is a form of *Trentepohlia* Mart. (*Chroolepus* Ag.). The branching resembles at first that of *Coleochæte irregularis* or *Trentepohlia umbrina*, forming a disk of cells from which the branches rise. In each cell is only one nucleus; the chlorophyll is parietal; sometimes a few drops of oil occur in the centre of the cell. The cell-wall is thick and evidently laminated, and readily becomes mucilaginous. Swarm-spores are formed in terminal sporangia, resembling those of *Trentepohlia*. No conjugation was observed, nor was the further development of the spores followed out. Propagation takes place by single cells becoming detached from the vertical branches, and developing directly into new plants.

The organs described by Rabenhorst as oogonia the author believes

* SB. Phytograph. Gesell. Lund., May 28, 1883. See Bot. Centralbl., xvi. (1883) p. 95.

† JB. Schles. Gesell. Vaterl. Cult., 1883, pp. 226–7.

‡ Anal. Aten. del Uruguay, iv. (1883) p. 18 (2 pls.). See Bot. Ztg., xli. (1883) p. 627.

§ Ofvers. K. Svensk. Vetensk. Akad. Förhandl., 1883, pp. 5–20 (1 pl.). See Bot. Centralbl., xvi. (1883) p. 162.

to be resting-cells similar to those of *Conferva pachyderma*. The immotile reproductive cells, which are formed directly without any true process of cell-formation, he calls "akinetes"; while to those formed asexually by true cell-formation he gives the term "aplanospores"; they germinate directly, or after a period of rest. Under cultivation *Trentepohlia umbrina* may become quite green.

Other species of the pseudo-genus *Gongrosira*, Wille refers as conditions of species belonging to different genera as follows:—*G. dichotoma* Kütz., is a peculiar aplanospore condition of *Vaucheria geminata* Walz.; *G. clavata* Kütz. is the sporiferous vegetative plant of *Botrydium granulatum*; *G. ericetorum* Kütz. is the protonema of a moss; *G. ericetorum* v. *subsimplex* Rab. is probably a *Ulothrix* or *Conferva*; *G. pygmœa* probably a *Stigeoclonium*; *G. Sclerococcus* Kütz. (*Stereococcus viridis* Kütz.) may be a *Trentepohlia*; *G. protogenita* Kütz. is probably the palmella-form of a *Stigeoclonium*; Reinsch's species cannot be determined; *G. onusta* Zell. comes near *Trentepohlia de Baryana*.

Phyllosiphon Arisari.* — M. Franke finds this parasitic alga abundantly on the leaves of *Arisarum vulgare* in the neighbourhood of Messina, and elsewhere in Sicily and Calabria; but it appears never to attack *A. italicum*. The spores are capable of germinating at any period of the year, but must go through a period of rest; the larger spores appear to divide into several. They always attack their host by penetrating the epidermis between two cells, which they force apart by their germinating filament. The restricted conditions necessary for the germination of the spores greatly diminish its destructive effects.

Occurrence of Crystals of Gypsum in the Desmidieæ.† — The occurrence of crystals of calcium sulphate, endowed with a peculiar "dancing" motion, has long been known in the terminal vesicles of *Closterium* and in other desmids; the phenomenon has now been carefully investigated by A. Fischer. Their chemical constitution was clearly established by different tests. They are always quite isolated from one another, and occur in all parts of the cells, though in the greatest quantity in the terminal vesicles; they are either carried along passively by the currents of protoplasm, or they "swarm" in the space filled with cell-sap between the cell-wall and the radiating chlorophyll-bodies; these vesicles are not true vacuoles, but portions of the cell-sap space. The crystals are not formed, nor do they grow, in this vesicle, but reach it in a mature condition from some other part of the cell, being formed apparently in the furrows between the bands of the chlorophyll-bodies; from here they are carried to the terminal chambers by the protoplasmic currents.

Fischer found these crystals in all the species of *Closterium* which he examined; also in various species of *Cosmarium* (though individuals are often entirely destitute of them), their form being the same as in *Closterium*. They occur also in *Micrasterias*, *Euastrum*, in which

* JB. Schles. Gesell. Vaterl. Cult., 1883, pp. 195–7. Cf. this Journal, ii. (1879) p. 606; ii. (1882) p. 391; iii. (1883) p. 108.

† Pringsheim's Jahrb. f. Wiss. Bot., xiv. (1883) pp. 133–84 (2 pls.).

genera also they are not invariably present, and always in *Pleurotœnium*, *Penium*, and *Tetmemorus*, but were absent from all the specimens examined of *Staurastrum*, *Desmidium*, and *Hyalotheca*. They appear to be entirely confined to the Desmidieæ, other fresh-water algæ containing calcium oxalate, especially species of *Spirogyra*, but not calcium sulphate.

The absence of crystals of calcium sulphate, either occasionally or regularly, does not, in the opinion of the author, imply the absence of the salt; since, from its solubility in water, it may be present in the cell-sap. The zygospores of *Closterium* were always found to contain crystals. Calcium sulphate is an excretory product in the process of metastasis, corresponding to the production of calcium oxalate in the higher plants; and the quantity excreted determines whether it shall remain entirely dissolved in the cell-sap, or whether a portion of it shall separate in the form of crystals.

MICROSCOPY.

a. Instruments, Accessories, &c.

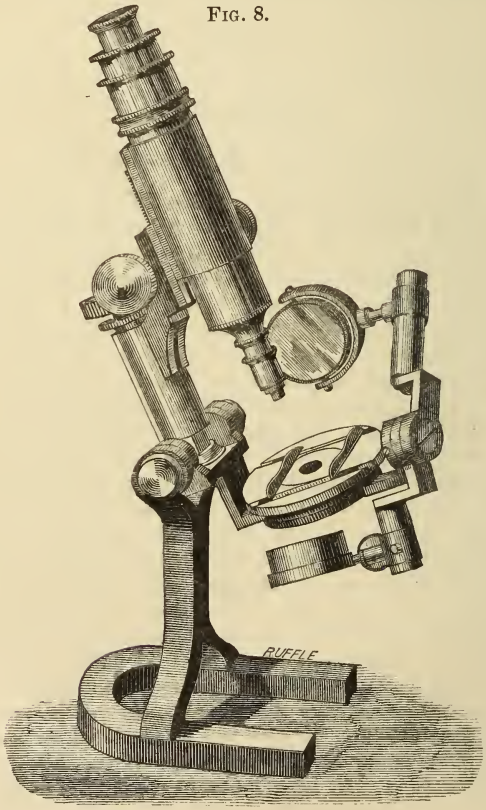
"**Giant Electric Microscope.**"—One of the attractions at the Crystal Palace is what is advertised as "Les Invisibles in the Giant Electric Microscope." We take the following description from a daily paper,* no other description being forthcoming. "A number of gentlemen assembled at the exhibition court of the Crystal Palace on Saturday, by invitation of the directors, to witness the first representation in England of 'Les Invisibles,' an exhibition of natural objects magnified and displayed by means of the great electric Microscope. The apparatus used in the exhibition is the invention of Messrs. Bauer and Co., and 'Les Invisibles' has quite recently attracted a good many visitors to the old Comédie Parisienne, where, as well as at the Athenæum at Nice, a series of representations has been given. The invention may be described in a few words as being the application of electric light to the Microscope, and the result, so far as the spectacle is concerned, is a sort of improved and enlarged magic lantern. Every one is familiar with the former exhibitions at the Polytechnic and elsewhere of the animalculæ (*sic*) in a drop of water, magnified and thrown, by the aid of the lime-light, on to a white screen. Precisely the same sort of effect was produced on Saturday by Mr. F. Link, the London agent for Messrs. Bauer and Co., with this difference, that the magnifying power was enormously in excess of that attained in the old magic lantern entertainments. The electric Microscope has, in fact, made it possible to exhibit in a most attractive form, the appearances presented by minute natural objects when placed under the most powerful magnifying glass. Indeed, the difficulty with which Mr. Link had to contend on

* 'Morning Post,' 5th Jan., 1881.

Saturday was the smallness of the screen upon which his pictures were thrown. For instance, only a small section of a butterfly's wing could be shown at a time, although the screen was as large as the size of the entertainment court would permit, whilst the living organisms in a spot of water and the mites in a small piece of cheese were enlarged until they presented a perfectly appalling spectacle to a timid mind. The capabilities of the apparatus may be imagined from the fact that the eye of a fly was presented in a form no less than four million times its natural size. The electric Microscope, which is worked by an ordinary primary battery, may be said to have extended almost indefinitely the possibilities of presenting in an attractive and instructive manner the wonderful facts of natural science."

Aylward's Rotating and Swinging Tail-piece Microscope.—Mr. H. P. Aylward has added a new movement to the radial swinging

FIG. 8.



tail-piece. Not only do the mirror and the substage swing on separate tail-pieces, either above or below the stage, but they can also

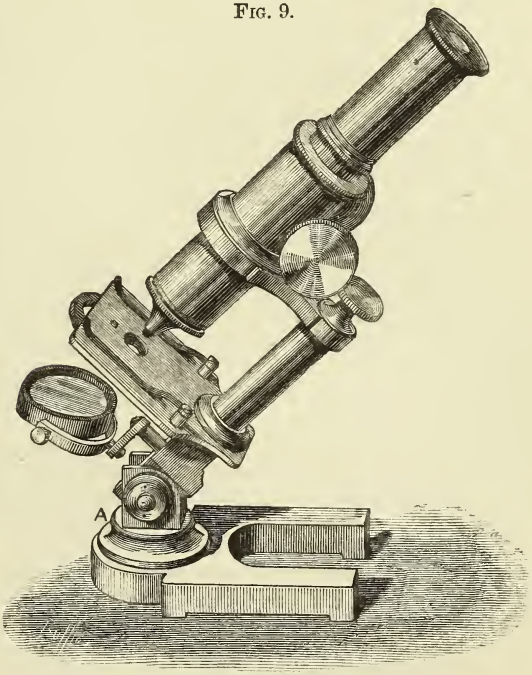
be rotated completely round the stage, so that the direction of the illumination in azimuth can be more readily varied than is the case with Zentmayer's form of tail-piece.

The stage consists of a fixed ring attached to the limb by an angle-plate of brass; this ring carries above it the rotating object-stage, and beneath a rotating collar is fitted, which has a shoulder attachment at right angles carrying the two tail-pieces on an axis slightly above the plane of the object-stage, and allowing of their rotation round the optic axis. The angle-plate, by which the stage-ring is fixed to the limb, is so arranged that the shoulder carrying the tail-pieces will pass behind it, and there is therefore no obstruction to complete rotation.

This plan of suspending the tail-pieces is far more convenient than that devised by L. Jaubert,* or that of J. Mackenzie.†

McLaren's Microscope with Rotating Foot.—Mr. A. McLaren has devised a simple plan of giving greater stability to Microscopes

Fig. 9.



mounted on a pillar support on a horse-shoe foot, which are very liable to be overturned when much inclined from the perpendicular. The plan consists in making the foot rotate at its junction (fig. 9, A)

* See this Journal, i. (1881) pp. 514–5.
† Ibid., pp. 825–7.

with the pillar support, so that when the Microscope is required to be used much inclined the horse-shoe base can be turned round as shown in the fig. This increases the stability of the Microscope, and adds so little to the original cost that the makers of these inexpensive forms may profitably adopt the suggestion.

Mr. McLaren also uses a system of fine adjustment applied at the nose-piece (shown in the fig.), consisting of a ring fitting in the lower end of the body-tube, in which the nose-piece proper, carrying the objective, is screwed by means of a very fine screw, 200 threads to the inch. The focusing is effected by turning the nose-piece either way, by which the objective is raised or depressed very slowly owing to the fine pitch of the screw. By this system, which is also applied to some old forms in our possession, the objective is made to rotate with every movement of focusing, which cannot be commended.

Schieck's Revolver School and Drawing-room Microscope.—Winter's and Harris's Revolver Microscopes.—F. W. Schieck has just issued the Microscope shown in fig. 10 A and B, intended for school and drawing-room demonstration. The peculiarities of the instrument are fully set forth by Herr Schieck himself in the following statement (translated), which also includes some very original directions for preparing objects:—

"The management of a Microscope of the ordinary construction, with fixed stage, movable tube, different eye-pieces, objectives, &c., offers, in most cases, so many kinds of difficulties to the lay public, especially to young students, in the inspection of the preparations accompanying the Microscope, and in the adjustment of the image, but especially in the self-preparation of objects, that this important and interesting instrument has not yet attained that position either among our intelligent youth, or in our drawing-rooms, as an object of instructive entertainment, which befits its high ethical importance. The management of the Microscope has even been found so intricate, that in consequence (as I have had the opportunity of seeing on numberless occasions) it has been very soon put aside again, after a short trial.

My new Microscope entirely removes this disadvantage. It is of such simple construction, and its management so thoroughly easy, that any one, even without any previous acquaintance with the use of a Microscope, is able to observe with it, as well as to make for himself beautiful microscopical preparations.

The new Revolver Microscope has, instead of a stage, a vertical drum, turning on its axis (like the chambers of a revolver), in which twenty different very beautiful and instructive preparations, from the three natural kingdoms, are arranged, which, on turning the drum, are brought successively into the field of view of the Microscope. The movable mirror is in the centre of the drum, and is easily and conveniently adjusted.

The Microscope is provided with a hinge for inclining the stand, so as to be able to observe conveniently whilst sitting.

The twenty preparations are numbered, and an explanation of them accompanies each Microscope.

As the Microscope has only one objective, and one eye-piece, and therefore only admits of a fixed magnifying power, a special focusing arrangement is not necessary. The tube of the Microscope is so fixed, that the image of the preparation is always in the field of view of the eye-piece, and only in the case of differences in the eyes of observers is a small shifting of the tube, amounting to a few millimetres, requisite. For this purpose the body-tube is easily pushed with the hand up or down, guided by a pin working in the

FIG. 10 A.

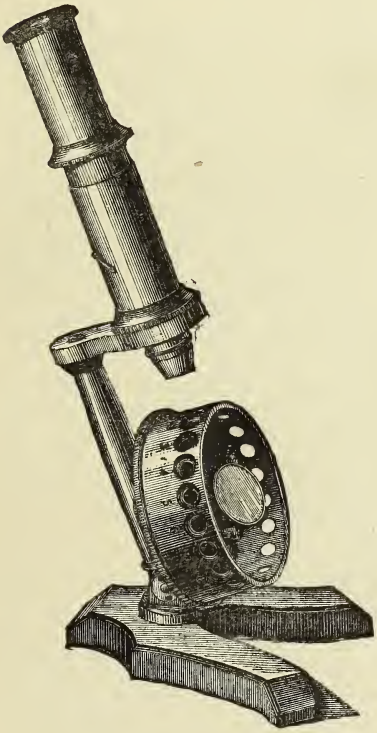
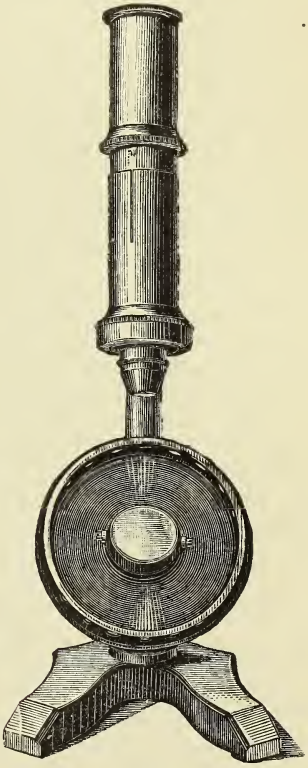


FIG. 10 B.



small slit in its sheath, without ever thereby losing sight of the image of the preparation, as happens with other Microscopes.

The magnifying power is such that most popular objects can be seen distinctly and perfectly. The images are of unsurpassed sharpness and clearness.

The field of view is very large, and all preparations which are not more than 4 mm. in diameter can be seen entire at one view.

An entirely special advantage of this new Microscope is the uncommonly simple manner in which the teacher or student is enabled

by its means to prepare by himself a new series of twenty preparations at pleasure. The hitherto general practice of laying the object to be inspected on large glass slides, and fastening over them the thin, round or square, cover-glasses, presented so many difficulties that a preparation seldom succeeded well, especially if it were put up for any length of time.

With each of my new revolver Microscopes is given a second stage-drum, with twenty empty apertures, and a sufficient number of small round glasses and spring-rings for firmly fixing the preparations. The stage-drum with the preparations already attached to the Microscope is unscrewed from the milled disk, and the second empty drum put in its place.

The insertion of a new object is so exceedingly simple, that directions for it seem, properly speaking, superfluous. In the first place a small round glass is washed clean, and with the forceps belonging to the Microscope, is laid in one of the apertures, then the object to be examined is laid in the middle of this glass, either dry or with mounting liquid (glycerine, gelatine, Canada balsam, or in cases where only a rapid observation of an object is required, even water, spirit, &c.), and covered with a second previously cleaned glass, fastened down with a spring-ring which goes into a small groove made for it, and the preparation is ready. (!) It must, however, be here observed that all hard objects (especially insects) must, in order to succeed well, be previously heated for a few seconds in a small reagent glass, with caustic potash over a spirit flame, by which means the preparations become soft and quite transparent.

The preparations are perfectly protected from dust by a pasteboard cover, and care must be taken always to replace the cover over the stage-drum, after using the Microscope. If, in spite of this, dust should after a time fall upon the preparations, it must be carefully brushed away from both sides by the soft hair brush accompanying each Microscope; any other cleaning of the preparations is never necessary.

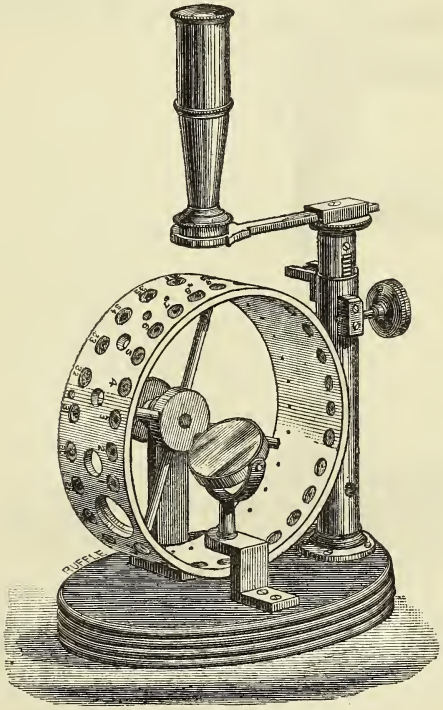
If desired these Microscopes can be supplied with special objects previously given me to prepare, and for the requirements of schools the stage-drum can be fitted with botanical, zoological, or mineralogical preparations. Price according to agreement.

This entirely new, and in every respect original and practical Microscope offers to every one such a fund of entertaining and instructive matter, and will prove to the teacher as well as the student such an inexhaustible source of suggestive occupation, by which to pass the leisure hours usefully and pleasantly, that there is scarcely anything better fitted for a present, always gladly seen, especially by the ripening student. The price is fixed as low as possible, and considering the prices ruling here may be called very cheap."

Herr Schieck intended, we have no doubt, to be strictly accurate when he announced his instrument as "entirely new" (*ganz neu*) and "in every respect original." But it was in fact anticipated by two now in Mr. Crisp's collection, which were made more than fifty years ago, by T. Winter (simple) and Harris and Son (compound, fig. 11).

They are in principle identical with that of Schieck. The revolving object-holder is, however, made of ivory, and is much larger, being $4\frac{1}{2}$ in. in diameter and $1\frac{1}{2}$ in. wide. There is also a double row of apertures for the objects—one row for transparent, and the other for

Fig. 11.



opaque—so that, instead of 20, it holds 44 objects. There is also at one point of the circumference an intermediate set of apertures, apparently for inserting further objects on disks, corks, &c. (In Winter's there is a complete row of 19 of these apertures, 10 with corks).

Winkel's Large Drawing Apparatus.* — This (fig. 12) is intended for drawing objects under a low power, and also without any magnification. On the side of the standard A, and above the stage T and mirror S, is a cross-arm B carrying a lens L, and over it a small right-angled prism P, which acts as a camera.† On the other side there is a longer arm, also with a prism for drawing objects in

* Dippel's 'Das Mikroskop,' 1882, pp. 632–3 (1 fig.).

† The text states P to be a prism (protected by a ring) though the fig. hardly agrees.

natural size. The arms can be raised and lowered by the sliding within A of the support to which they are attached, the screw on the right clamping it.

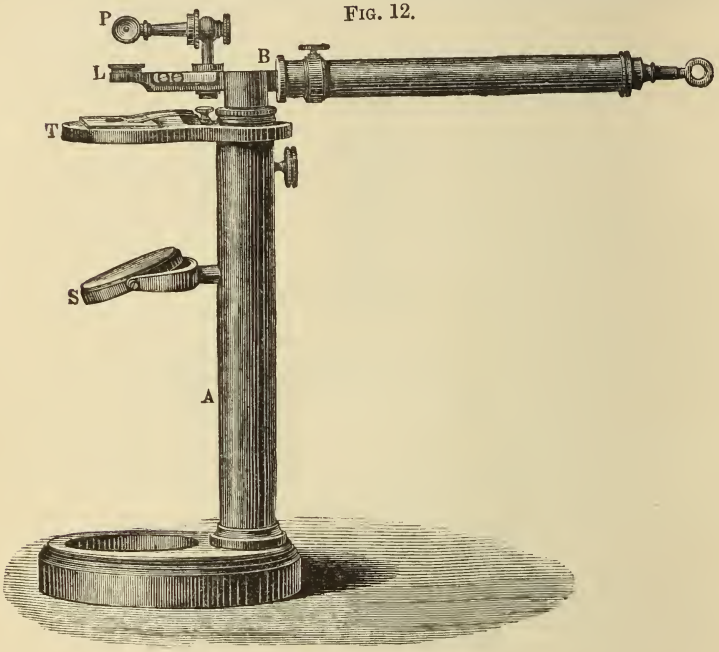


Fig. 12.

Jung's New Drawing Apparatus (Embryograph) for Low Powers.*—H. Jung was induced, by the inconvenient or ineffective performance of other drawing apparatus, to construct a new one (fig. 13) in accordance with the friendly advice of Professor v. Koch, giving powers of about 1 to 20 or 4 to 30 in continuous succession.

Upon the heavy square iron foot rests (besides the column and the bar P, movable by rack and pinion) a concave mirror to illuminate transparent objects. The latter is 80 mm. in diameter, and consists of a plano-convex lens silvered at the back. It is supported on a hinge-joint, which is attached to a short rod fitting into a spring-tube *h*, and this is screwed to a carrier T having a longitudinal slot. The carrier rests on the foot to insure greater stability, and on loosening the screw S which clamps it, it can be moved so as to obtain any desired position of the mirror, either by turning it round the screw as a pivot, or by sliding it along the slot.

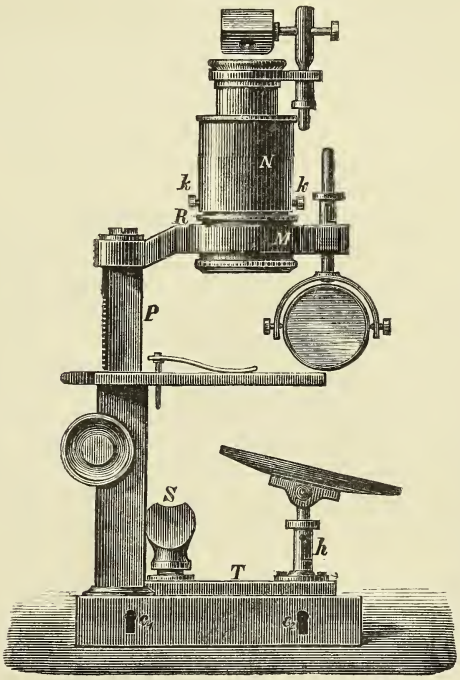
Upon the column is a stage 75 mm. deep, and 108 mm. wide. The stage, instead of a round aperture in the centre has a horseshoe

* Zeitschr. f. Instrumentenk., iii. (1883) pp. 165–7 (2 figs.).

aperture 40 mm. wide, which can be wholly or partially covered by two sliding plates.

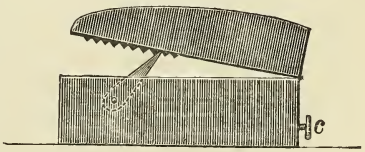
A special Brücke magnifier (with variable power) screws on the arm M. The arm has also a spring-tube into which a smaller mirror

Fig. 13.



can be inserted. This is for illuminating opaque objects, and receives its light from the larger mirror below. The focus of both mirrors is so regulated that with high powers the theoretically possible maximum of illumination can always be nearly attained. For very weak illumination there is on one side a plate of opal glass. "The mirror has the great advantage over ordinary illuminating lenses that the field of view is always somewhat faintly and evenly illuminated, which extraordinarily facilitates the visibility of many natural objects which have not sharp outlines." The upper mirror can be placed in any position with regard to the axis of the lower, and can besides, for special objects, be put in the spring-tube of the lower mirror.

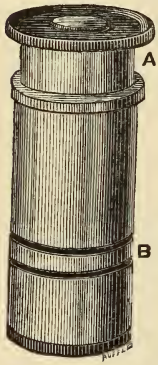
Fig. 14.



The Brücke lens consists of two achromatic objective lenses and a concave eye-lens. The objective lenses can be moved apart or brought nearer to one another by turning the ring R. In the same way the eye-lens can be placed at various distances from the objective by pushing the tube N up or down. This tube is so sprung in the inner fastening that by a somewhat firm pressing together of the two knobs *k*, the friction of the two tubes is lessened and an easy and smooth movement is obtained. For very low powers the lower objective lens can be removed. By this combination and also two stronger eye-pieces all gradations of power, in the given limits, can be obtained. The extent of the field of view is in inverse ratio to the power within the limits of 65 to 7 mm.

For convenient drawing a camera lucida is attached, which like Zeiss's allows the drawing surface to be inclined about 22° to the table. On turning the ring R, or on moving the tube to alter the power the camera always remains in the same position with regard to the ocular and the drawing surface, which is claimed to be "an advantage not to be undervalued, and not considered in many instruments."

Fig. 15.



In order to use the instrument for dissecting there are hand-rests, made to be easily removed. They consist of two hollow boxes (fig. 14) about 2/3 the height of the stage. They are attached by the button-headed screws *c* to the foot of the instrument, being inserted in the holes c_1 and c_2 (fig. 13) and the hinged tops can be set at different inclinations by the support and rack.

Zeiss's Micrometer Eye-piece.—This (fig. 15) is noticeable for the manner in which the micrometer disk is inserted. The eye-piece divides a little below the middle of its length, and has an additional piece between the upper and lower portions to which they are screwed. In this the micrometer disk is placed. The eye-lens is also in a sliding tube for adjustment to different sights.

Bulloch's Objective Attachment.—Mr. W. H. Bulloch has devised the objective-attachment shown in figs. 16 and 17. A is the nose-piece adapter to screw on the Microscope, and B is the ring, provided with three wedge-shaped studs, to be screwed on the objective. Three slots are cut in the body of the lower cylinder of the nose-piece A, and three similar slots in the inward projecting rim of a rotating collar. When the two sets of slots correspond, the ring B, with the objective attached, can be slid into the nose-piece, and then the studs are locked firmly by a slight turn of the rotating collar, which causes its projecting rim to slide over the outer halves of the studs. By reason of the wedge form given to the studs, the collar can be made to press down upon them with more or less force. The objective cannot be removed from the nose-piece until the rotating collar is turned back to the normal position, releasing the studs.

With this device both hands must be used either in attaching or removing the objective, and no provision is made to insure accuracy of centering. In the apparatus from which the above description was

Fig. 16.

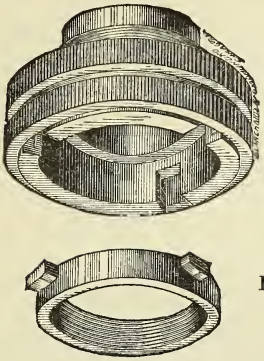
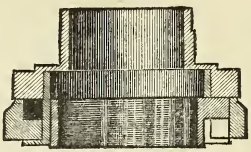


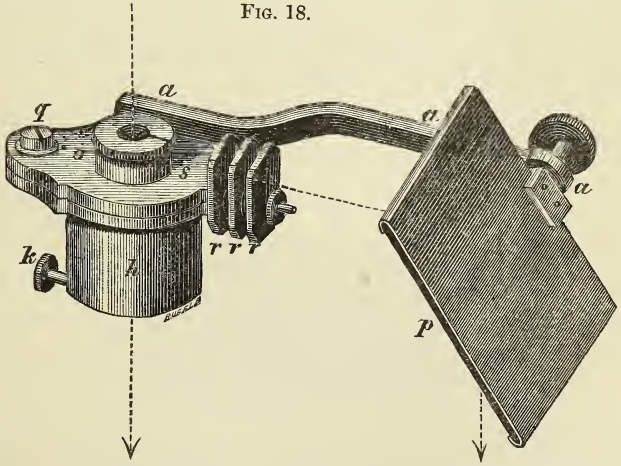
Fig. 17.



made the objective had a lateral play at the shoulder of about 1/50 in. when the collar was secured with moderate force. Such loose fitting would be found very inconvenient in the registration of the positions of small objects with high powers. Altogether, we cannot but think that the apparatus is more complicated than is at all necessary. Whilst it has the studs of Nelson's form it lacks the simplicity of the turn of the objective with the same hand that holds it, and whilst it has the rotating collar of the Watson-Matthews form (amply sufficient to hold the objective) it has the additional complication of studs in place of a simple conical fitting.

Abbe's Camera Lucida.*—G. Kohl gives the annexed fig., 18, of

Fig. 18.



what he terms "Boecker's new drawing apparatus after Dippel," but which is in reality Professor Abbe's Camera Lucida.†

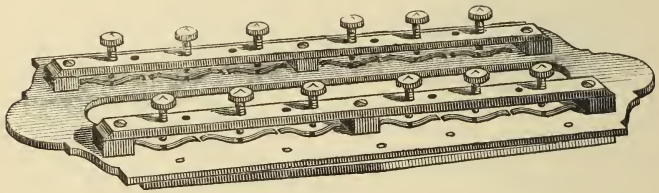
* Bot. Centralbl., xvi. (1883) pp. 385–6 (1 fig.).
† See this Journal, iii. (1883) p. 278.

The novelty consists in the introduction of the tinted glass plates * *r r r* in the path of the rays from the mirror. Also the upper part of the apparatus (mirror *p*, its arm *a*, the glasses *r r r*, and the plate *o s*) is movable on the pivot *q* upon the lower plate, which forms part of the tube *h* fixed to the eye-piece by *k*.

Millar's Multiple Stage-plate.—The object of this stage-plate (fig. 19) is to facilitate the exhibition of a series of slides so that they may be observed successively without having to remove and replace each object separately.

The base-plate slides on the stage after the upper stage-plate is taken off, and it holds six slides. Each of these is fixed by two small

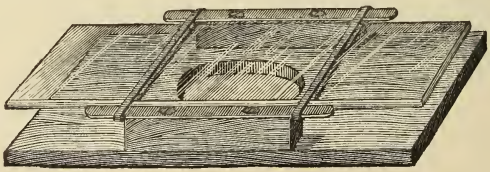
Fig. 19.



screws (passing through the two longitudinal bars) which press the slide against springs attached to the base-plate, there being six springs beneath each bar. The base-plate can be readily pushed in either direction by the hand when it is desired to examine a different object. The mechanical movements of the stage will bring various parts of an object into the field, but it is easy to adjust each slide on the plate in the first instance so that the object shall be central with the optic axis, there being sufficient spare room to move the slide both laterally and vertically.

Stewart's Safety Stage-plate.—This very simple device (fig. 20) was designed by Mr. C. Stewart to provide an economical but

Fig. 20.



effective arrangement for protecting slides from breakage when being exhibited under high powers to large classes of students.

It consists of a wooden slip the length of an ordinary slide and

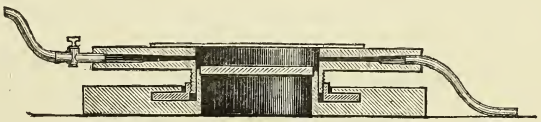
* See this Journal, iii. (1883) p. 119.

rather wider, with a central aperture and two side pieces ($\frac{1}{4}$ in. high), capped with thin strips of brass projecting at either end of the uprights as shown in the fig. Across the projecting ends two small indiarubber rings are stretched and the slide is passed through these rings and thus suspended. If now the objective is brought down on the slide the latter sinks on the least pressure and ample warning is given to the observer.

Parsons' Current-Slide.—Mr. P. B. Parsons has devised the new form of current-slide shown in figs. 21 (section) and 22 (perspective), which he describes as follows:—

"The slide consists of two plates, pierced with central apertures

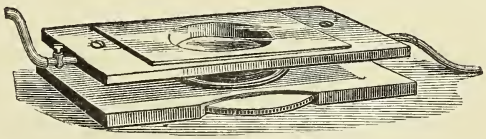
Fig. 21.



surrounded by tubular projections, and fitting together like a live-box. The top one is raised or lowered by a milled head fixed to the lower one and working in a thread cut on the tube of the upper. Two pins prevent the plates from coming apart or turning on each other.

The top plate has a hole at one end for the water supply and a

Fig. 22.



similar hole on the other for the waste, a piece of movable brass tube fitting into each.

The supply tube has a valve for regulating the quantity of water admitted, and beyond this is an indiarubber pipe connected with the water-vessel. A double-necked bottle is very convenient, so that a fresh supply of any fluid can be introduced without disturbing anything.

The advantages of this arrangement are:—

1. The depth of the cell is easily adjusted while on the stage, and the object can be brought within reach of fairly high powers by simply reducing the depth of water to a thin film. When not under examination with such powers the cell can be deepened, giving plenty of space with a constant current of fresh water, and yet enabling the observer to keep the object in view with a lower power.

2. The diameter of the cell, while large enough for all ordinary

purposes, admits of the use of very thin cover-glasses, ·005 or ·004 in., and when the cell is screwed up an 1/8 in., 1/10 in., or even 1/12 in. might be used if required.

3. The water supply is perfectly under control, and as there is at the same time no filtering action, the object can be supplied with water containing anything necessary to the life of the object.

4. The current is not interfered with by reducing the depth of the cell.

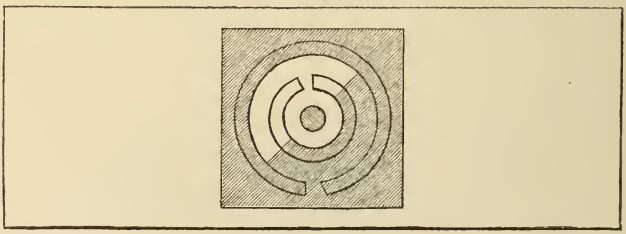
5. Objects can be easily put in, taken out, or manipulated in any way by stopping the supply and sliding the glass cover (which by preference should be square) downwards till the opening is large enough to do what is required. To replace the cover, slide it up till there is the least possible opening left and then fill up any air-space in the cell with water from a fine syringe before pushing it quite over the edge. If the under side of the cover-glass be slightly greased at the corners there will be no risk of it floating off.

This slide is manufactured by Messrs. Swift and Son, and can be made of varying depth and diameter to suit special purposes."

Stokes's Growing-cell.*—Dr. A. C. Stokes cements to a slide a disk and two rings made from cover-glass,† the rings having a small piece broken away from each and arranged as shown in fig.

To use, place on the central disk a small drop of the water con-

Fig. 23.



taining the organisms to be kept alive, and over it arrange a large square cover, taking pains to prevent the water from overflowing into the inner annular space. With a camel's hair pencil carefully, and in small quantities, add fresh water at the top or side of the square, until the space covered by the latter and bounded by the outer ring is filled. It will be found that this water will flow between the square and the upper surface of the exterior ring, will enter through the break in the latter, partially filling the outer annular space, and by capillary attraction will occupy a part of the vacancy between the cover and the interior ring, as shown by the diagonal lines in fig. 23, but unless too much water is used, or is supplied in too great quantities at a time, it will not pass the opening in the inner ring, thus leaving

* Sci.-Gossip, 1884, pp. 8–9 (1 fig.).

† These can be punched out by the method described by Dr. Beale, 'How to Work with the Microscope,' 5th ed., 1880, p. 73.

an abundance of air to supply the animal life under observation. The imprisoned air at once becomes saturated with moisture, as evidenced by the fogginess of the cover; the central drop cannot evaporate, and the external water will not come in contact with it if care is taken in filling and in adding that lost by evaporation. When not in use, the slide is placed across a small vessel of water, a double and twisted thread arranged in contact with the edge of the square cover, and the whole left for another examination at some future time.

Nunn's Pillar and other Slides. *—Dr. R. J. Nunn, under the heading of "*The Pillar-Slide—a new slide for the Microscope*," writes, "Every microscopist knows the difficulty of estimating exactly the amount of fluid which will completely fill the space between a cover and the slide, and consequently a bibulant must be applied to absorb the excess almost always present. This takes a little time, which, to one who has many examinations to make, and who is otherwise pressed, is a matter of some importance.

The following is a description of a slide intended to obviate this difficulty:—

Take a small thick cover (round or square, as desired) and cement it on the centre of a slide with Canada balsam. Let this harden thoroughly so that the cover will not slip during warm weather, and also to prevent water insinuating itself between the glasses during the frequent washing to which it will be subjected. Of course it would be better to have these little pillars ground upon the slides, but with care in using them the cemented ones will answer every purpose.

A drop of the fluid to be examined is placed upon the pillar just described, a cover larger than the pillar is placed upon it, when it will be seen that the excess of fluid flows into the annular space surrounding the pillar. Not the least advantage of this new form of slide is that evaporation takes place from the fluid in this annular space, and may go on for a long time without affecting the stratum under examination.

If desired, the annular space may be filled with oil, and evaporation thus be entirely prevented."

Under the heading of "*Chemical—new slide for the Microscope*," is the following:—"For the application of chemical tests to fluids under microscopical examination, the 'pillar slide' presents many advantages. The method usual in such cases is to place a drop of the reagent at one edge of the cover and a bit of blotting-paper at the opposite edge, with or without a hair inserted between the cover and the slide to facilitate the inflow of the reagent.

If the circular pillar-slide be used, then the cover must be pushed so that all the space is on one side; there will thus be formed a crescentic instead of an annular space. It is evident that in the latter, if the space is filled with reagent it will affect the film, but slowly, because evaporation takes place from the reagent itself, and there is nothing to draw it between the cover and the pillar. In the round

* Sep. repr. from Trans. Med. Assoc. Georgia, 1883, pp. 21–4.

pillar this is best corrected by having the diameter of the cover smaller than that of the pillar, and pushing it to one side so as to project a little beyond the pillar, the lunate space thus formed is filled with reagent, while the rest of the edge of cover is evaporating and drawing upon the reagent to supply the deficiency thus created, or, to hasten the reaction, a bit of blotting-paper may be applied in the usual way.

Another good way is to use a square cover: let one of the corners project beyond the pillar, and under this corner put the drop of reagent, in this way nearly the whole of the edge of the cover will be left free for evaporation, and the rapidity of the reaction will of course be proportionately great. If desired, a different reagent may be placed under each of the four projecting corners of the square cover.

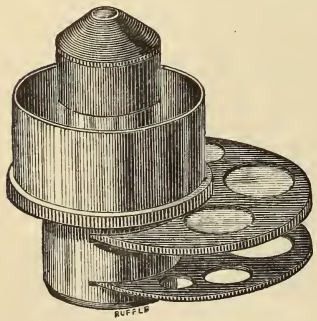
The 'square pillar-slide' seems, however, best adapted to this class of work, with a cover the same size or smaller than the pillar, and projecting a little beyond it; the reagent will then occupy one side of the square and evaporation go on from the other three sides. If an oblong cover is used which projects on opposite sides of the pillar, then the same or different reagents may be placed on opposite sides of the same specimen, without danger of mixing with each other."

Under "*Slides with hollows for chemical reactions*" Dr. Nunn says "Many of the advantages of the pillar slides for the observation of chemical reactions may be obtained by using polished glass slides with one or more hollows.

In using these the drop of fluid to be examined is placed by the side of the hollow, or between them, if there be two or more, and the cover is allowed to project over the hollow or hollows a little distance; under this projecting edge the drop of reagent is placed, and the bit of blotting-paper may be used as usual upon the slide if desired."

Beck's Condenser with two Diaphragm-plates.—Fig. 24 shows the condenser which accompanies Messrs. Beck's Pathological Microscope (Vol. III. 1883, p. 894). The peculiarity of its construction is that it has two rotating diaphragm-plates, one with the usual series of (7) apertures of different sizes, and the other with one clear aperture and three others filled with blue glass of varying tints, for moderating the light. The former is placed at a distance below the lenses sufficient for accurate centering of the condenser.

Fig. 24.

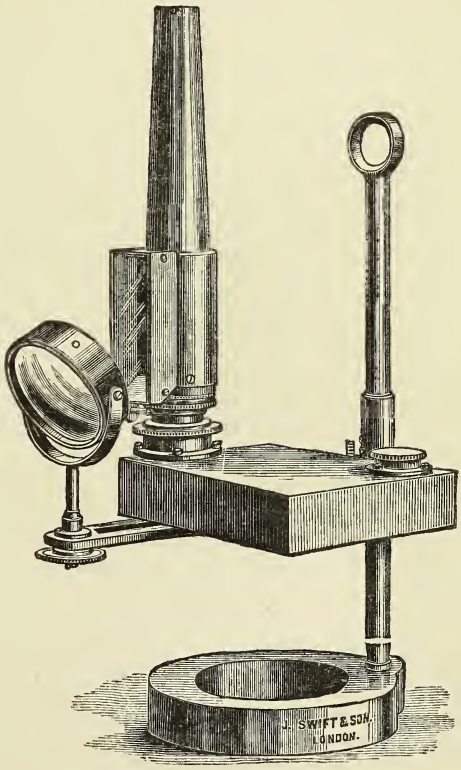


As shown in fig. 24, the condenser is for use with the smaller stands, but by reversing the optical combination and screwing it on the opposite side it is available for large stands.

By the removal of the sliding cap which carries the highest power lens of the three of which the optical combination is composed, the condenser is suitable for use with low-power objectives.

Nelson's Microscope Lamp.—Mr. E. M. Nelson some time ago devised the lamp shown in fig. 25; but no description or figure of it has been issued till now. The principal points in the design are (1) that the flame (using either the edge or the broadside) can be brought much nearer to the surface of the table than usual, which is secured by making the oil-well very shallow, large enough however to hold

Fig. 25.



sufficient for eight or nine hours' work, and with means for replenishing the supply of oil without touching the flame; (2) the metal chimney is arranged to cut off all the light except that required for actual use with the Microscope, and the only glass required is an ordinary 3 × 1 slip which slides in a groove about an inch in front of the flame and can be readily removed for cleaning; (3) the condensing lens is of the compound Herschellian form, by which a clearer disk of light can be obtained than with the usual bull's-eye, and is provided with means of adjustment in all directions. The lamp was constructed by Messrs. Swift and Son.

Developing Photo-micrographs.*—The microscopist who occasionally photographs his specimens finds that his developing solutions deteriorate by keeping, and often when he comes to use them, after standing untouched for some time, they do not act properly. Especially is this true of developers containing pyrogallic acid, which, as ordinarily made, soon lose their strength. It is customary to make up the solutions and keep them ready for use, but owing to the circumstances above mentioned, this plan is not a good one for microscopists who only use them occasionally.

Mr. R. Hitchcock has adopted the following plan for developing, which enables fresh solutions to be readily made without loss of time. There should be always at hand citric acid and pyrogallic acid in powder, strong ammonia (·880), and a solution of potassium bromide, 50 grains to the ounce of water. When about to develop the plates, dissolve 1·5 grains of citric acid in 8 ounces of water. In practice it is not necessary to weigh out the exact quantity, as it can be measured on the point of a knife, after a little experience. Then take half a drachm of ammonia and mix it with 8 ounces of water. Go into the dark room with the solutions, put the exposed plate into the developing dish, and proceed as follows: for a 4 × 5 plate take 1 ounce of citric acid solution and add to it 2 grains of the pyrogallic acid in powder, measuring that quantity in the hand, or on a spatula. It dissolves almost instantly. Then add one ounce of the ammonia solution and a drop or two of the bromide, and flow the whole over the plate. The development proceeds slowly, and may be controlled in the usual manner by adding more bromide, or a few drops of dilute ammonia, as the case may require.

Action of a Diamond in Ruling Lines upon Glass.†—Prof. W. A. Rogers writes, "In offering a communication upon the subject indicated by the title of this paper, I am not unmindful of the fact that I enter a field in which I acknowledge a master. Since the death of the incomparable Nobert, Mr. Fasoldt, of Albany, stands easily first in the art of fine ruling. I desire to repeat here the reply which for the past three years I have invariably made to inquiries for test-plates from my own machine—viz. that with Mr. Fasoldt's special facilities for this class of work he can, I have no doubt, produce far better results than it would be possible for me to obtain by chance efforts. I have thought it better to confine my attention to another equally important problem—viz. an attempt to obtain copies of the imperial yard and of the *mètre des archives*, at the temperature at which they are standard, to subdivide these units into aliquot parts and then to obtain a microscopical unit whose subdivisions should be so nearly equal that the Microscope would fail to reveal the difference. The first part of this work has been mainly completed. Two independently obtained copies of the imperial yard yield nearly identical values for the length of this standard unit. Three independent comparisons with the *mètre des archives* agree within very narrow limits in defining the absolute length of the metric unit, both

* Amer. Mon. Micr. Journ., iv. (1883) p. 198.

† Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 149-65.

of 32 and 62 degrees Fahrenheit. The subdivision of these units into aliquot parts—the yard into inches and the metre into centimetres—has been so far completed that any errors which may remain will not affect the microscopical unit sought. With regard to the exact subdivision of these units, I can only report progress.

Notwithstanding this abandonment of attempts to produce test-bands of the Nobert pattern, I have recently taken up the subject again, somewhat with the view of testing the claim of Mr. Fasoldt that he has succeeded in ruling lines one million to the inch, and especially by the claim that the existence of a spectrum in the bands is an evidence of the reality of the separate lines. The latter claim does not appear to be well founded. Aside from being at variance with theory, it can easily be disproved experimentally.

Before proceeding further with this investigation, I beg to refer to a theory proposed by the writer in a paper presented to the American Academy of Arts and Sciences, in relation to the method which Nobert may possibly have employed in the production of his test-plates. Briefly stated, this theory is that the lines composing Nobert's bands are produced by a single crystal of the ruling diamond, whose ruling qualities improve with use. In the light of subsequent experience this theory may be stated in the following way: When a diamond is ground to a knife-edge, this edge is still made up of separate crystals, though we may not be able to see them, and a perfect line is obtained only when the ruling is done by a single crystal. When a good knife-edge has been obtained the preparation for ruling consists in finding a good crystal. Occasionally excellent ruling crystals are obtained by splitting a diamond in the direction of one or more of the twenty-four cleavage planes which are found in a perfectly formed crystal. A ruling point formed in this way is, however, very easily broken, and soon wears out. Experience has shown that the best results are obtained by choosing a crystal having one glazed surface and splitting off the opposite face. By grinding this split face, a knife-edge is formed against the natural face of the diamond, which will remain in good condition for a long time. When a ruling crystal has been found which will produce moderately heavy lines of the finest quality, it is at first generally too sharp for ruling lines finer than 20,000 or 30,000 to the inch, even with the lightest possible pressure of the surface of the glass. But gradually the edges of this cutting crystal wear away by use until at last this particular crystal takes the form of a true knife-edge, which is parallel with the line of motion of the ruling slide. In other words, when a diamond has been so adjusted as to yield lines of the best character its ruling qualities improve with use. If Nobert had any so-called 'secret,' I believe this to have been its substance.

The problem of fine ruling consists of two parts—first, in tracing lines of varying degrees of fineness; and, second, in making the interlinear spaces equal. The latter part of the problem is purely mechanical, and presents no difficulties which cannot be overcome by mechanical skill.

It will be the aim of the present paper to describe the more

marked characteristics of lines of good quality ruled upon glass, and to illustrate these characteristics by corresponding specimens. To one who is familiar with Nobert's bands a perfect line need not be described. It is densely black, with at least one edge sharply defined. Both edges are perfectly smooth. Add to these characteristics a rich black gloss, and you have a picture of the coarser lines of a perfect Nobert plate. How are those lines produced? In the study of the action of a diamond in producing a breaking fracture in glass the Microscope seems to be of little service, but we can call it to our aid in the study of its action in ruling smooth lines. One would naturally suppose that a line of the best quality would be produced by the stoppage of the light under which it is viewed by the opaque groove which is cut by the ruling diamond. Without doubt this is the way in which lines are generally formed. But it is not the only way in which they can be produced. An examination under the Microscope will reveal the fact that in some instances at least, a portion of the glass is actually removed from the groove cut by the diamond; and that the minute particles of glass thus removed are sometimes laid up in a windrow beside the real line, as a plough turns up a furrow of soil. On the finest plate I have ever produced every line remained in perfect form for about two months. I then first noticed a tendency on the part of some of the single lines to disintegrate, while the lines ruled in closer bands seemed to retain their good qualities. This disintegration finally became so marked that, as an experiment, I removed the cover and cleaned one-half of the surface of the glass by rubbing with chamois skin. The difference in the appearance of the two halves is now very marked. Above, the dense black lines remain. Below, a ragged abrasion of the surface of the glass has taken place. Above, the furrowed lines as originally formed are preserved; below, there is a coarse scratch. It may be said that the action in this case is accidental and abnormal. In reply, I can say I have prepared plates which show that the particles of glass removed take four characteristic forms. (*a*) They appear as chips scattered over the surface of the glass. (*b*) They appear as particles so minute that when laid upon a windrow and forming an apparent line, they cannot be separated under the Microscope. (*c*) They take the form of filaments when the glass is sufficiently tough for them to be maintained unbroken. (*d*) They take a circular form.

I regret that three of the most striking specimens were broken in mounting. In one a perfect line about 1/30,000 of an inch in width was formed with a clear space between it and the groove cut by the diamond. There was not a single break in these filaments from beginning to end, but at nearly equal intervals of about 1/100 of an inch half-knots were formed similar to those formed in a partially twisted cord. By rubbing the surface of one end these filaments were broken up. For the most part they assumed a semicircular form, but some of them maintained their thread-like form and became twisted together in the most intricate fashion.

In the third specimen, which was broken in mounting, the glass removed took a spiral form like the spiral chips from steel when

turned in a lathe. A projecting crystal of the diamond caught these spirals and carried them unbroken to the end of each line, leaving them a tangled mass of threads. Even after they were protected by a cover-glass cemented to the surface, many of these spirals remained intact. Judging by the difference in focus of the various parts, the height of the mass, before the plate was covered, must have been 1/500 of an inch.

The same ruling crystal may produce smooth lines or either chips or threads, according to the motion of the diamond, as may be seen by examination of the accompanying rulings In these plates one-half of the lines of the bands are ruled by a forward motion and one-half by a backward motion of the diamond. Chips may be formed in ruling bands of very fine lines, as illustrated in the bands of lines 24,000 to the inch.

It must not, however, be supposed that lines of the best quality always present the appearance described above. While it is exceedingly rare that lines appear as well after the surface of the glass has been rubbed as before, many instances have occurred within my experience in which the difference, especially in fine lines, was not particularly noticeable. According to the limited evidence at hand, the coarser lines of Nobert's bands present some of the characteristics which I have described. I have restored two of these plates, in which the lines had become nearly obliterated by some kind of condensation under the cover-glass. In one the quality of the lines was not much affected by the operation of cleaning, but in the other the dark gloss which characterizes the heavy lines of nearly all of Nobert's plates was entirely destroyed. The finer lines, however, were much less affected than the coarse ones.

Lines of the character thus far described are evidently unsuited to the ordinary work of the microscopist. It is my experience that lines which are the most symmetrical in form and the most beautiful in appearance are produced indirectly rather than by the direct action of the diamond in cutting a groove in the glass. They can be protected to a certain extent by a cover-glass, but they are liable to undergo changes which will affect their original structure. Except for purposes of investigation, therefore, there is no advantage to be gained by ruling lines of this character. Three conditions must be fulfilled in the production of lines having a permanently good character :—

1. The glass must be tough. There is a marked difference in the character of the filaments produced, and, to a certain extent, of the lines themselves, yet the conditions under which the lines in the series of plates illustrating this paper were ruled were the same in nearly all of the plates—i. e. the same diamond was used, its setting remained unchanged, and there was no change in the pressure of the diamond upon the surface of the glass. I may add also, that I have in my collection several other plates which were ruled especially to test the question of the requisite quality of the glass. They all agree in giving evidence that glass of a given quality will always yield lines of nearly the same quality—the ruling crystal remaining the same and in the same position.

2. The greatest difficulty encountered in setting a ruling crystal is to obtain one which will rule lines of the required quality which will retain their form after the surface of the glass is rubbed. The crystal with which nearly all the plates of this series were ruled was only obtained after a search continued at intervals through several weeks. Sometimes a diamond which will rule good light lines will not produce good heavy lines, and *vice versâ*. According to my experience it is better to have a special diamond for each class of line desired, though the diamond with which the present series of plates was ruled seems well adapted to every kind of work required, except, perhaps, the production of the finest bands. An examination of plates illustrates the wide difference in the character of lines ruled with the same diamond, after the edges of the ruling crystal have been worn smooth. In one there are two sets of lines, side by side, in one of which the surface has been rubbed, and in the other of which the lines have been left undisturbed. The difference is very marked. It may be said here that the surface of a ruled plate should always be cleaned by rubbing in the direction of the lines only, never at right angles to the lines. It will often happen after sharp rubbing that the lines appear ragged, when the difficulty is that the chips have not all been removed from the grooves. Rubbing with Vienna lime, moistened with alcohol, will usually complete the cleaning satisfactorily.

3. After a crystal has been found which will fulfil the conditions of producing a line which will bear cleaning, there still remains a difficulty which will only be revealed after the lapse of considerable time. This is well illustrated in one plate in which the lines were as perfect as could be desired for several days after they were ruled. The lines of the band are now completely broken up. Evidently they were in a state of strain, which finally became so great that resistance to rupture became impossible. This, however, is an extreme case. Generally the lines simply enlarge at certain points. Usually the termination of the enlargement occurs at irregular distances along the lines, and it is nearly always very sharply defined. The most curious action of this kind which has ever come under my notice is where the lines have broken up into a form something like the strand of a heavy rope.

The process of setting a diamond is as follows: The holder has the means of adjustment in three planes: (*a*) an adjustment in a horizontal plane; (*b*) an adjustment in a vertical plane; (*c*) an adjustment in a plane at right angles to the ruled lines. It is my practice to begin by giving the knife-edge of the diamond considerable inclination to the line of motion of the ruling slide. I then rule a series of single lines at different known angles of inclination, care being taken to pass the line of parallelism. An examination of the character of the lines thus ruled will enable one to determine within narrow limits near which one the knife-edge is set parallel with the slide. After a fair line has been obtained in this way a sharp crystal is generally found by tilting the diamond in a vertical plane, though it will often be found necessary to make the third adjustment men-

tioned. Sometimes the cutting crystal is lost after ruling a few lines, but generally good results can be obtained after a constant service of weeks, and even months. A crystal is lost either by being broken off or by being worn out. When a crystal has been lost it need not be concluded that the diamond needs sharpening. It is only necessary to find a new crystal, an operation requiring patience rather than skill.

It should be stated, that while this theory of individual cutting-crystals seems to be the true one, I have never been able to detect them by an examination with the Microscope. It is only by their behaviour that their existence can be recognized.

One of the most severe tests of the ruling qualities of a crystal consists in producing, without fracture, heavy lines which cross each other at a small angle of inclination, and which will receive graphite without interruption of continuity at the intersection. Lines ruled at right angles and forming small squares afford a better test than parallel lines. In one plate presented the curved lines formed by the intersection of straight lines are nearly perfect in form, and they hold the graphite quite as well as the original lines. In another plate I have attempted a representation of the nucleus of a comet. The filling is not quite as perfect as in the other plate, but this is due to the quality of the glass. Attention is called to the granular structure under a moderately high power. I have found rulings of this form to be an excellent test of the quality of the glass required for receiving the best lines. In general, the first filling of the lines is the most perfect. One plate affords an illustration, exceedingly rare, of lines which receive the lines equally well after repeated fillings. Lines as fine as 50,000 to the inch very readily receive the graphite. The limit beyond which it seems impossible to go may be placed at about 100,000 to the inch.

A few words may properly be added here with regard to the protection of ruled lines. When lines are formed by a true groove in the glass, it is better that they should remain unprotected. But when the lines are formed in the manner illustrated by the plates of this series, the quality of the lines in the end is pretty sure to deteriorate whenever there is an actual contact of the cover-glass with the slide. I have made serious efforts to overcome this difficulty, but with only partial success. Slides mounted with gutta-percha rings generally remain in good condition for a long time, especially if, after expelling the air as far as possible by heat, a ring of white wax cements the rim of the cover-glass to the slide. But even with this precaution there is no certainty of final preservation. If it should be found that the brass slides of this series are convenient in manipulation, their adoption can be recommended, since they entirely obviate this difficulty. They are made in the following way:—A hole having been made in the centre, a flange is left 1/200 in. in thickness. The cover-glass is then cemented to the surface of the brass, and the rulings are made on the under side. The protection is made by dropping upon the ledge of brass a rather thick circle of cover-glass, which is held in position by a circular brass wire.

After this digression, I return to the consideration of the credibility of Mr. Fasoldt's claim that he has succeeded in ruling lines 1,000,000 to the inch. At this point it is only fair to say that until recently I have shared in the general incredulity with which Mr. Fasoldt's claim has been regarded. Indeed, I still think he has placed the limit just a trifle too high. But if the limit is reduced one-half, I am by no means sure but that it may be reached. Possibly it may have been already reached. But what evidence have we that it is possible to see single lines of this degree of fineness, granting that it is possible to produce them? The answer to this question involves another inquiry, viz. has the Microscope reached its highest visual possibilities? Here again it is necessary to draw a sharp distinction between visibility and resolution. In the matter of limit of resolution it must be admitted that little or no progress has been made since the resolution of Nobert's nineteenth band. The distinguishing feature of Nobert's lines is a certain boldness which enables them to be photographed, and it is to photography, supplemented by the statement of the maker, that we owe the certainty of the resolution of the nineteenth band. But all attempts to go beyond this band, even with Nobert's later plates, have proved failures. I cannot learn that any one has yet succeeded in photographing a Fasoldt plate as high as 100,000 to the inch. Certainly various attempts which have been made with bands of my own ruling higher than about 70,000 have not been successful. There are several Nobert plates of the new pattern in this country. They run as high as 240,000 lines to the inch,* but who has gone beyond the number of lines in the nineteenth band? † With great respect for the honest belief of several microscopists who claim to have resolved Fasoldt's bands as high as 152,000 to the inch, I must yet hold to the opinion that in no case has the resolution been proved by a test which will be generally accepted by microscopists. There is one test, and only one, which is absolutely decisive—viz. the one originally proposed by Nobert, that of ruling a definite number of lines in a band of given fineness, and keeping the number secret until the microscopist could give the correct count, not merely in one instance but in several. Even here we must depend upon the honesty of the maker in revealing the correct count. Has the correct count been made in any Fasoldt plate as high as 100,000 to the inch? I think not. Has it been done with any band of my own ruling of the same degree of fineness? No. Let us marshal the evidence pro and con, offered by experience.

(*a*) Mr. Fasoldt's finest bands present a perfectly smooth and uniform surface. They have well-defined limits, and the width of the bands is what it should be by the number of lines claimed to be ruled.

(*b*) According to present experience single lines can be ruled

* The highest is 1/20,000 of a Paris line, i. e. 224,000 to the English inch.—Ed. J.R.M.S.

† Mr. E. M. Nelson claims to have resolved the next finest band to the 19th, viz. the 11th band of the latest 20 band plate, the lines of which are at the rate of about 123,000 to the inch.—Ed. J.R.M S.

several degrees finer than I have been able to detect under the Microscope. About four years since I sent to Prof. J. Edwards Smith a ruled plate with a statement of the number of bands, accompanied with a description of the same. Soon after I received a letter from Prof. Smith, saying there must be some mistake in the description, as he was unable to find two of the bands. I replied that the bands were certainly ruled, and that I thought I could convince him of that fact. I therefore requested him to re-examine the plate with the greatest care, and if he was still unable to find the bands to return the plate to me. After a vain endeavour to discover them the plate was sent to me. I removed the cover, filled the lines with graphite, remounted the slide, and returned it to Prof. Smith. Not only had the invisible bands become visible, but the separate lines, with an interlinear space of 1/80,000 in., were easily seen. Now when Prof. J. Edwards Smith, an acknowledged expert in the manipulation of the Microscope, is unable to find lines which are really in the centre of the field of the Microscope, I suspect that other observers may find a similar difficulty. Among the plates presented is one series which were ruled to illustrate the possibility of producing lines which really exist, but which are invisible under the Microscope. On one plate there are two sets of lines, one set on the slide and the other on the under side of the cover. Between the bands, 10,000 and 24,000 to the inch, the entire intervening space is filled with a continuous series of bands, 24,000 to the inch. I have not been able to see the lines of the last band. In another plate there are a series of bands containing twenty-one lines each, the entire linear space being 1/2000 in. The first eleven lines are ruled with a forward motion of the diamond, and the second ten lines are ruled with a backward motion. The last two bands are preceded by heavy finding lines. Each of the last three bands is followed by bands 24,000 to the inch. I think it will be found difficult to see the lines of the last two bands under any illumination at present in use, and yet I am confident that the lines exist. I found my belief upon two bits of evidence: First, the pressure of the diamond upon the glass was sufficient to produce the lines. With considerable less pressure there would still have been a constant contact between the diamond and the glass. Second, I saw them ruled through the sense of hearing. When a diamond does its very best work it produces a sharp, singing tone, which is audible at a distance as great as twelve inches. This singing tone I distinctly heard for every line ruled. It is even more marked in ruling the finest lines than in coarse ones. I have two singing diamonds, or rather two diamonds with singing crystals, and these two are the ones with which I have done my best work.

The argument against the visibility of single-ruled lines which cannot be seen with the present means at command, even if within the limits of possibility, considered in a physiological sense, is in one respect a sufficient answer to the evidence offered in favour of their existence. This evidence, while not exactly negative in its character, is yet not sufficiently conclusive to be regarded as coming under the head of proof through the medium by which the

existence of any fact is attested, viz. the medium of some one of the senses. But may it not be true that we have not yet reached the fulfilment of the conditions necessary to visibility? It certainly cannot yet be safely asserted that it is impossible to see a material particle which has, in one direction, a magnitude not exceeding 1/500,000 in. Photography offers the evidence, somewhat negative in its character, that the limit of visibility is reached with lines having a width of about 1/200,000 of an inch. Lines of this width are the finest that have ever been photographed. But the most conclusive evidence against the certainty of being able to produce lines as fine as 500,000 to the inch consists in the fact, repeatedly proven in my own experience, that lines which appear to be excessively fine often have a real width two or three times as great as they appear to have, as has been proved conclusively by filling the lines with graphite, which brings out the real limit. This phenomenon will come up again in connection with the subject of resolution.

I have already stated my belief that the limit of resolution has been so nearly reached that, though it is quite possible under a combination of favourable circumstances to obtain a resolution a little beyond 113,000 to the inch, the uncertainty which must always attend observations of this character is so great that the certainty of resolution cannot be safely asserted. In consideration of this uncertainty, and of the fact that so little progress has been made in resolution compared with the recent advance in the construction of objectives, I beg to propose as a test the visibility of single-ruled lines in place of the resolution of these lines in close combination. Instead of bands of lines of the Nobert pattern, I propose a series of bands, each having the same interlinear unit, but with the lines of each successive band finer than those of the preceding band. The space between the lines should not be so great as to interfere with their easy detection, nor so small as to require any effort in resolution. One micron (μ) is a convenient unit. A heavy line should precede the band, in order to facilitate finding it.

According to my own experience there are four facts which must always throw grave doubt upon any reported case of difficult resolution:—

1. It is well known that by the manipulation of the light, every other condition remaining the same, it is possible to vary the apparent number of lines in a given band of coarse rulings. Can any one offer a reason why there should not be the same difference with bands of fine lines closely ruled?

2. I have many times ruled bands of lines with the interlinear spaces distinctly marked, but in which each line was in reality considerably wider than the space between the lines, as I have proved by extending single lines beyond the others and filling them with graphite. The only explanation of this singular fact which I can suggest is that the diamond may possibly cut square down at one edge of the line and for the remainder of the line produce only an abrasion of the surface of the glass, which is so slight as not to interfere with throwing up a furrow upon the remaining portion.

3. Lines of a given depth appear finer when closely ruled in bands than they do in single lines.

4. I add another observation with some hesitation, since I have not been able to prove its truth beyond peradventure. I have often, but not always, found that when single lines, apparently invisible, are placed in close combination in bands, they not only form a visible band, but a band capable of apparent resolution into separate lines. Can any one offer a reason why we can see in combination what we cannot see as separate parts? Of course I shall be at once reminded by the astronomer that it is much easier to pick up a cluster than to see scattered stars of the same magnitude. But when it is once found, the separate stars composing it are no more easily seen than stars of the same magnitude more widely scattered. I offer this observation in a tentative way, since it has, if true, an important bearing upon the question of the ultimate limit of resolution. Among the accompanying plates is one that illustrates the statement here made. This plate consists of a series of bands, 12,000 to 24,000 to the inch, each preceded by a heavy finding line. The lines of each successive band are finer than the preceding. The last two bands were ruled with the same pressure of the diamond as the fourth band preceding. The intervals at which they were ruled are 1/80,000 and 1/200,000 in. I do not by any means vouch for the existence of the separate lines, yet the bands are smooth, and there is a distinct difference in the appearance of the two halves of the 80,000 band, the first having been ruled with a forward and the second with a backward motion of the diamond. The corresponding single lines of the fourth band preceding are wholly invisible. This plate seems to show that the visibility of the lines in bands depends somewhat on the narrowness of the interval between the lines, since the lines of the same degree of fineness with an interval of 1/24,000 in. cannot be seen.

It is obvious that this whole question of resolution needs the most careful consideration and investigation, since it bears an intimate relation to the limit of visibility of single particles of matter. Mr. Hitchcock, in a recent number of his 'Journal,' has made the claim that resolution has to a certain extent ceased to be a test of the quality of an objective. I suspect that this claim will be found to have some foundation in fact. For the last ten years we have only the assertion of resolution, without doubt honestly made, but yet unaccompanied with the proof. It is time that the proof should accompany the assertion. I insist that simple vision does not afford the required proof.

Now we must face this question as honest inquirers after truth. There is a limit which theory places to resolution with objectives of given resolving power, not to visibility, as has been frequently stated. Before we can safely assert that observation has gone beyond theory, we must be prepared to offer evidence which can be placed upon record, can be discussed deliberately, can be weighed impartially in the balance with counter evidence, and can still stand unimpeached. Do you say that this is hardly worth the trouble? I reply that the issue here raised comes to the surface in one form or another at almost

every point in physiological and pathological investigations. It will do no harm to recall the number of times it has at this meeting stood as a sentinel at the entrance to the temple whose mysteries we are seeking to explore. Has not the question so tersely put by Dr. Gleason at the Elmira meeting of this Society, 'Do we see what we see, or don't we see what we see, or do we see what we don't see?' been the stopping place of more than one important issue raised at the meeting? I hope I do not need to say that I have no personal ends to serve in an inquiry in which I happen to be a personal factor. Let us then have a test which will for ever set at rest this vexed question of resolution. I submit for your consideration the following outline of a test which I venture to think will be sufficient and conclusive. Let Mr. Fasoldt rule three plates under as nearly the same conditions as possible, except in the number of lines in the different bands of each plate. Let him label each plate and accompany it with a full description of the number of lines in each band. Let these plates be sent to any gentleman in whom the great body of microscopists have confidence as eminently qualified to conduct an investigation of this sort, such as Prof. H. L. Smith of Geneva, or Col. J. J. Woodward of Washington. Let whoever receives the plates remove the labels of Mr. Fasoldt, and put in their place labels whose signification is known only to himself. Then let the gentlemen who think they have resolved 152,000 lines to the inch take the plates, make their count of the lines in each band, and send in their report. Let the plates also be photographed, and let the number of lines be counted; then let the results of these investigations be published. If all substantially agree in the count, this will end further discussion.

The limit of visibility of single particles of matter under the Microscope bears an intimate relation to the limit of naked-eye visibility. My attention was first called to the smallness of this limit by an accidental circumstance. I had ruled a micrometer upon a thin cover-glass consisting, as I supposed, of moderately coarse lines. After several vain attempts to discover traces of the lines ruled, I chanced while holding the glass at a certain angle with respect to the source of light to breathe upon it. At the instant the film of moisture was passing off, I was surprised to be able to see all the lines which were ruled, 100 to the inch, with the greatest distinctness. I then carefully filled the lines with graphite, when they were, after the closest inspection, found to be as fine as any I have ever ruled. According to the nearest measurement I could make, their width was about 1/6 of a micron. Repeated observations gave in every case satisfactory evidence of visibility. In order to ascertain what effect the thickness of the glass might have upon the visibility, the cover-glass was lightly cemented to a glass slide with guttapercha, when it was found that the lines were by no means as distinctly visible as before. The cover was then removed, when the original observation was easily confirmed. The lines of this plate were readily seen by Professor Pickering, and by several assistants connected with the observatory. Unfortunately the glass was broken in an attempt to mount it upon a brass slide. While it is a simple

matter to rule lines which are easily visible by the unaided eye, especially in sunlight, having a width not exceeding 1/50,000 in., I have never since succeeded in obtaining a plate quite as good as the one described. Clearly the ruling crystal had been broken off before this particular plate was ruled, and, as often happens, a minute and delicate crystal remained, which produced the lines which were really traced.

In the course of subsequent experiments I found that while the visibility was increased by the film of moisture, exceedingly fine lines could be seen without this aid to vision when the proper angles of inclination to the source of light are obtained. To get the best results the ruled surface should have an angle of about 15° with the source of light, and the lines themselves should have nearly the same angle of inclination. Everything depends upon getting the exact angles of inclination required. More striking results are obtained by sunlight than by artificial light. Highly polished metals, especially tempered steel and iridium, yield better results than glass. I will not undertake to say how fine lines traced upon metal can be seen, but I suspect that the limit of naked-eye visibility is far beyond the capacity of ruling. I have a plate of highly polished and nearly pure iridium upon which there are traced a series of lines which are discernible by the eye in sunlight, but which I have never yet been able to see under the Microscope by direct light. Yet these lines are easily seen with a low-power objective under certain conditions.

I do not propose to offer any theory to account for the facts which I have observed, not even the one which would naturally be the one first suggested—viz. that of visibility by reflection. I admit that the apparent width of the lines would be increased if the real and reflected lines could be seen side by side. It can be easily shown that the lines in one of the accompanying plates are visible under conditions in which it is impossible for reflection to take place. For the present I content myself with stating the facts of observation illustrated by the ruled plates by which these observations can be repeated.

I close this paper with the suggestion that the increase in the efficiency of the Microscope will probably come from the better manipulation of the light under which an object is viewed. At present the unaided eye is a not very unequal competitor of the Microscope in the matter of simple vision. In fact, there are certain phenomena connected with this question which can be better studied by the unaided eye than under the Microscope. I believe it to be possible to see under the action of sunlight what cannot be seen under any objective. There has been produced upon my ruling-machine, upon a polished surface of tempered steel, a band of 10,000 lines, covering a space of 4 inches. I have tested the equality of the spacing for aliquot parts of a revolution of the screw in every possible way by direct measurement. Other observers have done the same thing. I can hardly be wrong in the assertion that the spaces indicated by even tenths of a revolution are exactly equal as far as any tests of direct measurement can be applied. Yet, by holding this bar in a certain position with respect to the source of light, the limits of each revolu-

tion of the screw can be distinctly seen. These waves of light and shade indicate an error which can be seen by the unaided eye but which cannot be measured with certainty. Finally, if the visibility of ruled lines is so erroneously increased by the position which they occupy with respect to the source of light, why may not the visibility under the Microscope be increased in nearly the same proportion by some mechanical device which shall enable the observer to find exactly the proper angle of inclination at which the light should be thrown upon the object in order to secure the best possible result?"

Prof. Rogers, in the discussion on a paper by Dr. G. E. Blackham on the Relation of Aperture to Amplification, also said * "The whole thing depends on the question Can we compute resolving powers? I will not say that we cannot, and I have my doubts if we can. I question the truthfulness of the formula that is used in the computation. My confidence in it was shaken some time ago, when in the measurement of some plates I found errors of 1/40,000 in. I think that the formula is true, so far as it goes, but it does not tell the whole truth. There are conditions that affect it. Take, for instance, Bayard's formula for refractions. It is affected by the atmosphere and temperature. Now, I do not say that the two formulas are analogous; I use Bayard's only as an illustration of what may occur. My position is this: Take what we have as a basis of investigation, and go ahead to ascertain the truth. There is a great sea for exploration in the question."

Test-Diatoms in Phosphorus and Monobromide of Naphthaline.† —Canon E. Carr thinks those who are interested in the resolution of the more finely marked diatoms, and who have seen or heard of the magnificent image of *Surirella gemma*, mounted in phosphorus, shown by Mr. J. W. Stephenson at the Society's meetings and conversazioni, with a Zeiss' oil-immersion 1/8 objective and his own catoptric illuminator, will be glad to learn that Möller now supplies some of the more difficult test-objects mounted in highly refractive media. Having recently purchased a slide of *Amphipleura pellucida* mounted in phosphorus, and one of *Surirella gemma* mounted in monobromide of naphthaline, he gives the result of his examination of them. The resolution of the hemispherules on the latter was not remarkable, being much the same as that obtained on a slide of the object mounted dry. The resolution of the former, however, was all that could be desired with the means at command, and contrasted favourably with anything he had seen before. Previously, with a Powell and Lealand's water-immersion 1/8 objective, and Wenham disk illuminator, he had seen the striæ very faintly shown on a balsam-mounted slide. Much better resolution had been effected on a dry mount by a Powell oil-immersion 1/25 objective, and their achromatic condenser. But even this result was not to be compared with that obtained on the phosphorus mount. Using Powell's oil-immersion 1/12 objective (N.A. 1·43), and their oil-immersion condenser, the striæ came out

* Loc. cit., pp. 227–8.
† Engl. Mech., xxxviii. (1883) p. 280.

remarkably clear and sharp, and, though not distinctly broken up into dots, gave apparent indications of a want of continuity. It would be interesting (he adds) if other observers who possess large-angled object-glasses, and corresponding means of illumination, would give their experience in regard to the new slides of these difficult but fascinating objects.

Microscopic Test-Objects.* — Under the above title Mr. E. M. Nelson replied to Canon Carr as follows :—"Having worked at these objects for some years, and having also kept pace with the times in objectives and apparatus, I will, in answer to Mr. Carr's request, give the results of my experience: 1st, the total abolition of oblique illumination if one wishes to see the true structure of an object; 2nd, object mounted dry on cover.

I use a Powell achromatic condenser, accurately centered to the optic axis. The edge of the flame of a paraffin lamp, with 1/2 in. wick, exactly focused on the object, without bull's-eye or mirror. This illumination, with a Powell oil 1/12, N.A. 1·43, easily resolves *A. pellucida*, dry on cover, *with direct light*—i. e. without slot or stop.

If *S. gemma* is examined by this means, the hemispherule theory is at once exploded, and the true structure (which is far more beautiful) is revealed. It is something like a most delicate skeleton leaf. This, however, is very difficult for a beginner. The *P. formosum* is, perhaps, the best one to try first. Work away at that until the hemispheres, which are so easily seen, give place to a *square* grating! To see this, with a 1/4, N.A. ·74, will severely test the lens and the observer's manipulative skill. A coarse *N. lyra* and a *Tryblionella punctata* both have square apertures, and are very easy. N.B.—If the objective is much out of correction, the square apertures will blur round. The next one to try is *P. angulatum*. In this a fracture should be distinctly seen to pass *through* the apertures. The apertures will take a rose tint if the glass is properly corrected.

It is manifestly absurd to test an objective by a fine diatom seen with oblique light, for only a small portion of a narrow marginal zone of the objective is used. The central, and by far the more important, part of the glass might be stopped out.

By the central illumination, however, the whole of the objective is used; the centre by the dioptric beam, the margin by the diffraction pencils. In former days one used to hear this sort of thing said: 'This 1/12 is a beautiful diatom glass.' 'This 1/10 is splendid on *Podura*, but not good at diatom resolving.' (What a fine thing for the opticians! One had to buy two glasses, one for *Podura* and one for diatoms.) The explanation is very simple: for *Podura* a glass must be good in the centre, and for diatoms, with oblique light (the only light used in those days), good in the marginal zone. So then the 1/10, which was good for *Podura*, and the 1/12 for diatoms, could neither of them have been thoroughly corrected from their centres to their margins. I have a glass in my collection which is very fair on *Podura* when the screw-collar is in one position, and also is a

* Engl. Mech., xxxviii. (1883) p. 324.

good diatom resolver with its collar in another position; but when all its zones are tried at *once*, by the direct illumination, it utterly breaks down.

With regard to *A. pellucida*, the *strongest* resolution is obtained with Powell's vertical illuminator. The long striæ can only be seen by this method. Spurious longitudinal striæ may be easily seen; but the true lines are very difficult, and may be estimated to be 120,000 to the in. at the lowest. The transverse I have counted repeatedly, and find them, in Van Heurck's specimens, very constant at 95,000 per inch. The best picture of the trans-striæ is obtained with oil-immersion 1/12, N.A. 1·43, or oil-immersion 1/25, N.A. 1·38, and Powell's oil-immersion condenser, *used dry*, with single slot, edge of flame direct, valve being dry on cover. The lowest angled glass with which I have seen the transverse striæ, is a water-immersion 1/16, N.A. 1·08, and the lowest power 1/4, N.A. 1·17."

In reply to a letter from "Monachus" * inviting Mr. Nelson to state how he came to recognize that oblique illumination must be entirely abolished in favour of central, and that by so doing we shall see the *true* structure of the object, Mr. Nelson wrote: †—"I began to realize the uselessness of oblique light for the determination of true structure during a lengthened examination of a Nobert's 19-band plate. I was much struck by the appearance of a single line of the first band, when viewed by an oil-immersion N.A. 1·25, illuminated by a large angled cone of direct light. The groove which the diamond had ploughed in the glass was most distinctly seen, and along the sides of the groove there were places where the chips of glass had flown off. With oblique light all this was lost; the line appeared as if it had been painted on the surface of the glass. This showed me that if definition was wanted direct light must be used.

I do not intend for one moment to affirm that a higher band of Nobert can be resolved by direct than by oblique light; but this I do say, that the ultimate structure of a diatom can only be demonstrated by direct light.

No microscopist in the present day would uphold the theory that the ultimate resolution of the *P. angulatum* was six sets of lines or grooves, inclined at an angle of 60° to one another. But a similar view of it was held in Quekett's time, for in the frontispiece of his book there is a beautiful engraving of it, exhibiting diamond-shaped marks all over it; a false conclusion, the result of oblique light. Neither will any one insist that the ultimate resolution of the *N. Rhomboides* is represented by two sets of lines, at right angles to one another, a picture produced by the employment of two beams of oblique light. In the days of Griffith and Henfrey they got beyond that, and dotted the *Rhomboides*.

It is quite natural to expect that with the increase of aperture and the improvement in objectives there should be simultaneously a development in the resolution of the diatoms. One misses, too, with oblique light, all that beautiful tracery inside the hexagonal

* Engl. Mech., xxxviii. (1883) p. 341.
† Ibid., p. 386 (3 figs.).

areolation of the *Coscinodisci*, which can only be seen by direct light; for with oblique light the blur of the hexagonal structure blots out the fine markings. When we come to the very finely-marked diatoms, such as *A. pellucida* and some of the *Nitzschiæ*, we must be content with lines, by oblique light, until we can get sufficient aperture to enable us to see the ultimate structure."

"Monachus" rejoined as follows: *—"I am obliged to Mr. Nelson for his reply to my letter, as it leaves no room for ambiguity as to his views.

It is not of course my object, in occupying your space, to simply engage in a personal controversy with Mr. Nelson, and I therefore leave, for the moment at any rate, many points in his letters in regard to which he is mistaken, such as the statements about the two beams in the case of *N. Rhomboides*, the lines and dots he figures, &c. My object is to prevent your readers being misled on the cardinal statement of Mr. Nelson that he (or any one else) has seen the true structure of *Surirella gemma*, or any similar diatom. When this *is* seen we shall have reached the millennium of microscopical observation—how far we are from that day no one can tell, but it is certain we have not reached it yet; and in representing what he saw as the 'true structure,' Mr. Nelson was but falling into the same error as the old school of microscopists whom he criticizes.

I will first quote Mr. Nelson's statement *verbatim* :—'If *S. gemma* is examined by this means, the hemispherule theory is at once exploded, and the true structure (which is far more beautiful) is revealed. It is something like a most delicate skeleton leaf.'

Why *S. gemma* is beyond the reach of any such determination of its true structure, it is the object of the succeeding paragraphs to show.

When rays emanating from a luminous body are transmitted through any structure, which by its opaque, semi-transparent, or refractive constituents prevents the continuous propagation of the luminous waves, the rays cease to pass through in straight lines, and each pencil is split up into a conical pencil of rays, which are distributed round the course of the incident pencil, and which vary very much in the extent of their deviation.

When the elements of the structure are considerable multiples of a wave-length, that is, when they are relatively large, the spread of the diffracted rays is limited; but when the elements are only very small multiples of a wave-length, that is, when they are very minute, the diffracted rays are spread out very widely.

Most microscopists are by this time familiar with the practical effect of the diffraction-spectra under the Microscope, and have seen the experiments which show that the same diatom will give numerous very different images according as we admit all or some only of the diffraction-spectra. By stopping off successively the seven spectra, for instance, of *P. angulatum*, we get as many different structural appearances—indeed, no less than nine different sets of lines may be

* Engl. Mech., xxxviii. (1883) p. 431 (1 fig.).

displayed on this diatom, according as we admit or exclude particular sets of spectra. The results obtained from this manipulation may be summarized in three propositions:—

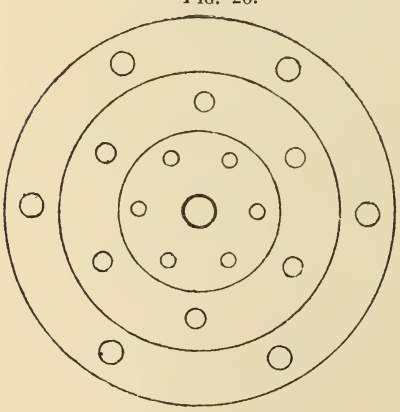
(1) The *same* structure will give *different* images when the diffraction-beams are made different.

(2) *Different* structures will give the *same* image when the diffraction-beams are made similar in each case.

(3) (the proposition which is most pertinent to our present subject). The microscopic image of a structure is never in perfect accordance with its actual composition, or true structure, unless *the whole of the diffraction-pencil is admitted to the Microscope*; or, in other words, the image is always more and more dissimilar from the true structure in proportion to the greater number of diffraction-pencils which are excluded from the Microscope.

The diagram will serve to illustrate the practical application of the last proposition to the examination of diatoms. If the structure is 'coarse,' the diffraction-beams will all be included within a small space around the central pencil (the inner circle of the figure), and in this case an objective, even of limited aperture, will receive them all, and we shall have an image of the true structure. If the object is finer, the limited aperture will not be sufficient to take up all the diffraction-pencils, but a larger aperture (the middle circle of the figure) will. Still more minute structure will require a still larger aperture, as is shown by the outer circle.

Fig. 26.



Now the elements of *S. gemma* are of such fineness that they far surpass the limits of any aperture that we are able to obtain at the present day. Aperture is limited by the refractive index of the glass of which the objectives are made, and that of the immersion fluid, cover-glass, and slide, and hitherto we have not been able to obtain more than 1·47 N.A. out of a possible 1·52. An aperture even of 1·52 would take up but a *part* of the diffraction-beams to which the structure of *S. gemma* gives rise, and, therefore, with our widest apertures it is impossible for us to see its true structure. I need not give the figures of the calculation here; but the fact is that to see the true structure in reality, we should require objectives, slides, and immersion fluids far surpassing in refractive index any substance hitherto known to exist in nature.

To quote Prof. Abbe: 'All speculations as to the true structure of even *P. angulatum*, so far as they depend on microscopic vision, are mere phantoms, castles-in-the-air. No human eye has ever seen,

or will ever see, the complete diffraction-spectra arising from a structure of this minuteness, nor will any Microscope ever show an enlarged copy of it, so long as the spectra cannot be observed in a medium of at least 5·0 refractive index, and by an objective of 5·0 N.A., which, as far as our present knowledge goes, is an impossibility. The Microscopes of the present day admit relatively a small central portion of the whole diffraction-pencil of the valve—i. e. the incident beam and the six spectra of the inner circle. But this portion is also yielded by a multitude of other objects which are endowed with an alternation of superficial or internal molecular structures which cross each other in two different directions at an angle of 60°. Such structures may be formed in various widely different ways; it may be by rows of spherules or other prominences of any shape whatever; rows of internal vacuoles of any figure, or the mere internal alternations of molecular aggregations within a perfectly transparent and smooth silica film. And yet all of these yield with central light the identical circular field of the *angulatum* valve, even to the most minute particular. But although these spectra are identical as far as the six inner spectral beams are concerned, they may be vastly different in regard to some or all of the more widely diffracted pencils which are not admitted by the objective.'

However expert, therefore, a microscopist may be (and every one knows the high point which Mr. Nelson has reached), he must not delude himself with the notion that perfection in technical dexterity enables him to determine the "true" structure of objects whose real structure cannot be revealed with our present appliances by any amount of manipulation. The greater his own reputation in this respect, the more undesirable it is that he should proclaim such misleading views, to the perplexity of his less experienced brethren."

Resolution of Amphipleura pellucida by Central Light.—This has been the subject of some controversy in America. Mr. A. Y. Moore* considers the real explanation of the resolution when the mirror is central to be that the edge of the front cell of the objective radiates the light and all light reaching the bottom of the slide at a greater incidence than the critical angle is reflected upwards and enters the lens after having passed through the diatom.

Dr. H. J. Detmers† considers this explanation to be quite untenable and the true cause to be that "the resolving rays are reflected from the (externally convex) internally concave surface of the edge of the immersion fluid."

Prof. A. Y. Moore, in reply,‡ insists upon the correctness of his view and the insufficiency of that of Dr. Detmers, inasmuch as the field of view takes the colour of the metal of which the front cell of the objective is made. This would not occur if the light were reflected from the edge of the drop of immersion fluid.

* The Microscope, iii. (1883) pp. 49–51 (1 fig.). Cf. this Journal, iii. (1883) p. 595.

† Ibid., pp. 197–201.

‡ Ibid., pp. 201–4.

Albertotti, G., jun.—Sulla Micrometria. (On Micrometry.) [*Post.*]
Ann. di Ottalmologia, XI. (1882) pp. 29–30 (1 pl.).
Klin. Monatsbl. f. Augenheilkunde, 1882.

Anon.—The Wonders of Optics.
[Inquiry for "a glass that I can see through paper or leather, and if you have one please to be kind enough to send me the price of it at once"; and reply of editor, "Punch a hole in the paper or leather."]
Micr. Bulletin, I. (1883) p. 7.

Barlow, T.—See Tolles, R. B.

Bausch and Lomb Optical Co.'s new pattern "Investigator Improved" Microscope, and 1/4 in. objective.
[Coarse adjustment moves nearly 2 in. higher—pillar heavier and higher—separable swinging tail-pieces—Objective with extra large working distance.]
The Microscope, III. (1883) p. 239.

Bell, J. S. B.—Warm Stage and Stage Condenser for Diatomaceæ.
[Warm stage *post.* Stage condenser "simply an addition of a shutter to the hemispherical lens . . . . similar to that used by Powell and Lealand."]
Micr. News, IV. (1884) pp. 19–20.

Blackham, G. E.—The relation of aperture to amplification in the selection of a series of Microscope Objectives. [*Post.*]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 33–41.
Discussion, pp. 227–31.

„ „ See also Tolles, R. B.

Bradbury, W.—The Achromatic Object-glass, XXIX.
Engl. Mech., XXXVIII. (1883) pp. 258–9 (1 fig.).

„ „ On Eye-pieces. „ „ (1884) pp. 401–2.

Bulloch, W. H.—New Congress Nose-piece. Patented 1883. [*Supra*, p. 118.]
The Microscope, III. (1883) p. 218 (2 figs.).
Also U.S.A. Patent, No. 287904, of 23rd January, 1883.

C., J. A.—See Penny, W. G.

Carr, E.—Microscopic Test Objects. [*Supra*, p. 138.]
Engl. Mech., XXXVIII. (1883) p. 280.

Cohen, E., and Grimm, J.—Sammlung von Mikrophotographien zur Veranschaulichung der Mikroskopischen Structur von Mineralien und Gesteinen. (Collection of micro-photographs for the demonstration of the microscopical structure of minerals and rocks.) Parts IX. and X. (conclusion). 38 pp. Plates 65–80. 4to, Stuttgart, 1883.

Cohn, F.—Bicentenary of Bacteria.
[Calls attention to the fact that, in a letter dated 14th September, 1683, A. van Leeuwenhoek gave notice to the Royal Society that with the aid of his Microscope he had discovered in the white substance adhering to his teeth very little animals moving in a very lively fashion. "They were the first bacteria the human eye ever saw." [See also "L.," *infra.*]
Nature, XXIX. (1883) p. 154.

Colt, J. B.—Determination of the Foci of Lenses.
U.S.A. Patent, No. 288025, of 17th September, 1883.

Coombs, C. P.—Address as President of the Postal Microscopical Society, 11th October, 1883.
[On "examining occasionally the food we eat or the clothes we wear."]
Journ. of Microscopy, III. (1884) pp. 1–7.

Cox, J. D.—A new form of Microscope-stand with concentric movements. [*Post.*]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 147–8 (1 fig.).
Discussion, pp. 235–6.

D., E. T.—Graphic Microscopy.
[Description of coloured lithograph of *Tingis Crassiochari.*]
Sci.-Gossip, 1884, pp. 1–2 (1 pl.).

Darling, S.—Micrometer. U.S.A. Patent, No. 287420, of 1st March, 1883.

D., E. T.—Drawing from the Microscope.

[Points out the error of B. Hobson's suggestion—Vol. III. (1883) p. 725—of a semi-rotation of the stage to cure the inversion with the neutral tint reflector. Also remarks on the value of the camera lucida: "In microscopical work the camera lucida is merely a preliminary adjunct of limited utility in determining proportions; no graphic or perfect drawing is helped by its continued use; after affording the barest outlines and positions the instrument becomes an encumbrance, and those who are practised in its employment feel a palpable sense of relief, and breathe again, when it is got rid of, to settle down to the earnest work of direct vision from the Microscope."]

Sci.-Gossip, 1883, pp. 265–6 (1 fig.).

Dean, A.—Microscopical.

[Description of a "micro-magic lantern" with or without camera lucida.]

Engl. Mech., XXXVIII. (1884) p. 391 (1 fig.).

Detmers, H. J.—Resolution of *Amphipleura* by sunlight, mirror-bar central; with letters from R. B. Tolles and A. Y. Moore.

The Microscope, III. (1883) pp. 197–201 and p. 221.

Dickenson.—Art of photographing microscopic objects.

[The apparatus consists of (1) an inexpensive magic lantern, illuminated by a triplex petroleum lamp with the ordinary combination of lenses, and an exfra tube with a small bull's-eye condenser; (2) a Microscope, placed horizontally, without the eye-piece; and (3) a frame to hold the glass screen for focusing the image, and to receive the sensitized plate when photographing. The period of exposure is from eighteen seconds to two hours.]

Note read before Academy of Medicine in Ireland.

Engl. Mech., XXXVIII. (1883) p. 279.

Sci.-Gossip, 1884, p. 17.

Dinner, Microscopists at.

[Facetious account of a mythical dinner at which "every article of food was carefully examined."]

The Microscope, III. (1883) p. 233.

Dippel, L.—Ein verstellbares Zeichenpult. (An adjustable drawing desk.)

[Reported as from *Lab. Hist. Collège de France*, 1883, p. 188, instead of 1879. [See Vol. III. (1883) p. 565.]

Bot. Centralbl., XVII. (1884) pp. 62–3 (2 figs.).

Eye-pieces, Report of the Committee on.

[Vol. III. (1883) p. 711.]

Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 175–7. Discussion, pp. 238–9.

Fischer, G.—Ueber einige Versuche zur Hebung der Chromatischen Aberration dioptrischer Fernrohre. (On some attempts to remove the Chromatic Aberration of dioptric Telescopes.)

[Contains an abstract of S. Merz's article "Ueber Dispersionsverhältnisse optischer Gläser" (Vol. II. (1882) p. 565), with additional remarks. Also report of letter from K. W. Zenger on his Endomersion Objectives, *ante*, Vol. III. (1883) p. 596, and *post*.]

Central-Ztg. f. Optik u. Mech., IV. (1883) pp. 265–7.

Grimm, J.—See Cohen, E.

Hager, H.—Le Microscope. Théorie et Application. (The Microscope. Theory and application.) Translated from the 4th German edition with annotations by L. Planchon and L. Hugouenq. Introduction by J. E. Planchon. x. and 264 pp., 350 figs. 18mo, Paris, 1884.

Hammond, A.—Address on resigning the chair of the Postal Microscopical Society.

[Account of the notes written by members of the Society on the slides circulated.]

Journ. of Microscopy, III. (1884) pp. 7–17.

Hilgard, Prof.—See Micrometer Scale.

Hitchcock, R.—Notes from Abroad.
[Ross & Co.'s establishment and Dr. Schröder. Messrs. R. & J. Beck. Mr. Crouch. Powell & Lealand. Swift & Son. Swift's Achromatic Condenser (2 figs.). Swift's Wale's Stand (1 fig.).]
Amer. Mon. Micr. Journ., IV. (1883) pp. 226–9 (3 figs.).

" " A new Camera Lucida.
[Dr. H. Schröder's, Vol. III. (1883) p. 813.]
Amer. Mon. Micr. Journ., IV. (1883) p. 230.

" " The Army Medical Museum.
[As to Dr. Woodward's retirement.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 236-7.

" " Testing a Microscope.
[Directions for testing (1) the centering of objectives, (2) the binocular.]
Amer. Mon. Micr. Journ., V. (1884) pp. 7–8.

" " A simple Eye-piece Indicator.
[A hair attached to the diaphragm of the eye-piece and extending half-way across the field of view.]
Amer. Mon. Micr. Journ., V. (1884) pp. 8–9.

" " Bulloch's improved "Biological" stand.
[Improved substage. *Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) pp. 9–10.

" " Microscopical Societies.
[Recommending practical demonstrations like those of the Quekett Microscopical Club.]
Amer. Mon. Micr. Journ., V. (1884) p. 16.

See also Tolles, R. B.

Holmes, E.—Drawing from the Microscope.
[Remarks on E. T. D. *supra*, and suggesting that with the neutral tint reflector "he has but to turn his slide over, i.e. cover downwards on the stage, to make his outlines, and then put his slide right way up when he fills in his detail freehand."]
Sci.-Gossip, 1884, pp. 17–18.

Holmes (O. W.) Dr., and the Microscope.
[In a recent speech, in illustrating the microscopical facilities of the Harvard Medical School, he said :—"A man five feet high, enlarged to correspond with the Microscope power used, would be a mile high, would weigh 120,000,000,000 lbs., and could pick up the Boston State House and chuck it into the sea, cleaning out that ancient structure by a summary process which would put to shame the exploits of Commodus and his kind."]
Micr. News, III. (1883) p. 340.

Hugounenq, L.—See Hager, H.

James, F. L.—The Fakir and his little Fakes.
[I. Warning against using silver-plating fluid sold by street venders as it disintegrates the brass of objectives ; formula for a good fluid. II. Anecdote of a street vender of Microscopes who showed paste eels as animalcules in water.]
The Microscope, III. (1883) pp. 193-7.

Kohl, G.—Boecker s neuer Zeichen-Apparat nach Dippel. (Boecker's new Drawing Apparatus after Dippel.) [*Supra*, p. 119.]
Bot. Centralbl., XVI. (1883) pp. 385–6 (1 fig.).

L.—Bicentenary of Bacteria.
[Suggests that the Royal Society should celebrate it by urging on the Government the formation of a national laboratory of hygiene.]
See also Cohn, F., *supra*.
Nature, XXIX. (1883) p. 154.

Lippich, F.—Vorschlag zur Construction eines neuen Spectral-apparatus. (Proposal for the construction of a new spectral apparatus.)
[Contains a description of an "Astigmatic Mikroskop-Ocular," consisting of two cylindrical and two plano-convex lenses, for use with a spectroscope.]
Zeitschr. f. Instrumentenk., IV. (1884) pp. 1–8 (2 figs.).

MANSFIELD, J. M.—Division of labour among microscopists. [*Post.*]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 43–5.
Discussion, pp. 231–2.

MATTHEWS' (J.) Simple Revolving Table.
[Two perfectly flat wooden boards, placed face to face, the upper one turning on a pivot in the centre of the lower. The lower board should have some rubber on its under surface, or some material which will cause it to remain in position on a table while the upper one is caused to revolve.]
Amer. Mon. Micr. Journ., IV. (1883) p. 238.

Micrometer Scale, A, 1882.
1. History of the National Committee on Micrometry. By R. H. Ward.
2. Report of the National Committee on Micrometry, and accompanying report of Prof. Hilgard.
3. A study of the Centimetre marked "A," prepared by the U.S. Bureau of Weights and Measures for the Committee on Micrometry. By W. A Rogers.
4. Rules for the control of the standard Micrometer.
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 178–200.

"Monachus."—Microscopic Test Objects. [*Supra*, pp. 140–1.]
Engl. Mech., XXXVIII. (1883–4) p. 341 and p. 431 (1 fig.).

MOORE, A. Y.—The Resolution of *Amphipleura pellucida*. A reply to Dr. Detmers.
The Microscope, III. (1883) pp. 201–4. (See also pp. 200–1.)

NELSON, E. M.—Microscopic Test Objects. [*Supra*, pp. 139–40.]
Engl. Mech., XXXVIII. (1883) p. 324 and p. 386 (3 figs.).

" " On the relation of Aperture to Power in Microscope Object-glasses. [*Post.*]
Engl. Mech., XXXVIII. (1883) pp. 367–8.

NUNN, R. J.—The Microscope in Medical Gynecology.
["For clinical microscopy no great depth of learning nor an intimate acquaintance with fine-spun theories is required, but a plain practical knowledge of the names and appearance of a few of the forms which the Microscope reveals. It is not necessary to know what everything seen in the Microscope is; it is sufficient to know what it is not. Just as it is not necessary to be an accomplished botanist to distinguish an oak tree from a turnip, or to be a deeply learned naturalist to tell a horse from a goat, so it is unnecessary to be a thorough pathologist to be able to make good use of the Microscope for clinical purposes."]
Sep. repr. from *Trans. Med. Assoc. Georgia*, 1883, pp. 8–10.

PENNY, W. G.—Theory of the Eye-piece. I. The Dispersion of Light. II. Dispersion of Light. Also criticisms by J. A. C. III. Spherical Aberration.
Engl. Mech., XXXVIII. (1883) p. 283 (1 fig.), p. 367 (1 fig.), p. 390 (1 fig.).

PFAFF'S Mikrogoniometer.
Hoffmann's Bericht u. d. Wiss. App. a. d. Londoner Internat. Ausstell. 1876 (1881) pp. 435–6 (1 fig.), p. 738.

PLANCHON, J. E.—See Hager, H.

POULSEN, V. A.—Botanical Micro-chemistry. Translated with the assistance of the author, and considerably enlarged by W. Trelease. [*Supra*, p. 91.] xviii. and 118 pp., 8vo., Boston 1884.

POWELL, Hugh, Death of.
Engl. Mech., XXXVIII. (1883) p. 279, from *Times*, Nov. 1883; *Sci.-Gossip*, 1884, p. 17; *Journ. of Science*, VI. (1884) p. 51.

"Prismatique."—Object-glass working, IX. and X.
Engl. Mech., XXXVIII. (1883–4) p. 296 (1 fig.), pp. 420–1.

REZNER, W. B.—See Vorce, C. M.

ROGERS, W. A.—A critical study of the action of a diamond in ruling lines upon glass. [*Supra*, p. 126.]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 149–65.

" " See Micrometer Scale.

STOKES, A. C.—A Growing-cell for minute Organisms. [*Supra*, p. 122.]
Sci.-Gossip, 1883, pp. 8–9 (1 fig.).

Stowell, C. H. and L. R.—A new Microscopical Journal.
['Science Record.'] *The Microscope*, III. (1883) p. 223.

" " Fasoldt's Micrometers.
[Micrometer which showed Newton's rings in a beautiful manner; also a newly ruled micrometer, each alternate line being ruled longer, so that the end of each band is half the value of the band proper; that is, if the band was in the field ruled 50,000 to the inch, then the end of that band would show 25,000 to the inch. Therefore, as Mr. Fasoldt says, "one can easily judge if there is any diffraction."]
The Microscope, III. (1883) p. 239.

" C. H.—A Microscopic Inflation.
[Facetious rejoinder to Dr. O. W. Holmes' statement, *supra*, as to the size of an enlarged Harvard student.]
The Microscope, IV. (1883) pp. 10–11.

" " See Tolles, R. B.

T. T.—Microscopic Test Objects.
[Points out the error in E. M. Nelson's suggestion, *supra*, p. 139, that objectives should not be tested by oblique light.]
Engl. Mech., XXXVIII. (1884) p. 386.

" Relation of Aperture to Power in Microscope Object-glasses.
[Reply to E. M. Nelson, *supra*, showing the wide difference between his figures and those of Prof. Abbe.]
Engl. Mech., XXXVIII. (1884) p. 410.

Tetlow, D.—Microscope. U.S.A. Patent, No. 287978, of 24th August, 1883.

Tolles, R. B., Death of. *Boston Evening Transcript*, 28th Nov., 1883.
Engl. Mech., XXXVIII. (1883) p. 336.
Science, III. (1883) p. 726.
["Mr. Tolles has been long known for the construction of Microscopes and Telescopes of unusually short focus. He made the highest-power Microscope produced in America"!] *Athenæum*, 1883, p. 819.
Micr. News, IV. (1884) p. 25.
The Microscope, IV. (1884) pp. 3–4 (T. Barlow); pp. 4–5 (C. H. Stowell); pp. 5–6 (G. E. Blackham).
Amer. Mon. Micr. Journ., V. (1884) pp. 10–11 (S. Wells and R. Hitchcock).
Micr. Bull., X. (1883) pp. 5–6.
Science Record, II. (1883) p. 43.

" " See Detmers, H. J.

Törnebohm, A. E.—Ueber eine Vorrichtung an Mikroskoptischen zur allgemein gültigen Fixirung eines bestimmten Punktes in einem Präparat. (On an arrangement of the microscope-stage for the universal fixing of a given point in a preparation.) [*Post.*]
Neues Jahrb. f. Mineral., 1883, I., pp. 195–6.

Trelease, W.—See Poulsen, V. A.

Vorce, C. M.—A Memoir of W. B. Rezner.
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 242–5.

Walmsley, W. H.—Photo-micrography with dry-plates and lamplight.
[Vol. III. (1883) p. 556.]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 59–64 (1 fig.).

Ward, R. H.—See Micrometer Scale.

Wells, S.—See Tolles, R. B.

Whiting, Sarah F.—College Microscopical Societies.
[Advantages of such societies, and how they can be made a success.]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 27–31.
Discussion, pp. 225–7.

Wright, L.—Lantern and Limelight matters.
[Comparative optical conditions of wick'd lamps and the limelight—Condensers—Lime-jets.]
Engl. Mech., XXXVIII. (1883) pp. 343–4 (2 figs.).

Zenger, K. W.—See Fischer, G.

β. Collecting, Mounting and Examining Objects, &c.

Mounting and Photographing Sections of Central Nervous System of Reptiles and Batrachians.*—Dr. J. J. Mason describes the methods he employed in mounting the sections from which the plates illustrating his book † were "artotyped."

"Both the brain and spinal cord were entirely separated from the body, and, with their membranes, placed in iodine-tinted alcohol until they had acquired a slight degree of consistency—from six to twelve hours. They were then transferred to a 3 : 100 solution of bichromate of potash, with a small piece of camphor, in a tightly corked wide-mouthed bottle, and allowed to remain until ready for cutting, renewing the solution every two weeks.

The time required for the hardening process varies considerably in different animals, and this variation is more dependent upon the class of animal than upon the relative dimensions of the specimens.

For example: on the same day I placed the brain of a large rattlesnake with that of a small salamander in the same bottle, and at the end of six weeks the former was ready for section, whilst the latter was not sufficiently hard until a month afterwards. By thus employing the same reagent in all cases, I have been able to note constant differences in the action of both the hardening and the colouring agent, carmine.

Perhaps the most striking illustration of this is furnished by the nervous centres of tailed batrachians, which, while they stain very readily, invariably require about a third more time to harden than specimens from the other orders. Specimens from ophidians stain less satisfactorily than those from any other of the classes which I have studied, while with the spinal cords of alligators, turtles, and frogs failure to obtain good results in this particular is very rare.

In all cases the sections have been stained after cutting, injury from excessive handling being wholly avoided by the use of siphon-

* 'Minute Structure of the Central Nervous System of certain Reptiles and Batrachians of America,' 1879–1882. Cf. iii. (1883) p. 910.

† "The methods of histology have reached a perfection which is building up new departments of knowledge, and among successful pioneers in these labours Dr. Mason will always hold an honoured place for the technical skill with which he brings the reader face to face with the revelations of his Microscope, and for the sumptuousness with which his work is given to the world. No such monograph has previously come under our notice, for the illustrations of a difficult research leave nothing to be desired. . . .

"No words could do justice to the beauty of the plates or the value of the information they convey; and it is not too much to regard this work as opening a new era in research by substituting knowledge of facts of microscopical structure for their interpretation by the hand of artist or author; but we can scarcely hope to see many books so beautifully illustrated. The author's method has the merit of inaugurating a comparison of the minute anatomy of the nervous system by enabling the reader to see the structures which he has discovered as he saw them; and hence the book will always be a valuable work of reference; and it will certainly induce others to hand on the torch of knowledge in a like excellent way."—From Bibliographical Notice in Ann. and Mag. Nat. Hist., xii. (1883) pp. 270–4.

tubes to remove the alcohol and washings. For producing transparency, oil of cloves has been used, and the mounting has been done under thin, clear covers, in a solution of Canada balsam in chloroform.

All the negatives have been made on glass thoroughly cleaned and lightly coated with a solution of wax and benzole, so that the collodion film, previously made adherent to thin sheets of gelatine, could be safely removed from the plate. The flexible negatives thus obtained are well adapted to the artotype process, and, as they can be indefinitely preserved between the leaves of an ordinary scrap-book, are very desirable for a series of illustrations. In making the original negatives on glass, the 'wet collodion process,' with the sulphate of iron developer, has been exclusively employed.

The prints correspond exactly with the negatives, both in outline and detail. No distortion occurs as in silver printing, in which process the paper is subjected to prolonged washing.

In many of the photographs the grey substance appears lighter in shade than the white substance. This appearance is due to a greater degree of transparency of the grey substance in these sections, resulting from the action of the oil of cloves, followed by an increased action of the transmitted light on the sensitive collodion film of the negative, and hence by a thinner deposit of ink over corresponding parts of the positive plates from which the artotypes are printed."

With regard to the process employed, Dr. Mason says that after experimenting with various methods he found that satisfactory prints could be made in ink directly upon plate paper, and that these impressions were as perfect in fine detail as any of those obtained by the silver process of printing. The plates (all printed by the artotype process) are as durable as steel engravings. "While a photograph cannot often show all that can be discovered by more direct microscopic observation with a judicious working of the fine adjustment, high authority has stated, and perhaps correctly, that a good photograph with a low power—say from 3 to 1/2 in.—is a better means of illustrating the anatomical structure of the nervous tissues than hand drawing. Some of the plates with high powers leave much to be desired both in distinctness and tone, and in general it may be affirmed that the same defect as regards distinctness always exists, and for obvious reasons, in photographs of sections with powers much above 1/2 in. In fact it now appears to be established that immersion objectives can never be employed for photographing section-preparations with the success that has attended their use for blood corpuscles, diatoms, and similar specimens."

Preparing Spermatozoa of the Newt.*—G. F. Dowdeswell writes that to prepare the spermatozoa of the newt for the examination of the minute barb discovered by him, the first essential is to get them as nearly as possible in contact with the cover-glass and flat upon it; this requires some care to avoid their drying, by which they are

* Quart. Journ. Micr. Sci., xxiii. (1883) pp. 336-9 (1 fig.).

materially altered. They may be preserved by several methods, either by treating for twelve to twenty-four hours with a concentrated solution of picric acid, a dilute solution of chromic acid, by Dr. Klein's method with a 5 per cent. solution of ammonium chromate, by iodine, by silver nitrate, or by osmic acid or gold chloride; the latter are convenient as being quicker. He has most usually employed picric acid. For staining glycerine, magenta* is the best method, as it stains all parts as strongly as desired. To show the general structure alcoholic carminate of ammonia is the most satisfactory, but it does not stain the barb deeply. Other anilin dyes have not been found to answer so well.

The use of glycerine as a mounting fluid for preparations stained with any of the anilin dyes is at best troublesome,† and sooner or later, in the author's experience, the staining runs and the preparation is spoiled. Solutions of acetate of potash or chloride of calcium have not been found satisfactory, the forms, even of such resistant objects as bacteria, in some cases becoming materially altered by these reagents. With Canada balsam, even when dissolved in chloroform or turpentine, the preparations have not been found to fade, as has sometimes been said to be the case, and as we should have expected; nor, if they are sufficiently washed in alcohol and passed through oil of cloves, will they run. The risk, however, of both fading and running may be entirely obviated by using benzine as a solvent for the balsam, or by employing it undiluted and liquefied by warmth.

Killing Hydroid Zoophytes and Polyzoa with the Tentacles extended.‡—H. C. Chadwick recommends the polyzoon to be placed in a small beaker or clear glass bottle, and allowed to remain at rest for several hours. Now take a dipping-tube drawn out to a very fine point and charge it with absolute alcohol. Having ascertained by means of a pocket-lens that the polypides are fully extended, allow the alcohol to drop very gently from the point of the tube, which should be held just above the surface of the water. The success of the experiment depends largely upon the care with which the first quantity of alcohol is introduced into the water. After the lapse of an hour, if the polypides are still extended, a further quantity of alcohol is added until the quantity reaches 60 per cent.

After passing through 75 per cent. alcohol, the specimens may be kept in 90 per cent. of the same until required for mounting. Experiments with alcohol upon hydroid zoophytes were not so successful, but Kleinenberg's picrosulphuric acid solution § gave excellent results. The use of this reagent is attended with much less difficulty than that of alcohol. If the subject of the experiment is a zoophyte,

* Magenta cryst. 1 part; glycerine 200 parts; alcohol 150 parts; aq. 150 parts; immerse the preparation in the solution for from two to four minutes, according to the depth of colouring required, and then wash.

† The method is, add an equal bulk of glycerine to the aqueous solution of the anilin dye used, stain somewhat more deeply than requisite, mount on slide with cover-glass in the staining fluid, which is to be gradually replaced as the water evaporates by plain glycerine.

‡ Micr. News, iii. (1883) pp. 333–4.

§ Cf. this Journal, ii. (1882) p. 867.

such as *Aglaophenia pluma* or *Plumularia setacea*, it must be allowed to remain some hours until the polypides are fully extended. Kleinenberg's fluid must then be introduced by means of a dipping-tube. It may be allowed to flow over the specimen in a continuous stream, until the whole of the water assumes a golden yellow colour. The reagent causes instant death, so that the specimens may be transferred immediately to 60 per cent., and afterwards to 75 per cent. alcohol, allowing them to remain in each solution for some hours. Keep in 90 per cent. alcohol. From four to six minutes' immersion in Martindale's picrocarmine staining fluid is sufficient to stain specimens killed by either of the above methods.

Mounting Pollen as an Opaque Object.*—W. Blackburn gives directions for mounting pollen dry upon the anther from which it has escaped. For collecting and drying the anthers, the flowers should be gathered when full-blown, just before they begin to fade, and the stamens then cut with fine scissors a short distance from the anthers, the latter being allowed to fall upon clean writing paper, when a selection may be made with a pocket-lens of the specimens most suitable for preservation. Folding the paper without pressure, place the packet in a box, where the author lets it remain in oblivion for twelve months or perhaps two years. In the case of large anthers, such as the *Lilium auratum*, it may be advisable to lay them on a piece of blotting-paper, inside the writing-paper, in order the better to absorb moisture, care being taken when mounting, to remove any adhering fibres of the blotting material with a needle.

Thin metal and bone cells may be used for mounting. The metal ones may be either of brass or block tin. For small anthers, such as those of *Ranunculus aquatilis*, the ordinary 1/2 in. brass cells are suitable. For larger anthers, or groups of stamens and anthers, such as may be made from the *Abutilon*, 5/8 in. and 3/4 in. bone cells are the best. Bone is much preferable to metal for its adhesive capacity when affixed to glass, and the bone cells usually sold have their surfaces "truer" than those of metal. For cement use "quick-setting" gold size.

When about to mount the anthers, paint the bottom of the cell with "matt-black," using the turntable, so as to distribute it evenly over the glass. When the "black" is partially dry, place the anthers upon it in suitable positions, and gently press them with a blunt needle so as to secure their adhesion to the cement. The best effect will be produced when the anthers are arranged in the centre of the cell with the stamens directed on one side, as in their natural position. This, however, may be left to the taste of the mounter; and in many cases no arrangement of this kind will be required, as one or other will be found large enough to fill the cell. When there is found to be a deficiency of pollen on any of the anthers after mounting, some pollen may be taken on the point of a needle from other anthers and placed in position on the bare parts, when gently breathing upon it will fix it.

* Micr. News, iii. (1883) pp. 297–9.

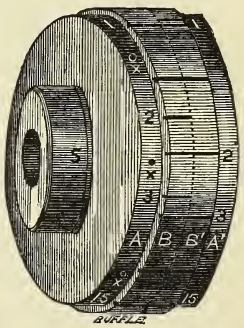
Mounting Fluid for Algæ.*—For preserving the cell-contents and the natural colour and form of desmids, volvox, and other algæ, G. W. Morehouse finds a mounting fluid made as follows to act well: Dissolve 15 grains of acetate of copper in a mixture of 4 fluid ounces of camphor water, 4 fluid ounces of distilled water, and 20 minims of glacial acetic acid; add 8 fluid ounces of Price's glycerine, and filter. When sections of plant-stems, or other vegetable specimens, are mounted in this fluid, the protoplasm is preserved. If, in any case, it is thought desirable to increase or diminish the specific gravity of the preservative, the proportion of glycerine may be changed. Used as above, or modified as indicated, he thinks it also a trustworthy medium for mounting infusoria and the softer animal tissues.

Mounting Diatoms in Series.†—P. Francotte has applied Giesbrecht's method ‡ of mounting sections in series to the mounting of diatoms. The slide is coated with the solution of shellac in alcohol washed over with oil of olives or creosote, and the diatoms, previously placed in absolute alcohol, arranged in order. The slide is then warmed, and the oil of cloves or creosote evaporated.

Schällibaum's process § for sections would also be available for the same purpose.

Registering Micrometer-screw to the Thoma Microtome.‖—Dr. C. O. Whitman gives the following more detailed description of this screw, which we described at pp. 914–5 of vol. iii. (1883) from the original article of Andres, Giesbrecht, and Mayer, the designers of the arrangement for regulating its movement. This arrangement consists of a spring which, after a given number of divisions of the drum, registers to the ear and finger of the manipulator the number of micromillimetres which the object has been raised. The intervals between the registering clicks can be varied by means of a vernier-like adjustment of the two halves of the drum, so as to equal an entire revolution of the drum, or only 1/15, 1/3, or 1/2 of a revolution.

Fig. 27.



An examination of fig. 27, which illustrates the new form of the drum, will show how the intervals are regulated. The drum is composed of two symmetrical halves, A B and A′ B′, so closely opposed that the dividing line (dotted in the figure) is scarcely visible. The periphery of each half is composed of two zones of unequal radii. The large zones, B and B′, are in apposition, and together form the graduated

* Amer. Mon. Micr. Journ., iv. (1883) pp. 234–5.
† Bull. Soc. Belg. Micr., x. (1883) pp. 43–8.
‡ See this Journal, ii. (1882) p. 888.
§ See this Journal, iii. (1883) p. 736.
‖ Amer. Natural., xvii. (1883) pp. 1313–4 (1 fig.).

portion of the drum. Each of the smaller zones is marked with the figures 1, 2, 3, and 15. When the drum is in order for work, it rotates with the screw, which is marked *g g* in fig. 53, vol. iii. (1883) p. 302.

The left half of the drum A B is held in position by the screw S, and may be rotated independently of the right half A′ B′, or of the screw *g g*, by the aid of a handle which fits the holes *x x x*.

When the half A B is adjusted to the half A′ B′, in the manner represented in the figure, the fifteen equal parts into which the zone B is divided exactly correspond to the same number of parts in the zone B′, so that the grooves which mark these parts in one zone, become continuous with those of the other zone. Thus adjusted, the spring, which rides on the zones B B′, with a sharp edge parallel to the grooves, will give fifteen sharp clicks in the course of one rotation of the drum, the click being heard every time the sharp edge falls into coincident grooves. In order to adjust for fifteen clicks, it is only necessary to rotate A B until groove 15 becomes continuous with groove 15 of the opposite half (A′ B′). For one click in one rotation, the grooves 1, 1 must be made to coincide; for two clicks the grooves 2, 2, and for three clicks the grooves 3, 3. The intervals between successive clicks may thus be made to correspond to 1/1, 1/2, 1/3 or 1/15 of a complete rotation of the drum, and the thickness of sections corresponding to these intervals should be respectively ·015, ·0015, ·005, ·001 mm.

Acheson, G.—Biological Study of the Tap Water in the School of Practical Science, Toronto.

[Methods of examination—Diatomaceæ—Desmidiaceæ—Phycochromaceæ—Schizophytæ—Protozoa—Vermes—Arthropoda.]

Proc. Canad. Institute, I. (1883) pp. 413–26 (1 pl. to follow).

Ady, J. E.—Microscopical Technology. On the exhibition (*sic*) of Canada Balsam.

[Directions for mounting sections of tissues in Canada balsam.]

Sci.-Gossip, 1884, pp. 5–8.

Ady's (J. E.) New Morphological Institution [for the production of micrographical preparations, and especially of rock and mineral sections].

Sci.-Gossip, 1883, pp. 276–7; 1884, p. 18.

See also *Nature*, XXIX. (1884) p. 283.

Ami, H. M.—Use of the Microscope in determining Fossils, with especial reference to the Monticuliporidæ. *Science*, III. (1884) pp. 25–6.

Aylward's (H. P.) Pond-life Apparatus. [Vol. III. (1883) p. 911.]

Sci.-Gossip, 1883, p. 276.

Barré, P.—Sur un procédé de préparation synoptique d'objets pulvérulents. Diatomées des guanos, terres fossiles, &c. (On a process of synoptic preparation of pulverulent objects. Diatoms from guano, fossil earths, &c.)

[*Post.*] *Bull. Soc. Belg. Micr.*, X. (1883) pp. 16–8 (1 pl.).

Belfield, W. T.—The Microscope in the detection of Lard Adulteration.

Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 97–103 (1 pl.).

Bennett, C. H.—Mounting Entomological Slides.

[Treat the object for a week or a month, as the case may require, with liq. potassæ until thoroughly bleached; then, without removing the contents of the cavities, or in any way subjecting to the slightest pressure, mount in glycerine in a cell of ample depth so as to allow the object to retain its natural form and position.]

The Microscope, III. (1883) p. 220.

Braman, B.—Microscopic Evidence of the Antiquity of Articles of Stone.

Amer. Mon. Micr. Journ., V. (1884) pp. 14–5.

Brooks' (H.) Sets of sections of Woods for instruction in schools.
["The sections are about 2 × 4 in., and are neatly mounted between plates of mica. Three sections (one cross and two longitudinal) are given for each kind of wood, and these are thin enough to make their study with the naked eye or with a low power very easy and instructive."]
Amer. Natural., XVII. (1883) p. 1285.

Burrill, T. J.—Preparing and mounting Bacteria.
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 79–85.
" " To stain *Bacillus tuberculosis*.
["Many ways have been tried to leave the alcohol out and yet obtain a stain as good as that of the published formulas. The following seems to be the thing sought:—Glycerine, 20 parts; fuchsin, 3 parts; anilin oil, 2 parts; carbolic acid, 2 parts."—Also directions for use.]
The Microscope, IV. (1884) pp. 6–8.

Carpenter, W. B.—Remarks on Microscopical Observation.
Syllabus of Carlisle Microscopical Society, 1884.
Micr. News, IV. (1884) pp. 23–4.

Chadwick, H. C.—On some experiments made with a view of killing Hydroid Zoophytes and Polyzoa with the tentacles extended. [*Supra*, p. 151.]
Micr. News, III. (1883) pp. 333–4.

Chester, A. H.—A new method of Dry Mounting.
[Vol. III. (1883) p. 737.]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 143–5 (1 fig.).

Cheyney, J.—The Microscopic Study of Fibres.
[The Microscope in the dye-room—The marks of perfect dyeing—Marks of imperfect dyeing—The location of defects.]
Micr. News, IV. (1884) pp. 7–9, from *Textile Record of America*.

Cole, A. C.—Popular Microscopical Studies.
No. III. The Scalp. Vertical Section of Human Scalp. Double-stained. Plate 3 × 25. pp. 11–14.
No. IV. The Ovary of a Poppy. Transverse section of Ovary of *Papaver rhœas* (unfertilized). Plate 4 × 50. pp. 15–20.
No. V. A Grain of Wheat. pp. 21–4. Plate 5. Long. sec. of Embryo at base of wheat-grain. Stained carmine. × 50.
" " The Methods of Microscopical Research. Part V. The Preparation of Animal Tissues (*continued*). pp. xxv.–xxxii. (2 figs.).
[Silver nitrate—Chloride of gold—Injection of Blood-vessels (Injecting Apparatus, Fearnley's Constant Pressure Apparatus).]
Part VI. pp. xxxiii.–xl. How to preserve Botanical specimens. On Animal and Vegetable Section-cutting. Rutherford's, Williams', Fearnley's and Cathcart's Microtomes. Gum and syrup preserving fluid. To cut tissues soaked in gum and syrup medium. Cutting by imbedding.
" " Studies in Microscopical Science.
Vol. II. No. 7. Section 1. No. 4. Epithelium. pp. 13–16. Plate 4, × 400.
No. 8. Section 2. No. 4. Chap. II. The Cell as an Individual. pp. 13–16. Plate 3 (*Micrasterias denticulata* × 200).
No. 9. Sec. 1. No. 5. Cartilage. pp. 17–19. Plate 5. T. S. Hyaline Cartilage. Human Trachea × 250.
No. 10. Section 2. No. 5. Chap. III. The Morphology of Tissues. pp. 17–20. (Plate to follow.)

Dowdeswell, G. F.—Note on a minute point in the structure of the Spermatozoon of the Newt.
[Contains directions for preparing the spermatozoa, *supra*, p. 150.]
Quart. Journ. Micr. Sci., XXIII. (1883) pp. 336–9 (1 fig.).

Francotte, P.—Description des différentes méthodes employées pour ranger les coupes [et les Diatomées] en série sur le porte-objet. (Description of the different methods adopted for mounting sections [and diatoms] in series on the slide.)
[Description of Mayer's, Giesbrecht's, Schällibaum's, and Threlfall's methods; also the application of the second and third to diatoms, *supra*, p. 153.]
Bull. Soc. Belg. Micr., X. (1883) pp. 43–8, 63–6.

Francotte, P.—Microtomes et méthodes d'inclusion, I. (Microtomes and methods of imbedding.)
[Describes Thoma's Microtome and various methods already published.]
Bull. Soc. Belg. Micr., X. (1884) pp. 55–63 (1 fig. and 1 pl.).

Freeman, H. E.—Cutting Glass-circles.
[Perforated wooden slips and writing diamond with *turned* point, the thin glass to rest on plate-glass; very little pressure on diamond; it is better to leave the circles a day or two before breaking them out of the glass.]
Journ. of Microscopy, III. (1884) p. 47.

G., W. B.—Cement for objects mounted in spirits of wine.
[Same as *ante*, Vol. III. (1883) p. 613. The cement a "secret."]
Midl. Natural., VI. (1883) p. 282.

Gage, S. H.—Cataloguing, labeling, and storing Microscopical preparations.
[Vol. III. (1883) p. 924.]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 169–74 (2 figs.). Discussion, pp. 236–8.

,, „ and Smith, T.—Serial Microscopic Sections. [*Post.*]
Medical Student (N.Y.) I. (1883) pp. 14–6.

Gilliatt, H.—Some remarks on the action of Tannin on Infusoria.
[Vol. III. (1883) p. 861.]
Proc. Linn. Soc. N. S. Wales, VIII. (1883) pp. 383–6.

Grant, F.—Microscopic Mounting.
IV. Section Cutting, Staining, &c.
[1. Sections. 2. Section Cutting. 3. Staining. 4. Various practical details.]
Engl. Mech., XXXVIII. (1883) pp. 285–6.

V. The Use of Reagents.
[1. The use of Reagents in general. 2. Glycerine and Syrup. 3. Acids and Alkalis.]
Engl. Mech., XXXVIII. (1883) pp. 365–7.

VI. Chloroform.—Vegetable Objects.
[1. Chloroform or Benzol, for thinning Canada balsam. 2. Non-fructifying organs of higher plants. 3. Ways in which vegetable sections should be cut. 4. Bleaching. 5. Staining.]
Engl. Mech., XXXVIII. (1884) pp. 386–8.

VII. Staining.
[1. Staining in general.—Transient stains. 2. Metallic impregnations.—Diffuse, bioplasmic, and special tissue stains. 3. Hæmatoxylin and Carmine. 4. Indigo Carmine, Aniline, and Phthalein stains. 5. Double staining.]
Engl. Mech., XXXVIII. (1884) pp. 449–50.

Griffith, E. H.—Practical Helps.
[Ringing slides—Photograph slides—Mounts without covers—Arranging Diatoms, *post.*]
The Microscope, III. (1883) pp. 204–6.

H., H.—Microscopic Mounting.
Engl. Mech., XXXVIII. (1883) p. 266.

Haacke, W.—Ueber das Montiren von Alcoholpräparaten. (On the mounting of alcohol preparations.)
[For microscopic objects for Museums.] *Zool. Anzeig.* VI. (1883) pp. 694–5.

Hamlin, F. M.—The microscopical examination of seminal stains on cloth.
[Describes a new process, as "Koblanck's method, with its soakings and manipulations, tends to destroy so many of the spermatozoa as to lessen greatly the certainty of finding them."]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 21–5. Discussion, pp. 220–5.

„ „ The preparation and mounting of Foraminifera, with description of a new slide for opaque objects. [*Post.*]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 65–8.

Hitchcock, R.—Preservation of Museum specimens.
[Description of the Naples Zoological Station specimens at the Fisheries Exhibition. The living creatures are plunged into a solution of iodine or a strong solution of corrosive sublimate and transferred to dilute spirit, in which they are permanently preserved.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 217–8.

„ „ Exorbitant prices of mounted specimens of microscopic objects in America. *Amer. Mon. Micr. Journ.*, IV. (1883) p. 218.

„ „ Glycerine in Mounting.
Amer. Mon. Micr. Journ., V. (1884) pp. 15–6.

„ „ See Vorce, C. M.

Jacobs, F. O.—How to make a section of Tooth with pulp.
The Microscope, IV. (1884) pp. 8–9.

Kellicott, D. S.—Notes on Protozoa. No. 2.
[Agrees with the opinion of H. Gilliatt, III. (1883) p. 861, that the needle-like bodies seen when *Paramecium* is treated with tannin and glycerine are not cilia but trichocysts.]
Bull. Buffalo Naturalists' Field Club, I. (1883) pp. 109–17.

Kingsley, J. S.—Rapid Microscopic Mounting.
[Describes Giesbrecht's and Caldwell's methods of series preparations.]
Science Record, II. (1883) pp. 1–2.

„ „ Glycerine Mounting.
["One great difficulty in its use is in fastening the cover-glass firmly. Various modes of procedure have been described, possibly the best the writer has seen in print being that which employs paraffin. A still better method is to use a very small amount of glycerine, so little in fact that when the cover is applied the margin of the glycerine does not reach the edge of the glass. Then with a fine brush, balsam or dammar dissolved in benzol is allowed to run in under the edge of the cover-glass, and after becoming hard the superfluous balsam is cleaned off and the slide finished in any desired manner."]
Science Record, II. (1883) p. 17.

Könike, F.—Die zweckmässigste Wasser-regeneration der Aquarien mit microscopischen Sachen. (The most effective mode of regenerating the water of Aquaria having microscopical objects.) [*Post.*]
Zool. Anzeig., VI. (1883) pp. 638–9.

Low-Sergeant, W. [*Low-Sarjeant* p. cxxxi—*Low-Sargeant* wrapper].—New process for Preserving Plants. [*Post.*]
Proc. and Trans. Croydon Micr. and Nat. Hist. Club, 1882–1883, pp. cii.–iii.

Maggi, L.—Technica Protistologica. Cloruro di Palladio. (Protistological Technics. Chloride of Palladium.) *Bollett. Scientif.*, V. (1883) pp. 48–51.

Mayer, P.—Einfache Methode zum Aufkleben mikroskopischer Schnitte. (Simple method of fixing microscopical sections.) [*Post.*]
MT. Zool. Stat. Neapel, IV. (1883) pp. 521–2.

McCalla, A.—President's Address to the 6th Annual Meeting of the American Society of Microscopists. The Verification of Microscopic Observation.
[Vol. III. (1883) p. 766.]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 1–19.

Morehouse, G. W.—A new Mounting Fluid. [*Post.*]
Amer. Mon. Micr. Journ., IV. (1883) pp. 234–5.

Muller, C. J.—The discrimination of Species of Wood by a microscopical examination of sections of branches.
Trans. Eastbourne Nat. Hist. Soc., I. (1883) pp. 4–12.

Parietti, E.—Ricerche relative alla preparazione e conservazione di Bacteri e d'Infusori. (Researches on the preparation and preservation of Bacteria and Infusoria.)
Bollett. Scientif., V. (1883) pp. 95–6.

Peticolas' (C. L.) New Slides of Diatoms.

["Slide No. 1, *Stauroneis acuta*.—Microscopists are familiar with the beautiful effects of dark-field illumination upon certain diatoms. Some peculiarities of structure are shown by this method more clearly than by transmitted light. A recent gathering of *St. acuta* (*Pleurostaurum acutum* Grunow) has given me a sensation, although I have practised this method of illumination for years. With a 1/2 inch objective and a strong artificial light on dark field, this diatom seems literally to blaze, and surpasses in splendour the finest polariscope objects in my cabinet. With the light thrown across the short diameter, there is a strong resemblance to a section of ostrich tendon, only some peculiarity of striation seems to impart motion to the light, and the diatom seems on fire; across the long diameter the colour is changed to a brilliant sapphire.]

Amer. Mon. Micr. Journ., IV. (1883) p. 234.

Pillsbury, J. H.—A new Microscope Slide Cabinet. [*Post.*]

Science Record, II. (1883) pp. 25–6 (2 figs.).

Queen, J. W. & Co.—Improved Slide Box.

[Covered with cloth instead of paper; inside of lid with numbered lines for indexing.]

Micr. Bulletin, I. (1883) p. 7 (1 fig.).

R., D.—Classification and Labelling of Microscopical Objects.

[Suggestion that locality should be added to I. C. Thompson's labels, Vol. III. (1883) p. 926.]

Sci.-Gossip, 1883, p. 276.

Ralph, T. S.—Thymol as a Polariscopic Object.

[A most splendid polariscopic object. If a very small piece, about the size of a mustard-seed (or perhaps two) is placed at the edge of a cover-glass on a slide (not under), and then made to melt, it will run under it in a very fine film and crystallize on cooling. But before this take place, it should be placed on the stage, with the polarizing apparatus ready, so as to watch the process of crystallization. The effects far exceed that of most polariscopic objects. The same specimen carefully remelted can be used over and over again.]

Journ. of Microscopy, III. (1884) pp. 31–2.

Rataboul, J.—Les Diatomées. Récolte et préparation. I. Récolte des Diatomées. (The Diatomaceæ. Collection and preparation. I. Collection of the Diatomaceæ.) (In part.) *Journ. de Microgr.*, VII. (1883) pp. 644–6 (1 pl.).

Reinold, A. W., and A. W. Rücker.—Liquid Films and Molecular Magnitudes. [*Post.*] *Proc. Roy. Soc.*, XXXV. (1883) pp. 149–51.

Renson, C.—Nouveau procédé de recherche des Trichines dans les Viandes. (New method of research for *Trichinæ* in meat.) [*Post.*]

Bull. Soc. Belg. Micr., X. (1883) pp. 24–25.

Rothrock, J. T.—Some microscopic distinctions between good and bad Timber of the same species. *Amer. Phil. Soc.*, Feb. 1883.

Rothwell's (W. G.) Educational Slides. *Micr. News*, III. (1883) p. 340.

Royston-Pigott, G. W.—Note on the structure of the Scales of Butterflies.

Trans. Eastbourne Nat. Hist. Soc., I. (1883) pp. 41–5.

Rücker, A. W.—See A. W. Reinold.

Schaeffer, E. M.—The Microscopical Study of the Crystallization of Allotropic Sulphur.

[Contains directions for preparing.]

Amer. Mon. Micr. Journ., V. (1884) pp. 1–3.

Schnetzler.—Notiz über Tanninreaction bei Süsswasseralgen. (Note on the reaction of tannin in the fresh-water Algæ.) [*Post.*]

Bot. Centralbl., XVI. (1883) pp. 157–8.

Scott, W. B.—Imbedding in Egg-mass.

[Ruge's improvement of Calberla's method. Cf. Vol. III. (1883), pp. 303–4.]

Science Record, III. (1883) pp. 41–2.

Slack, H. J.—Pleasant Hours with the Microscope.
[Muscular System of Insects.]
Knowledge, IV. (1883) pp. 316–7 (2 figs.), 383–4.
„ „ [Trichinæ.] „ V. (1884), pp. 20–1 (2 figs.).
„ „ [Examination of atmospheric dust.]
„ „ pp. 51–2 (3 figs.).

Stanley's Stained Sections for use of students.
[In tubes ready for mounting and previous examination, so that students can try the effect of reagents upon them before putting them up as permanent objects. A circular accompanies, detailing the method of mounting and what to observe in the finished slides.]
Micr. News, III. (1883) p. 340.

Taránek, K. J.—Monographie der Nebeliden Böhmen's.
[Contains a note on preparing Fresh-water Rhizopoda. *Post.*]
Abh. K. Böhm. Gesell. Wiss., XI. (1882) Art. No. 8, iv. and 56 pp. (5 pls.).

Taylor, T.—Freezing Microtome.
Proc. Amer. Assoc. Adv. Sci., 1881, pp. 119–21.

Thoma, R.—Microtome à glissement et méthodes d'enrobage. (Sliding Microtome and methods of imbedding.)
[Same as *ante*, Vol. III. (1883) p. 298, and *post.*]
Journ. de Microgr., VII. (1883) pp. 576–83 (7 figs.), pp. 639–44 (1 fig.)

Thompson, I. C.– Microscope Labels.
[Claim of priority over Mr. Quinn for the labels described Vol. III. (1883) p. 926.]
Micr. News, III. (1883) pp. 334–6.

Thomson, W.—The size of Atoms.
[*Post.*] *Proc. Roy. Instit.*, X. (1883) pp. 185–213 (11 figs.).

Vorce, C. M.—The microscopical discrimination of Blood.
[Six propositions "generally and with rare exceptions true," setting forth the author's "views of micrometry in general in relation to minute objects, including blood."] Also comments by R. Hitchcock.
Amer. Mon. Micr. Journ., IV. (1883) pp. 223–5, 238–9; V. (1884) pp. 17–8.
„ „ Expanding the Blow-fly's Tongue. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) p. 12.

W., D. S.—Washing and mounting objects containing a considerable quantity of air. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) p. 18.

Ward, E.—Mounts and Mounting.
[Abstract of the author's 'Microscopical Mounts and Mounting,' and 'Micro-crystallization.']
Amer. Mon. Micr. Journ., IV. (1883) pp. 149–56 (in part).

West, T.—"Polariscope objects, with few exceptions, are merely pretty things, well enough calculated, in moderation, to relieve the solid bill of fare at a soirée or conversazione, but nothing whatever is to be learnt from them save that by certain arrangements of apparatus belonging to our Microscopes, some things become decked in gay colours; that is literally all."
[This statement will, we think, be generally recognized as very much too sweeping!—Ed. J.R.M.S.]
Journ. of Microscopy, III. (1884) p. 47.

Whitman, C. O.—Recent improvements in Section-cutting.
[Contains abstracts of Andres, Giesbrecht, and Mayer's section-smoother, III. (1883) p. 916—The registering micrometer-screw, III. (1883) p. 914 and *supra*, p. 153—The new object-holder, III. (1883) p. 915—An improvement in the carriers, III. (1883) p. 916—Type-metal boxes for imbedding, III. (1883) p. 913.]
Amer. Natural., XVII. (1883) pp. 1311–16 (3 figs.).

Whitman, C. O.—Methods of preventing the rolling of microtomic sections.
[Transverse knives, *post.* Schulze's section-smoother (1 fig.) III. (1883) p. 450.]
Amer. Natural., XVIII. (1884) pp. 106–8 (1 fig.).

Woodward, A. L.—Unpressed mounting of the Tongue of the Blow-fly.

["While it is an easy matter to catch and decapitate your blow-fly, unfortunately he will not always protrude his tongue properly during the operation, and my experience is that the tongue remains for ever after fixed in the position that it happens to be in when life in the fly becomes extinct. To remedy this, I tried the plan of immersing the living insect in alcohol, and with perfectly satisfactory results. At the moment of death the tongue is forcibly protruded to its entire length. Even the short proboscis of the house-fly is satisfactorily displayed. I tried carbolic acid in the same way, but the results were not nearly so good, and, besides, alcohol is a much nicer fluid to handle."]

Amer. Mon. Micr. Journ., IV. (1883) p. 239.

Wright, L.—Microscopical Mounting.

[Impossibility of procuring insect preparations "mounted in a really *first-class* manner," &c.]

Engl. Mech., XXXVIII. (1883) pp. 343-4 (2 figs.).

PROCEEDINGS OF THE SOCIETY.

MEETING OF 12TH DECEMBER, 1883, AT KING'S COLLEGE, STRAND, W.C., JAMES GLAISHER, ESQ., F.R.S., VICE-PRESIDENT, IN THE CHAIR.

The Minutes of the meeting of 14th November last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting, was submitted, and the thanks of the Society given to the donors.

	From
Balbiani, G.—Leçons sur les Sporozoaires. viii. and 184 pp. (51 figs. and 5 pls.). 8vo, Paris, 1883	*The Author.*
Ferguson, J.—The Microscope, its Revelations and Applications in Science and Art. viii. and 160 pp. 8vo, Edinburgh, 1858	*Mr. Crisp.*

The Chairman said it was his painful duty to announce that since their last meeting, the death had occurred of one of their number, who during almost the whole of his life had been held in the highest esteem and respect by all microscopists. He referred to Mr. Hugh Powell, of the firm of Powell and Lealand. It was truly a ripe old age to which he had attained, but nevertheless it was always painful when at length the time of parting came, and both as a Society and as individuals, he was sure they must deeply regret the removal of one whom they had always held in such respect. It was by an unfortunate coincidence that it fell to his lot to announce to the same meeting the death of Mr. Powell's most distinguished rival in America, Mr. R. B. Tolles, of Boston, who had also done so much for the improvement of objectives. Peace be to both of them, with the kindliest feelings of sympathy towards their respective families, of every Fellow of the Society.

Mr. Crisp exhibited (1) Mr. H. P. Aylward's Microscope, having a swinging tail-piece rotating completely round the stage, so that the mirror and substage could be set in any required azimuth (p. 110); (2) a Microscope by Mr. A. McLaren, rotating upon the horse-shoe foot, so as to secure greater stability for the instrument when the body was inclined at any considerable angle (p. 111); (3) a Microscope by Herr F. W. Schieck (p. 112), with a number of objects inserted in the circumference of a revolving drum, so that each could be passed in turn beneath the objective. A translation of the inventor's description of the instrument and its advantages was read to the

meeting, and his claim to absolute originality shown to be erroneous by the exhibition of Harris's Microscope (p. 115), obviously of considerable age, in which the same idea had been carried out.

Mr. W. H. Walmsley's photo-micrographs were exhibited, two of which in particular (of Möller's diatoms) were characterized by the Chairman as very excellent examples of photo-micrography.

Mr. W. M. Bale's note on Mounting in Glycerine was read.

Dr. J. H. L. Flögel's paper on "Researches on the Structure of Cell-walls of Diatoms" was brought before the meeting by Mr. J. Mayall, jun., who, in his preliminary remarks, said that it would be remembered that some time ago they had heard reports that some one abroad was making sections of diatoms, and he was requested by Mr. Crisp to institute inquiries with the view of bringing the method before the Society. He subsequently found that this work was being done by Dr. Flögel of Holstein, who, there appeared no reason to doubt, was not only a skilled and competent observer, but that he possessed every kind of appliance for making careful observations. Having ascertained this, the next thing was to obtain specimens of actual sections of diatoms, without which it was of course not possible to form any satisfactory judgment on the matter. He was fortunate in persuading Dr. Schröder, now resident in London, to write to Dr. Flögel upon the subject, and in the result they had received a very elaborate paper accompanied by a dozen slides and a number of photographs and drawings in illustration.

A careful examination of the slides showed that Dr. Flögel was thoroughly familiar with the finest processes of mounting, and with all that had been done by Möller. One of the slides was exhibited in the room under a 1/25 in. objective by Mr. Powell. It was a section of *Triceratium favus*, and the excellence of the specimen gave rise to the impression that something even more difficult than this could be accomplished. Amongst the other specimens sent, were some very clean cut sections giving an exceptionally clear image. It was stated by Dr. Flögel that as many as 174 transverse sections had been made of one diatom, all of which could be plainly identified as belonging to the same diatom. Mr. Mayall said that he could not pledge himself as to the correctness or otherwise of the theory set up by the author of the paper, as the subject was not one which he had made his own, although he had taken some pains to translate the paper for publication in the Journal of the Society.

Mr. Mayall then read an abstract of the paper to the meeting, and the subject was discussed by Mr. Curties, Mr. Crisp, and other Fellows.

The Chairman in proposing a vote of thanks to Dr Flögel for his paper, said that he was sure the Society would feel doubly indebted to Mr. Mayall for the exertions which he had made to procure the paper, and also for trouble he had taken in the matter of its translation.

The following Instruments, Objects, &c., were exhibited:—

Mr. Crisp:—

(1) Aylward's Rotating and Swinging Tail-piece Microscope.
(2) McLaren's Microscope with Rotating Foot.
(3) Schieck's Revolver School and Drawing-room Microscope.
(4) Harris's Revolver Microscope.

Dr. J. H. Flögel:—Sections of Diatoms illustrating his paper.
Mr. J. Mayall, jun.:—Ditto.
Mr. T. Powell:—Ditto.
Mr. W. H. Walmsley:—Photo-micrographs.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. John Butterworth, W. T. Cleland, M.B., T. B. Rossiter, and Andrew F. Tait.

Conversazione.

The first Conversazione of the Session was held on the 8th November, 1883. The following objects, &c., were exhibited:—

Mr. H. P. Aylward:
Set of collecting apparatus.

Mr. Chas. Baker:
New Mineralogical Microscope by Zeiss.
Portable Student's Microscope by Leitz.
Stewart's Safety Stage.
Test Diatoms in monobromide of naphthaline and phosphorus, by Möller.

Mr. J. Badcock:
Ophrydium Eichhornii and *Fredericella sultana*.

Messrs. R. and J. Beck:
Bacillus tuberculosis in liver of a bird, and *Bacillus Anthracis* in human liver.

Mr. Thos. Bolton:
Cordylophora lacustris.

Mr. W. G. Cocks:
Megalotrocha albo-flavicans.

Mr. F. Crisp:
Type-Plate of 400 Diatoms, with names photographed, by J. D. Möller.

Mr. G. F. Dowdeswell:
Spermatozoa of Water Newt (*Triton cristatus*). (1) Showing general structure, with the filament and membrane. × 200 diameters. Powell's 4/10 in. (2) Showing minute barb on point of head of the same. × 3600 diameters. Powell's 1/24 in. homogeneous immersion, N.A. 1·37.

Mr. F. Enoch:
Various species of minute Hymenoptera.

Mr. F. Fitch:
Dissection of *Phalangium opilio*.

Mr. H. E. Freeman:
Acarina from a hay-rick.
Mr. J. W. Groves:
Hydra fusca and *Amœba* of large size.
Mr. A. de Souza Guimaraens:
Hyphersthene, St. Paul's Island; Porphyritic Melaphyre, Plauen, near Dresden. Stained blue?
Mica Diorite, Freiburg; Mica Diorite, Wölsau, Fichtelgeb.; Quartz Diabase, Gotha; Quartz Diorite, Bingen. The same rock?
Mr. H. Hailes:
Abnormal forms of Foraminifera (*Peneroplis*).
Mr. J. D. Hardy:
Chromatoscope and transverse section of eyelash of Whale.
Mr. J. E. Ingpen:
Cyclosis in Australian *Vallisneria*.
Mr. W. Joshua:
Sea skimmings from the east coast of New Guinea, containing the following species:—*Rhizosolenia styliformis, striata, alata, setigera, calcaris, Shrubsolii; Chætoceras peruvianus* and *Wighamii; Coscinodiscus nobilis, concinnus, radiatus; Lauderia annulata; Mœlleria caudata; Eucampia zodiacus; Palmeria Hardmaniana; Melosira grandis*, &c.
Dr. Matthews:
Sponge from the base of *Stylaster*.
Mr. J. Mayall, jun.:
Dr. Schröder's Camera Lucida.
„ 1/4 in. Eye-piece.
„ 1 in. do.
McLaren's new Fine Adjustment.
Mr. A. D. Michael:
Hoplophora magna. The muscles for raising the cephalothorax, showing the tendonous attachments; and a trachea of *Damœus geniculatus*, showing the spiral structure not before detected.
Mr. E. M. Nelson:
Human Spermatozoon, showing a division in the tail not before observed, with Powell and Lealand's oil-immersion 1/12.
Mr. F. A. Parsons:
Cerataphis lataniæ, the Horned Aphis.
Messrs. Powell and Lealand:
Scale of *Podura* with 1/25 oil-immersion, N.A. 1·38.
Mr. B. W. Priest:
Section of *Placospongia melobesioides*, and *Plumularia setacea*, with tentacles expanded.
Mr. S. O. Ridley:
'Challenger' Deep-sea Sponges.
Messrs. Swift and Son:
Small Petrological Microscope.
Mr. G. Smith:
Fossil Wood silicified in section; Dolerite, &c.

Mr. C. Stewart:
Scale of Lizard (*Cyclodus ?*).
Mr. J. H. Steward:
Davis's Central Aperture and Iris Diaphragm, and Prowse's Ophthalmoscope.
Mr. Amos Topping:
Some Vegetable Preparations.
Mr. J. G. Waller:
Excavating Algæ? in calcareous particles from the Gabbard and Galloper Sands, off east coast of Essex (decalcified).
Mr. H. J. Waddington:
Examples of Foliated Crystals, polarized Erythrite, Sulphocarbolic acid (?), Kinate of quinine, and Magnesium platinocyanide.

MEETING OF 9TH JANUARY, 1884, AT KING'S COLLEGE, STRAND, W.C.
THE PRESIDENT (P. MARTIN DUNCAN, ESQ., F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 12th December last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Harting, P.—Recherches micrométriques sur le développement des Tissus et des Organes du Corps humain, précédées d'un examen critique des différentes méthodes micrométriques. viii. and 88 pp. 4to, Utrecht, 1845	*Mr. Crisp.*
Heller, K. B.—Das dioptrische Mikroskop, dessen Einrichtung und Behandlung. vi. and 56 pp. (18 figs.). 8vo, Wien, 1856	*Mr. Crisp.*
Magnin, A., and G. M. Sternberg.—Bacteria. xix. and 494 pp. (30 figs. and 12 pls.). 8vo, New York, 1884	*Dr. Sternberg.*
Set of Collecting Apparatus	*Mr. H. P. Aylward.*
Slide of *Microthamnion vexator* (Cooke)	*Mr. W. B. Turner*

Mr. Crisp exhibited and described Mr. Bulloch's new Objective Attachment (p. 118), which he thought was more complicated than was at all necessary, and which on that account could not be considered an improvement on that of Mr. Nelson, or the Matthews-Watson form.

Mr. John Mayall, jun., exhibited and described (1) Mr. Parsons' Current Slide (p. 121), and (2) Nelson's Microscope Lamp, with the oil vessel in the original square form (p. 125), and also with the improved round vessel as suggested by himself. With the exception of the very elaborate and expensive lamp devised by Mr. Dallinger, he considered this to be the best lamp yet produced for microscopical purposes.

Mr. Crisp pointed out that the device made use of in Mr. Parsons' slide was adopted by M. Nachet, some years ago, for adjusting the depth of the cell in counting blood-corpuscles.

Mr. W. J. Sollas's letter on the subject of cutting sections of diatoms was formally laid before the meeting. It had reference to the paper of Dr. Flögel, read at the December meeting, and was also intended to be read at that meeting, but did not come to hand until the meeting was over, when it was informally communicated to those present. The letter was as follows :—

"For some time past I have been engaged in cutting sections of diatoms. My plan is to scrape off a green slime from our river mud, consisting chiefly of *Pleurosigma zigzag*—a large species suitable for cutting. The slime, together with some mud, unavoidably gathered at the same time, is placed in a saucer and covered with a piece of muslin, which lies in immediate contact with the mud, while a film of water lies above it. The saucer is now exposed to daylight, and the diatoms creep through the muslin, collecting in a consistent film on its upper surface. The muslin may now be lifted from the mud, it comes away clean bringing all the diatoms with it, but leaving the mud. The muslin with the diatom film is now immersed in the usual hardening and staining reagents. I have used a mixture of chromic and osmic acids and absolute alcohol for hardening; borax-carmine, hæmatoxylin, and eosin for staining. When duly stained and hardened the diatom films may be removed from the muslin without difficulty, and cut, either by imbedding in pure paraffin (melting point 58°) and mounting in Canada balsam, or by freezing in gelatine jelly, which allows one to cut *consistent sections which may be mounted direct in glycerine* on a glass slide, without passing through water. By employing these two processes, I have made out the internal structure of diatoms, and believe that I can detect fine protoplasmic threads proceeding from the protoplasm that surrounds the nucleus and passing through apertures in the median keel. I am not yet, however, in a postion to demonstrate this with absolute certainty, but hope to do so soon."

Dr. Beale gave a resumé of his paper on "The Constituents of Sewage in the Mud of the Thames" (p. 1), illustrating his remarks by numerous drawings, and pointing out the important bearing of the matter upon the question of the health of the population of London in the probably near future.

The President thought the Society would feel greatly indebted to Dr. Beale for bringing before it this very unpleasant subject in a truly scientific spirit. Of its great importance from a sanitary point of view there could be no manner of doubt.

Mr. Bennett said he could confirm from his own experience the view expressed by Dr. Beale, that by no means all of the sewage of London was discharged into the Thames. As an instance in point, he might say that he had lived for some time in the north of London, and had recently discovered that there was no connection between the house and the main drain, but that the house drains merely led to a cesspool. He was told that this was the case with at least half the other houses in the road. He should be sorry to appear to throw the slightest doubt on any point touched upon by Dr. Beale, as of course,

when they appeared in print, many of the particulars would be more fully entered upon; but with regard to the spiral vessels of plants found in the mud, and the suggestion that they belonged to cabbage which had passed through the intestinal canal of man, he believed that it was a fact that they were without any work upon the anatomy of the spiral vessels which was at all conclusive upon the subject, or any information which would enable them to discriminate between the spiral vessels of different plants, or between those from different parts of the same plant. Before, therefore, it would be possible to accept the evidence as conclusive, they required some controlled experiments to prove that such things did not exist in water which was free from all suspicion of sewage. The cabbage, as was well known, belonged to an order of plants very common on the banks of the Thames, watercress for example growing there in large quantities, besides which cabbage was an article extremely likely to be thrown overboard from vessels and barges, so that he should be very careful in coming to a conclusion that these spiral vessels necessarily had their origin in the sewage.

Dr. Maddox said that some years ago he made a similar examination of water and mud from a field which had been irrigated with sewage. He took some from the inlet, and the other from a place just below the inlet, and he had not the slightest difficulty in recognising specimens in Dr. Beale's drawings as being of the same kind as those which he found on that occasion. Amongst other things, it was quite easy to identify muscular fibre, some of which was very imperfectly digested, also minute portions of broken shell, but the chief thing which struck him was the great excess of muscular fibre in proportion to the quantity of vegetable matter. There might have been portions of coal, but he did not remember recognizing its structure so clearly as Dr. Beale had done, but it struck him as being a dangerous process to irrigate fields with this kind of refuse, and then to drink the water from streams into which such water drained.

Dr Beale said he quite agreed with Mr. Bennett that it was impossible actually to identify the spiral vessels, but having regard to their identity with those obtained from cabbage, the chief point upon which he laid stress was the very great quantity of them found, in excess of all that could be well accounted for in any other way. Then again, it was well known that the number of vegetables growing upon the banks of the river went on decreasing, whilst the quantity of mud kept increasing. There was one point of interest in connection with the subject which he ought to have mentioned, and that was the marked difference in the death rate of London since the present system of drainage was adopted. In 1870, when the system was first set to work, the rate of mortality was 24·4, and it had since that time decreased, until now it was only 21·4, so there was every encouragement for every one to do his best to get rid of the sewage, or to dilute it still further.

Mr. Crisp referred to a paper by Mr. G. Acheson (Proc. Canad. Inst. i. (1883) pp. 413–26), with fourteen pages of description of organisms found in the tap water of Toronto.

Col. O'Hara's communication on some peculiarities of form and independent movement in blood-corpuscles, and a subsequent letter on the subject were read. Photo-micrographs in illustration were also exhibited.

Dr. Maddox said that in Dr. Sternberg's "Photo-micrographs," a blood-corpuscle from a yellow-fever patient was figured which he thought showed the same kind of appearance as that described.

Col. O'Hara also further explained the results of his examination.

Mr. Crisp read a letter from Dr. Van Heurck on the advantage he had found in mounting in styrax, and exhibited the slides which he had sent.

Mr. J. P. Bisset's "List of Desmidieæ, found in gatherings made in the neighbourhood of Lake Windermere during 1883," was taken as read.

Mr. W. B. Turner's communication on *Microthamnion vexator*, a new species of fresh-water algæ, was read, and a specimen exhibited.

Mr. Crisp read a list of Fellows who had been nominated for election at the February Meeting as Officers and Council for the ensuing year.

Mr. P. J. Butler and Mr. R. Kemp were duly elected Auditors of the Treasurer's accounts.

The following Instruments, Objects, &c., were exhibited:—

Dr. Beale:—Slides illustrating his paper.

Mr. Crisp:—Bulloch's Objective Attachment.

Mr. J. Mayall, jun.:—(1) Parsons' Current Slide; (2) Nelson's Microscope Lamps.

Col. O'Hara:—Photo-micrographs of Blood-corpuscles.

Mr. W. B. Turner:—New Fresh-water Alga.

Dr. Van Heurck:—Diatoms mounted in styrax.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL 1884.

TRANSACTIONS OF THE SOCIETY.

III.—*Observations on the Life-History of Stephanoceros Eichhornii.* By T. B. Rosseter, F.R.M.S.

(*Read 8th November* 1882, *and 12th March* 1884.)

Plate V. Figs. 1–3.

In the course of some observations to verify the fact that the cell of *Stephanoceros Eichhornii* is tubular, I determined to try the experiment of freeing the creature from its cell. I accordingly took a fine and healthy individual from my tank, placed it on the plate of the live-box with a small quantity of water, and after carefully observing it with a 1/2 in. objective and C eye-piece, I made an incision in the cell, and severed the creature's tail just above the sucker. After paring down the leaf to which it was attached, and substituting a 2-in. objective, I took a very fine lancet, and steadying the leaf with a needle and watching my opportunity, I severed the muscles, cutting the tail through close to the base, and I had the gratification of seeing it swim out of the cell, leaving the cell perfectly intact. I subsequently again tried the experiment, with the following results (extracted from my diary).

On Monday, May 15th (10 p.m.) I placed a good specimen of *Stephanoceros Eichhornii* in a moderately deep circular trough with a square base, my object for so doing in preference to using the live-box being to ascertain what amount of vitality existed after disconnection. This time, instead of merely making a small incision in the cell, I cut it straight across, completely dividing the cell, a small portion with the lower end of the tail being left attached to the piece of weed. The other, containing the animal and the greater portion of the cell, I dragged away into the middle of the trough, and awaited results. At first the creature did not attempt to move, its tentacles being completely closed up

in the cell; but the mastax and the intestines kept moving. It remained in this state for two hours, and then began to rouse up, but instead of expanding the tentacles and making an exit out of the upper end of the cell as before, it began to *back* out of the cell by the lower end, and after some time cleared it, turned round, and gradually expanded the tentacles. I watched it a greater portion of the night, and it seemed in no way the worse for the operation it had undergone.

On Tuesday, 16th, 9 A.M., I found it alive and to all appearance anchored by the remaining portion of its foot, one cannot say sucker, because that had been left behind. At 10 P.M., twenty-four hours having elapsed, it was still alive, and seemed to be in the best of health in spite of the change in its circumstances. The tentacles were perfectly semicircular and rigid, which is a sure indication of health, they becoming limp and straggling when the creature is sickening or about to die.

On Wednesday, the 17th, at 7 A.M., I found the creature alive, and what is more strange, that it had thrown off an ovum in an advanced stage of development. The ovum was close to its side, but whether attached to it or not I do not know. Agitating the liquid in the trough as far as I dared did not disturb the ovum. By 11 A.M. the young *Stephanoceros* broke the shell and swam away, leaving the shell still clinging to the parent, where it remained until my observations came to a conclusion. At 11 P.M. (49 hours having passed) the creature was alive and well, and firmly fixed by its portion of tail, with algæ commencing to form at the base. At first I took this for the commencement of a new cell, but in this respect I was mistaken, for up to the time of its death it remained in the naked condition.

Throughout the day on Friday, the 19th, the creature was wonderfully active in finding and selecting food.

On Sunday, the 21st, all through the day there were unmistakable signs of approaching dissolution. The mastax worked in a very fitful manner. I left it in the evening, feeling sure it would be dead by the morning, as was the case, just eight days from the time of leaving the cell. I had great difficulty in finding the dead body and empty case, the growth of Oscillatorieæ, &c., having for the last day or two been so great that it was with the greatest difficulty the animal and the case could be kept from being hidden.

Another fact I think worthy of noting: Examining some *Anacharis*, I found an empty case of *Stephanoceros Eichhornii* containing an ovum left by the parent. I watched it, and saw the young one break the shell, come out into the cell, and after swimming round inside it, pass out of the aperture.

The above observations will speak for themselves, not only as to the character of the cell of *Stephanoceros Eichhornii*, but that

it is able to live and propagate its species independently of the cell.

On another occasion I watched the development of a young *Stephanoceros* from the moment of hatching, and am able to verify the fact that the tentacles originate as buds, and unroll like the fronds of ferns. After the lapse of about eleven hours from the time of hatching, the upper portion of the young animal commenced to swell, and small buds began to be pushed upwards much in the same way as the tentacles begin to show themselves on the more advanced buds of *Hydra*. These buds were covered with minute cilia, and when they had been pushed up a short distance they began to gradually unfold (plate V. figs. 1 and 2) in the same manner as one sees the fronds of ferns unfold. They remained in this drooping state for two days, but on the third day took the beautiful arched form of the adult.

Ehrenberg was correct when he stated that *Stephanoceros Eichhornii* was viviparous, although at the time his ideas were considered erroneous. I have seen them give birth to young in this way very frequently, and on one occasion Dr. English * watched an individual under the same circumstances. The specimen that I watched was, when I found it, thoroughly sunk into the cell. The cell had not been retracted with the creature (fig. 3), but was perfectly erect. The creature was as I thought in a dying state, and nothing in the shape of food tempted it to come out of its cell. The posterior portion of the body was very much enlarged, and hung down like a bag (fig. 3, *a*). The tentacles seemed with the funnel to be thrust into the body of the creature; in fact, at times, it seemed huddled in a heap. After a short time it revived a little, and seemed inclined to elongate, but quickly retreated again. With a 1/2 in. and C eye-piece I saw the outlines of a young *Stephanoceros* in the pendulous portion, and later a slight opening in it through which it began to protrude head first. As it gradually came out, the posterior portion opened much wider, and the parent seemed to strain itself to get rid of its burden. At length it seemed about to do so, but the young one, as if fearful to trust itself from its mother, withdrew, but soon to be expelled by a violent effort on the part of the latter. After floating about in the cell for a short time, it made its escape in the usual way through the natural orifice. The mother never recovered, but died in the cell about half an hour afterwards.

The fact of the parent dying might at first sight seem to lead to the conclusion that this was not a true act of viviparousness, but I have, as I have said above, witnessed several similar cases, but not attended with the same fatal results to the parent.

* Resident Medical Officer at St. Mary's College, Canterbury.

I may mention here the process which I adopt in examining *Stephanoceros*. I take an ordinary glass slip and place the object with a small quantity of water in the centre. I then shred some blotting-paper very thin, cut three small squares and place them at different intervals round the fluid, but taking care not to let the blotting-paper touch the fluid, or else the object will be drawn towards it by capillary attraction. I usually wet the blotting-paper, previous to putting it on the slip. I mention this as I have lost some valuable specimens through inadvertence. I then place the cover-glass over the object, letting it rest on the edges of the blotting-paper; and as the fluid evaporates it is easily renewed by wetting the edges of the paper. I find twice in twenty-four hours quite sufficient. The process is very simple and inexpensive, and I have found it answer better than the usual live-box or compressorium. I have kept *Stephanoceros* alive thus for ten and twelve days, and have watched its progress from the ovum to maturity. What is important to any one whose means are limited, it is inexpensive, and very convenient. I keep it covered, when not under observation, with a small watch-glass.

IV.—*The President's Address.*

By Prof. P. Martin Duncan, F.R.S., V.P.L.S., &c.

(*Annual Meeting*, 13*th February*, 1884.)

The two addresses which I have had the honour of delivering as your President, were mainly devoted to the consideration of the practical optics of objectives of high power. On the present occasion I desire to direct attention, amongst other matters, to the importance of the perfection and use of those combinations of lenses which do not amplify greatly, and yet are more frequently employed than high powers and quite as usefully.

The combinations which give large amplification, are doubtless very attractive to the high-class microscopist, who prides himself on overcoming the difficulties attending the employment of his objectives, and they are of course absolutely requisite in most microscopical investigations. But the low powers—so readily and easily managed, so necessary before the employment of the high-power objective is attempted, so important in the use of the binocular Microscope and of the polarizing apparatus, and such auxiliaries to the hand-lens, from the readiness with which opaque objects can be viewed—are of paramount importance to microscopists of every degree.

There are many microscopists who enjoy the use of their instruments without any desire or power to add to the original research which accumulates so seriously year by year. They like to see beautiful things, to marvel at the æsthetics of nature, to examine the intricacies and delicacies and exquisite symmetry of the structures of natural objects which so far surpass the results of the art and industry of man. To all these followers of our science the low-power objective is of primary importance. Many hundred lithographic plates are published, year by year, on which are depicted minute recent and fossil forms which could not be studied without the low-power objective, and which do not come within the scope of high amplification. As being necessary to the most advanced investigators of minute things in their preliminary work, as absolutely necessary for the draughtsman and describer of opaque and transparent small objects, and as the media of great intellectual enjoyment, the objectives which are termed low in power, from their magnifying capacity being small, and which have from 1/2 in. to 4 in. of focus, should always receive attention. They illustrate the supreme ease with which former weary labour has been superseded.

A good monocular or binocular stand, a large and movable

stage with its proper accessories, and the bull's-eye, mirror, and illumination to match, are almost invariable accompaniments of the low power. The observer can work hour after hour and with but little fatigue. The object can be drawn with or without the camera lucida; and if it is a rock specimen the polariscope can be used with ease.

It was quite another matter in days gone by, when, however, most lasting—indeed everlasting—work was done with the aid of the low and imperfect powers. Compare the luxurious microscopist of to-day with the painfully labouring yet ever illustrious Swammerdam. In working at his memoir on the Day-fly, the figures in which are marvels of exactitude, Swammerdam excited the admiration and pity of Boerhaave, who wrote of him as follows: "All day he was employed in examining objects, and at night described and delineated what he had seen by day. At six in the morning in summer, he began to receive sufficient light from the sun to enable him to trace the objects of his examination. He continued dissecting until 12 o'clock, with his hat removed, lest it should impede the light, and in the full glow of the sun, the heat of which caused his head to be constantly covered with profuse perspiration. His eyes being constantly exposed to a strong light, the effect of which was increased by the Microscope, they were so affected by it that after midday he could no longer trace the minute bodies which he examined, although he had then as bright a light as in the forenoon."

But it was long after the time of Swammerdam before comfort and microscopical investigation were associated. Even after the achromatic system had been discovered and utilized, the "doublet" and "triplet" were used; but these scientific atrocities gave way to the combination of lenses now employed, and the days of comparatively easy working began. Great care was taken in the manufacture of the objectives of low power in this country, and magnificent specimens of science and art were speedily brought forth. I speak under correction, but it appears to me that there has not been any great improvement upon the low-power objectives which were produced by our great Microscope-makers a quarter of a century since. There has been an influx of second-rate low-power objectives, together with those of a high class, and the reason has been, not from any deterioration in the skill of the artizan, but from the belief, on the part of the public, that low-power objectives are more easily made than those of high power, and that therefore they should not be so costly. This is a great mistake, and the mischief produced by it, in the demand for cheap low-powers, has not been checked by the experience of those microscopists who almost entirely use objectives of a high amplification. Many investigators rarely employ a low power, and provided their high

power objectives are good, they are satisfied with something that will act as a low magnifying power. It does not require much experience to prove the great differences between the qualities of low powers of the same supposed amplification. A good low-power objective requires more work to be done on it than does a high-power combination, and hence the similarity in cost of a first-rate English low power and a foreign high power. This special work is not always given, and hence the diversity of merit in the lowest powers obtained from different quarters. The absolutely requisite qualities of first-class low-power objectives are a large flat field, achromatism, definition, a good penetrating power, accurate centering and as little spherical aberration as is possible. Of the vast number of cheap lenses now produced, it can only be said that it is to be regretted that the public will not consider that they cannot be made good for the money they cost.

There are very considerable differences in objectives of 1/2 in. focus, but it is really a good plan to have one of a considerable aperture and another for ordinary work, with a less aperture and greater penetrating power. Those of the last-mentioned kind are the most valuable with the binocular, after having their brasswork shortened. These lenses and, indeed, all the low powers which are so readily used with the binocular, are often severely tried by it, and their errors become very prominent. Moreover, the indifferent prismatic arrangement of many binoculars is exposed by the objective.

The lowest powers compete with the hand-lenses, and these are rapidly increasing in excellence. It is remarkable how necessary it is to employ the simple hand-lens after or before submitting small, irregularly shaped, opaque objects, like corals and foraminifera, to the compound Microscope for purposes of illustration.

Most artists acknowledge that the details of the object are beautifully rendered by the objective and Microscope, but that they only get a true and general idea of it by using the hand-lens. Particular direction of the light, the depth of shadow, and the exaggeration of the details of one part over those of another, characterize the performance of the Microscope armed with a low-power objective; and a diffused light, less contrasting shadow, and a more symmetrical and general amplification are the gifts of the hand-lens. The Microscope employed with a low-power objective is further removed than the single lens from the eye, as an instrument. These differences are amongst the proofs of the distinction between ordinary and microscopic vision.

The utility of low powers and their easy manipulation have been greatly increased by numerous appliances, most of which have been carefully considered by this Society. The different kinds of reflectors and condensers of light, and the methods of dark-ground

illumination with oblique rays of light, are amongst the most important. The alteration of the binocular system to suit a more or less horizontal position of the tube and to correct reversal of the image, has produced an instrument which gives the greatest facilities to workers, and under which dissection and selection can take place very readily. It supersedes the old plan of placing a low-power objective on the draw-tube when using a low objective, although this is an excellent plan.

The improvements in the camera lucida are all in favour of the low powers, and certainly during the past year this important adjunct has been presented in many forms to the Society. One apparently diminishes the almost inevitable distortion of the reflected image, and another gives a great field with a very visible end to the operator's pencil.

The improvements in the manufacture of the polarizing apparatus and the admirable substage movements, which have so frequently been exhibited before the Society, raise the value of the low powers in the important and most necessary study of rocks. Finally, the ready change of objective by such methods as that of Dr. Matthews, is gradually doing away with the nose-piece, an adjunct to the Microscope which, if well made, is very useful, but which if badly made is especially pernicious to the development of the good performance of the low-power objective.

Some important communications have been read before the Society on the theory of the Microscope, and it is satisfactory to acknowledge their great practical bearings. I allude especially to the papers of Prof. Abbe and our Secretary, Mr. Frank Crisp.

Prof. Abbe's communications are full of interest. One relates to the measurement of the refractive index and dispersive power of fluids, without having resort to the old cumbrous methods by hollow prisms. Abbe's refractometer is said to fulfil all that is required of it. The leading principle of the apparatus depends upon the obstruction of the rays by total reflection at the surface of the fluid under examination.

Wollaston and others adopted the method of observing the maximum intensity of the reflected ray; but a great advantage is gained by observing instead, the maximum intensity, so to say, of the transmitted ray. In the former case there is a difficulty in ascertaining the precise point where the light reaches its maximum, whilst in the latter a very small amount of light is easily detected in the darkened field. A second communication is a continuation of one on the Rational Balance of Aperture and Power, and relates to the division of the entire power of the Microscope between ocular and objective. The necessity for this balance was urged in my last Presidential Address.

Our Secretary's paper relates to the measurement of the magni-

fying power of the complete instrument with eye-piece, tube, and objective, and exposes the fallacious empirical methods hitherto employed, and showing that the correct amplification can be determined by the use of a very simple formula.

The last year has shown that there has been more activity amongst the Fellows of the Society in original researches and in the practical employment of the Microscope.

Mr. Michael has continued his most interesting and valuable work on the Oribatidæ, and now science has the advantage of much correct knowledge regarding the anatomy of this interesting group.

Dr. Hudson, pursuing his admirable researches amongst the Rotifera, has added three new and very remarkable species of the exquisite genus *Floscularia* to natural history. Most of us recollect the first *Flosculariæ* that we ever saw: how out of a dull looking indefinite lump a projection appeared, and how long, slender, apparently never ending, threads grew on; how these slender threads radiated from certain spots and seemed as rigid as bristles; and how this most delicate creature possessed rotifer-like jaws, and how the whole gradually retracted, and as it were turned itself in. Some of Dr. Hudson's new forms depart, however, considerably from the common type of *Floscularia*. His *Floscularia hoodii* (*hoodii* by name, *cucullatus* by nature!) is the largest of all the rotifers, has only three lobes and possesses two remarkable flexible processes placed one on each side of the summit of the dorsal lobe. These have been carefully studied by Dr. Hudson, because their antenna-like appearance is striking. He did not find the slightest trace of setæ in connection with these processes. They appear to be hollow, and to communicate with two sub-spherical spaces lying between the two surfaces of the dorsal lobe. Fine muscular threads pass down and across them, and the animal can contract and expand each independently of the other and throw them into all kinds of positions. The upper end of each seems to be separated partly from the remainder by a constriction, from which a muscular thread runs down to the base. These movable processes do not both project invariably when protrusion of the animal occurs from its case, and they appear to discharge a granular matter. There is a point of interest also in the long filamentous setæ. Dr. Hudson states that, the thickened rim of the three lobes carries a double fringe of setæ, set just as they are in *F. trifolium*, the larger row stretching outwards and the smaller inwards; and he has on several occasions seen a rapid flicker run all along the smaller setæ, not constant or regular enough to produce the phenomena of "rotation," but still a very obvious motion of each separate seta. The gape of the mouth-funnel of this rotifer alters constantly and closes by means of its many muscular threads. It has two

pale pink eyes and the contractile vesicle is large and plain and contains a cluster of yellow globules.

It is to be hoped that Dr. Hudson will continue to investigate this most remarkable form. Another species discovered and described by Dr. Hudson is *Floscularia ambigua* which, he says, is the least elegant of all the species, being broad and stumpy and trilobed. It is, however, allied to *F. hoodii* in some points, and its curious habits compensate for its inelegance. Mr. Hood writes: "This Floscule is not a beauty, but what it wants in grace it gains in interest, for it is most amusing to watch it feeding. As soon as it has fully expanded its large head, infusoria of various species may be observed to be drawn swiftly down the large cavity formed by the lobes. The inward-setting current, thus formed by the cilia at the base of the cavity, seems to be stronger in this species than in the others, for large animalcules, such as *Kolpoda* and *Paramecium*, and even free-swimming rotifers will often fall victims to this big, burly and voracious creature. It has an insatiable appetite; I have frequently seen the young of *Œcistes pilula* and *Œcistes umbella* devoured by it, the young of the large rotifers making even less resistance than the infusoria. It is not purely carnivorous, for the young of *Volvox globator* fall a prey. Whenever it has got a victim within its great mouth-funnel, there is no possibility of its making its escape; although, with a full stomach, *F. ambigua* seems inclined to play with its prey as a cat would with a mouse, allowing it to swim about within the funnel, and to try and escape over the margin. Whenever the animalcule approaches the setigerous rim, a sharp stroke from one or more setæ drives it back into the funnel. I have seen the attempt to escape made over and over again, but always with the same result; in no single instance have I ever witnessed the escape of a captive. No one could credit the voracity of this Floscule who had not watched it. I have seen one eat in half an hour no less than twenty-four live infusoria of various sizes with a young Rotifer and Volvox now and then."

Dr. Hudson notices that the males of *F. ambigua* are hatched from smaller and rounder eggs than the females. Their digestive organs and mastax are wanting; the anterior portion of the body was transparent, bearing a wreath of long vibratile cilia and two red eye-spots. Dr. Hudson bears testimony to the variation in the number of the setigerous lobes of the Floscules, and after noticing that three and five are common numbers, and that five and six in the same animal is a somewhat doubtful fact, determines that a new form, *F. regalis*, has seven lobes, which are knobs on festoons, and are crowded with setæ.

Dr. Hudson has also communicated a very interesting paper on the Humped Rotifer, *Asplanchna Ebbesbornii*, and has not only

treated his subject zoologically, but also morphologically. Of the male of this species, Dr. Hudson states, the whole range of the Rotifera does not contain a more curious or more beautifully transparent creature; it may be 1/30 in. long, and is a slow swimmer; yet it is so transparent that it is almost invisible to the naked eye. Under the Microscope it looks like a many-pointed bubble of glass. This male has no digestive organs, and nature in compensation has given him some stored material for his nutrition. Dr. Hudson gives drawings of the tortuous threads and tags that are so constantly present in Rotifers. He delineates the spermatozoa and the central portion of the ovary of the female with maturing germs.

Our Secretary, Professor Bell, has given us some accurate figures and descriptions of the spicules of the body-wall and suckers of the Holothurians named *Cucumaria hyndmanni* and *C. calcigera*, and in concluding his essay he remarked that the greatest care is required to preserve the parts of typical specimens if they are to continue to be of value. The spicules of one of these species, *C. calcigera*, were carefully studied by my colleague, Dr. Percy Sladen, and published in our work on the Arctic Echinodermata. On examining our figures, plate I. figs. 6, 7, and comparing them with those of Professor Bell, it would appear that there must be alterations proceeding in the spicules during the preservation of the specimens. Possibly the methods employed to exhibit the specimens may modify them. The microscopic details in our figure of a small spicule in profile (fig. 7) are more ample than those in our Journal (vol. iii., plate VIII., fig. 2*a*) and it would appear from our figure (6) of spicules from the superficial layer *in situ*, that there must be variation in those structures in different individuals.

Mr. Conrad Beck has described some very interesting Cladocera from the English Lakes in our Journal, and his figures of them are most praiseworthy. It is to be hoped that this is by no means the last of his communications. He has chosen a subject full of interest to the naturalist as well as to the investigator of the great movements of the crust of the earth. The relation which some of these Cladocera bear to marine forms is obvious, and Lovén, Agassiz, and myself have pointed out their occurrence in positions which indicate their entry before the country assumed its present physical aspect. Their occurrence in the Swiss and Norwegian lakes is very antagonistic to the idea of the excavation of these areas by ice.

The Diatomaceæ have been the subject of some very interesting researches. Methods of making fine sections of these delicate silicious bodies have been suggested and carried out with some success. It could hardly be expected that a year could pass without some further researches on the cause of the movement

of the diatom when free. The mechanism has not yet been publicly demonstrated, however, although some few microscopists have had the good fortune, under very exceptional circumstances, to see (or fancy they saw) external protoplasmic movements. The communications on this subject to the different scientific journals are, as is usual when the subject is in the non-verifiable stage, very dogmatic and contradictory. Still the homogeneous-immersion lens of high power should be the means of determining the cause or causes of the movement.

Our Journal has been made more valuable during this year by the publication of the very careful and intelligent researches of Messrs. Morris and Henderson on *Trichophyton tonsurans*. They describe the life-history of the fungus from the sowing of the spore to the branching of the resulting filaments on the sixth to eighth day. Moreover they describe the aerial hyphæ and fructification. Remarking on the difficulties of determining the botanical position of the ringworm fungus, on account of the frequent development of adventitious fungi, Messrs. Morris and Henderson endeavoured to obtain a medium which should possess perfect sterilization and should have sufficient consistence to retain spores in a fixed position for continuous observation. They came to the following conclusions, illustrating their paper by photo-micrographs (employing a 1/5 in. object-glass of Beck and an amplification of 1000):—That the spores of *Trichophyton tonsurans* grow freely on the surface and in the substance of gelatine peptone at from 15° and 25° C. That the mycelium only will grow in the substance of the jelly, and that the hyphæ require air to produce conidia. That the branching, septa-formation, and fructification are identical with those of *Penicillium*. That the spores of the second generation reproduce ringworm on the human skin. That outgrowths resembling resting spores appear on some of the filaments.

The red mould of barley has been most carefully examined and illustrated by Mr. C. G. Matthews, F.C.S., and published in one of the parts of the Journal. The common coloured mould seen at the germinal end of the corn was grown on a large scale by breaking up germinating barley with a little water into paste. Very fine silky tufts of the red mould were thus obtained from 1/2 to 3/4 in. in length and nearly 2 in. in diameter. Much of the red colouring matter was diffused amongst the plasma and the hyphæ were tinged with it, where they sprang from the nutrient surfaces, though their extremities were colourless. The hyphæ gradually became interlaced and flattened down as a mass and a kind of sporulation began to be noticed, and pseudo-spores—very minute bodies—came from the threads. They did not appear to develope. Shortly after the flattening of the hyphæ, a pink dust

was seen here and there on its whitish surface. This consisted of clusters of crescent-shaped spores. They appear to sprout from the extremities of short hyphæ. From these crescent-shaped bodies, which are spores, fresh growths of the mould could be obtained by sowing on a suitable surface. The red colour is the matter surrounding the crescent-shaped spores. The mould holds its own against other kinds, and sooner or later swellings occur in the threads of the hyphæ and on sporangia. The contents discharge with the application of water, and the spherical spores were sown, and they reproduced the red mould. The author described a similar mould on the melon.

I speculated in my last address regarding the future of research into the life-history of bacilli, and the results of the work on this subject during the past year have been really most wonderful. Dr. Ransom condensed the breath of phthisical patients and obtained bacilli, rendering them visible by what may be called the Gibbes process. He found that they were indistinguishable from those found in the sputa and in tubercle. It is not reassuring to know that bacteria exist in vast multitudes in the soil, but M. Miquel has shown that at Montsouris an average of 750,000, in the Rue de Rennes 1,300,000, in the Rue Monge 2,100,000 germs exist per gramme. Brautlecht mixed baked sand, gritty earth, and tolerably loamy garden mould with liquid containing bacteria and covered the mixture with a bell-glass. A few hours after, there were a great number of micro-organisms in the vapour condensed under the bell-glass, and of the form of those contained in the liquid. The sprinkling of dry sand over the earth diminished the number of organisms. It is comforting to read that while rain is falling, the number of the bacteria in the air is sensibly diminished; it increases, however, when the ground dries, and diminishes with ten to fifteen days' drought. Miquel states that at Montsouris, the average number of bacterial germs per cubic metre of air is 142 in autumn, 49 in winter, 85 in spring, and 105 in summer. The same author states that the number of germs in hospitals is vast, amounting in the summer months to an average of 5600, and in the autumn to considerably over 10,000 per cubic metre of air.

The sensitiveness to light of *Bacterium photometricum* is accompanied by more remarkable properties, for these organisms accumulate in media in positions where the invisible ultra red rays of the spectrum penetrate. The influence of light on the development of bacteria has been shown in the instance of *Bacterium termo* to be remarkable. Direct sunlight kills bacteria, diffused sunlight does not; but this statement has to be qualified, for Jamieson discovered that temperature has to do with the matter, and that at moderate and low temperatures direct sunlight does no

harm to the organisms. Direct sunlight and air, by drying up bacteria, destroy them. Some bacilli, those of anthrax for instance, which exist in serous matter from anthrax tumours, may be dried at a temperature of 32° C. = 89°·6 F., and then exposed to 100° C. = 212° F. It is stated that not only do the organisms resist heat, but become able to resist antiseptic agents. They do not, however, appear to act as definitely as before, but they produce modified anthrax. Following on these results, those of M. Chauveau are very interesting. He mixed a sterilized infusion of meat with the blood of cattle disease, and placed the mixture first in a temperature of 42-43° C., and then to 47° C. It appeared subsequently that although the vital activity of the bacillus was not interfered with, its capacity for acting as a disease-producer was destroyed.

One of the most suggestive observations on bacteria has been that which indicates that they act as starch and diastase in the absence of other carbon nutriment, and that the action on starch is effected by a ferment secreted by them, and which like diastase is soluble in water, but precipitable by alcohol. This ferment acts as diastase, changing the starch into a sugar capable of reducing cupric oxide, but not possessed of peptonizing properties. It is to be hoped that after all this searching after bacteria and after these recondite experiments have been conducted over again, that some definite study of the bacteria of a locality where such diseases as ague prevail, will be undertaken. The whole history of the disease points to a bacterian origin and there should be no difficulty in examining the secretions with a view of thoroughly investigating the organism.

A paper lately read before the Royal Society proves that solution of quinine is fatal to certain bacteria, even to those of phthisis, and the well-known influence of that drug over ague should stimulate therapeutists to investigation.

There have been two communications to the Society on special methods of preserving delicate organisms for the use of the Microscope, which are of exceptional interest and value. Mr. Lovett has explained his intelligent method of using what he properly calls a judicious admixture of various proportions of alcohol, glycerine, and water to Haentsche's fluid, which consists of alcohol absolute 3 parts, pure glycerine 2 parts, and 1 part distilled water. *Limnocodium Sowerbii*, the wonderful medusoid which, living in fresh water at 85° Fahr., is such a marvel so far as its origin is concerned, has become preservable, thanks to Mr. Squire's weak solution of bichloride of mercury. There is no doubt that this medium will be further employed. Mr. Saville Kent has suggested the use of weak solutions of potassic iodide for preserving infusoria, and Mr. Waddington has contributed a paper on the use of tannin in showing infusoria.

It is a matter of great congratulation that the Society maintains its character at home and abroad as a useful and truly scientific institution. There is no doubt that great progress has been made in microscopical science during the last few years and that the communications read before this Society, the recorded debates and their influence on our large and increasingly important number of Fellows have assisted in this satisfactory state of things. The Society may take the credit of having now completely eradicated the old and very erroneous notions regarding what was called "angular aperture," and of having disseminated and established the knowledge of aperture in its correct signification and the use of the "numerical aperture" notation. The first term has, indeed, almost ceased to be employed by advanced microscopists. The homogeneous-immersion principle has been developed and the media which have been proved to be so valuable have originated with Fellows of the Society and have been recorded in the Journal.

I feel a sensation of some pride that I should be able to hand over the presidency of this Society in the midst of its useful and prosperous career to an observer of the highest class of excellence, whose success has been assured by the employment of the instrument which has been largely perfected by the intellectual and mechanical gifts of Fellows of this Society. I may, I trust, (without the least desire to stop the particular physical and mathematical tendencies of many of our Fellows) urge the great number of good observers of nature amongst us to be stimulated by the very valuable reports of the researches on the structures of the invertebrata and plantæ, which appear in the Journal—a compendium of which the Society may justly be proud—to undertake work which may come before their future President and receive his criticism. In fact it may be hoped that that excellent Journal will contain more records of the labours of the Fellows of the Society.

In the proceedings of all great Societies there are occasions when congratulations and the desire for future usefulness have to give place to very opposite expressions. Men toil and pass away, and others enter into their labours.

The present occasion is no exception to the rule. We have to deplore the loss of three great practical opticians, two of them being microscopists of the highest renown. One had attained an age far beyond that which is usually noticed amongst men who have laboured with head and hand, and on looking back at his life it must be admitted that by his means an immense amount of intellectual pleasure was given to the world, and a great amount of exact knowledge has been consolidated.

For fifty years the name of Powell has been a household word

amongst microscopists, and now it remains only to the sons of the late Mr. Hugh Powell. The distinguished man whose name I have just mentioned was amongst the first of the Fellows of this Society, and long before the year 1840, he had become celebrated for his microscope-stands and lenses. His name will always be remembered as that of a designer and maker of first-class high-power objectives, and as a conscientious maker of the ordinary powers. The following obituary notice has been already published, and it expresses the merits of Mr. Powell :—

"In 1834 he was awarded a silver medal by the Society of Arts 'for a stage for a Microscope.' In 1840 he succeeded in making an achromatic object-glass of 1/16 in. focal length, which the late Professor Quekett, in his treatise on the Microscope, stated was 'the first that had been seen in this country'; and in 1841 the Society of Arts awarded him a silver medal 'for his mode of mounting the body of a Microscope.' Mr. Powell was the first optician in England to construct object-glasses on Amici's 'immersion' system. A 1/25 in. was made by Mr. Powell in 1860, a 1/50 in. was perfected in 1864, and a 1/80 in. in 1872. The more recently developed formula of the 'homogeneous immersion' system was the subject of special attention on the part of Mr. Powell and his brother-in-law and partner, Mr. Lealand, but failing health compelled him to rely upon the efforts of his son, by whom object-glasses on this formula having the highest apertures on record have been constructed. Mr. Powell was among the earliest on the roll of Fellows of the Society at its foundation in 1840."

Microscopical science has also to deplore the death of a very able and most distinguished practical optician in the United States. Mr. Robert B. Tolles has left a name in America and Europe which will always be mentioned with respect. He was a skilled objective-maker of the first class, and like most men of his mental and artistic calibre was a quiet and unassuming gentleman. Tolles was always ready to avail himself of discoveries and seized at once upon the value of the lenses with large numerical apertures, and he also speedily availed himself of the improvements of the homogeneous-immersion principle. He was not, as one of his friendly biographers states, entitled to the credit of showing the practicability of this system. It was Amici, Stephenson, and Abbe, as I stated in my first Presidential Address, who established the homogeneous-immersion system. Tolles, however, developed the apertures of high-power objectives and produced admirable results, being the first to manufacture combinations of lenses of high amplification and suited to the immersion system in America.

The last obituary notice relates to Henry Dallmeyer, who was so well known in the sister sciences of astronomical and photographic optics. Mr. Dallmeyer left Germany in 1849

and came to England, entering the house of the late Andrew Ross, the founder of the well-known optician's business bearing his name. Mr. Dallmeyer's attention was at first devoted principally to the construction of astronomical telescopes, for which, in conjunction with Mr. Ross, he computed a large number of formulæ. At his death, Mr. Ross bequeathed to Mr. Dallmeyer the bulk of his optical appliances for the manufacture of telescopes. About this date (1855) photography began to be popularized by the general adoption of the collodion process. Mr. Dallmeyer quickly discovered that the photographic lenses then in use stood in great need of improvement in every direction. In rapid succession he produced lenses for landscape and portrait photography, and it is greatly owing to his efforts that English lenses now rank second to none. He was specially commissioned to provide several of the telescopes and photographic appliances used by the different Government expeditions for the observation of the recent transit of Venus, and his telescope object-glasses are in high repute among the leading astronomers. Mr. Dallmeyer died at the age of 53.

One more duty falls upon me, and it is a very pleasurable one. I have to thank the Fellows of the Society for the consideration they have shown me during my three years of office, and for the manner in which they have borne with my shortcomings. In taking leave of you as your retiring President I do most sincerely congratulate you on the accession of Mr. Dallinger to the presidential chair, a position for which his great scientific reputation so thoroughly recommends him.

V.—*On the Mineral Cyprusite.*

By Julien Deby, C.E., F.R.M.S.

(*Read 14th November*, 1883.)

In November 1881, Dr. Paul Reinsch, through Professor Stokes, communicated to the Royal Society a note on a mineral to which he gave the name of *Cyprusite*, of which he had brought back to Erlangen a small specimen on his return from Cyprus.

Having myself had the opportunity of visiting the same region of country during the present summer, I took advantage of it to collect numerous specimens of this substance, from many different localities.

Believing that further observations relating to this cyprusite may prove of interest to petrological microscopists and others, I have drawn up a short note summing up the further history of this curious natural product, the result of my own investigations.

The cyprusite is found in the shape of rocks, forming several bold superficial parallel outcrops of rather irregular longitudinal outline, running in a direction north-west to south-east in the district of Chrysophou, in the north-west portion of the island of Cyprus, and mostly distributed over the mountainous territory comprised between the villages of Poli, Lisso, and Kynussa. These outcrops extend in some cases several hundred yards in length, with a width oscillating irregularly between 30 to 100 yards. Their colour varies from a pale dirty yellow to a bright cinnabar red, with all intermediate tints.

The texture of the rock varies from a quite soft friable consistency, falling to dust between the fingers, to a quite hard and compact rock. The former or softer variety is the most abundant.

A careful geological examination shows that the cyprusite is imbedded in plutonic rocks, melaphyres, and wakes, containing occasionally zeolites, it occupying wide crevices in these eruptive rocks, which latter have forced their way in vast masses through the stratified tertiary fossiliferous limestones of the country.

The present height above the sea of the cyprusite deposits varies from 350 to 1200 feet, the distance of the same to the north coast of the island in a straight line varying from three to six miles. The principal deposits are situated on the right bank of the Ballahusa river, and below the village of Kynussa.

Having noticed that wherever cyprusite outcrops were to be seen traces of ancient mining and heaps of old slags were also to be discovered in the vicinity, and that the old workings penetrated in many places into the hill-sides below the yellow masses, I came to the conclusion that the cyprusite knobs and bluffs formed

the outcrop ("gossan," as Cornish miners would call it) of the copper lodes so celebrated in the times of remote antiquity. A further investigation has led me to the belief that, at a certain depth, the cyprusite is replaced by iron pyrites, and that lower down still these pyrites become cupreous, and that these constituted a portion of the mineral which was worked by the Phœnicians, Greeks, and Romans in the island of Cyprus.

I observed in several places below the cyprusite the efflorescences mentioned by Dr. Reinsch; their composition is as follows:—

Insoluble in water	4·88	per cent.
Copper	0·45	„
Iron	none	
Alumina	17·70	„
Sulphuric Acid	35·19	„
Water of crystallization	39·00	„
Total	97·22	„

This mineral had a whitish, slightly greenish tinge and semi-crystalline structure, and looked exactly like weathered sulphate of iron. It consists, however, essentially of sulphate of alumina (nearly $2\,Al_2O_3.5\,SO_3 + 25\,H_2O$) coloured by copper.

The cyprusite was submitted for complete analysis to my friend Henry Fulton, Esq., the late well-known and able chemist to the Rio Tinto Company, now of Aguilas, Spain, to whose kindness I am indebted for the greater part of the chemical determinations in the present communication.

A first experiment consisted in simply drying the mineral to from 100 to 115 degrees Centigrade, when slight vapours which coloured litmus blue were given off. Another portion was next submitted to a red heat in a platinum crucible for six hours, until the fumes ceased to colour litmus paper, when it was found by analysis that 17·19 per cent. of sulphuric acid had been given off. At the same time the colour had passed from yellow through bright red to a dark purple.

The *average* of several carefully made analyses of the yellow or typical and most abundant variety of cyprusite, after separation of the insoluble portion, which, as we shall see, does not enter into the chemical composition of the mineral, was found to be:—

Ferric oxide, Fe_2O_3	49·68	per cent.
Alumina, Al_2O_3	3·89	„
Sulphuric acid, SO_3	35·34	„
Water, H_2O	11·06	„
Total	99·97	„

The mineral is thus seen to constitute a normal sulphate of alumina with anhydrous ferric tribasic sulphate, the whole having

the formula, $Al_2O_3 . 3SO_3 + 18H_2O + 8(Fe_2O_3 . SO_3)$, the theoretical composition of which would be as follows:—

Ferric oxide, Fe_2O_3	49·47 per cent.
Alumina, Al_2O_3	3·98 „
Sulphuric acid, SO_3	34·00 „
Water, H_2O	12·52 „
Total	99·97 „

differing from the result of Dr. Reinsch's essay, as published by him in the 'Proceedings of the Royal Society' for 1881, No. 217.

The most interesting facts connected with the cyprusite are, however, revealed by a careful microscopic examination of the mineral. It is then found to consist of a loose to compact aggregate of very minute, translucent, very slightly coloured crystals, the microscopic "projection" of which is generally more or less regularly hexagonal. These crystals vary in diameter from 1/120 to 1/300 of a millimetre = 8·30 μ to 3·32 μ = 0·00032 of an inch to 0·00013 of an inch. These are entirely soluble in hydrochloric acid, but insoluble in water.

Calcining converts these crystals into an opaque substance, which generally retains the previous outline.

Crystals are frequently found irregularly formed, as also occasionally compound or twin-crystals. Under the polariscope the micro-crystals, if examined dry or immersed in water, would, by a superficial examination, be taken for isometric, an appearance which is due to the hexagonal disks, all presenting this same face towards the optical axis of the instrument, but if mounted in thick balsam so as to lie in various positions to the observer, they are found, small as they are, to be beautifully anisotropic, the hexagonal sections alone remaining obscure under the crossed Nicols, so that the crystalline system may be safely laid down as rhombohedral or hexagonal. This determination is further supported by the fact that some of the larger crystals seem to present apical modifications which are multiples of three.

It will be remembered that the ordinary alums, as also copperas, crystallize in the monometric system, so that cyprusite seems to constitute a really good and distinct mineral species.

I may add that cyprusite is insoluble in water, and that analysis has failed to detect in it either lime or magnesia. The specific gravity is 1·8. Completely immersed in this bed of minute crystals of cyprusite are to be found scattered numerous *silicious* organic remains (non-polarizing) to the extent, on an *average*, of about 16·90 per cent. of the whole bulk, along with a very few small grains of quartz sand, which last are readily distinguishable under the micro-polariscope.

The Microscope shows that these silicious organic remains,

invisible to the naked eye, consist of the skeletons of marine polycistins (Radiolaria) in a tolerable state of preservation, along with many smaller débris of the same, as also of a few sponge spicules, but I could discover no diatoms among them.

The cyprusite polycistins belong principally to the group comprising the *Heliosphæridæ*, but a curious elongate conical form of a *Polycyrtida* is not uncommon in the deposit as well as representatives of some other families. The insoluble residue of the mineral after treatment by acids consists almost entirely of these organic remains. Ehrenberg's and Haeckel's works not being at my disposal at my present residence in Spain, I cannot determine the species nor even the genera of these Radiolaria, nor can I establish if these forms are still living in the present surrounding seas. I must, in consequence, leave this work for others better situated, and to whom I will be glad to communicate the necessary material on application.

One thing is certain, namely, that at one time or another, the cyprusite beds must have existed under the level of the sea.

The origin of the cyprusite is a subject of some difficulty, and lies, to a certain extent, within the realms of scientific speculation. Its chemical production, as well as its geological genesis, may, however, I believe, be explained theoretically by reference to the following considerations:—

It is well known that a solution of a ferrous sulphate, exposed to the air, undergoes oxidation. According to F. Muck,* in the earlier stages of the oxidation, the solution contains normal ferric sulphate $Fe_2O_3 . 3SO_3$, and even free sulphuric acid, but ultimately the basic salt $Fe_2O_3 . 2SO_3$ distinguished by its deep brown colour. At the same time the deposit becomes progressively richer in acid, without, however, attaining the composition $2Fe_2O_3 . 3SO_3$ assigned to it by Wittstein.†

The products of the oxidation vary with the continually changing composition of the solution, and cannot therefore be reduced to any simple expression. As a rule, ferric sulphates, occurring as natural products, are partly precipitates of this kind, and partly dried up mother-liquors.

The *tribasic ferric sulphate* $Fe_2O_3 . SO_3 = Fe_2(SO_4)_3\,2Fe_2O_3$ is produced artificially as a reddish yellow powder, containing about 3 at. water, by dissolving the basic double salts of potassic sulphate and sesquibasic ferric sulphate in water, and heating the solution (Soubeiran).

If potash or soda be added to a concentrated solution of ferric sulphate till the precipitate no longer redissolves, the filtered solu-

* Journ. Pr. Chem., xcix. p. 103; Jahresb. 1866, p. 241.
† Rep. Pharm. [3] i. p. 185.

tion yields by spontaneous evaporation olive green or *yellow six-sided tables* of the basic salt ($Fe_2O_3.2SO_3$) $2(K_2O.SO_3)$ $6H_2O$ (Maus).

It is also well known that ferric sulphate is easily formed by oxidation in the air of ferrous sulphate, and that this latter is frequently produced naturally from pyrites through the agency of air, light, heat, and moisture. While the oxidation of ferrous sulphate is in progress, ferric oxide is precipitated.

This ferric oxide is soluble in the simultaneously produced ferric sulphate, giving rise to a series of basic ferric sulphates which are more or less insoluble, and most of which have been but little and very imperfectly studied by chemists.

From what we have just stated, it is clear that, beginning with a solution of ferrous sulphate and submitting it to oxidation under varying circumstances, almost any of the possible basic ferric salts may be produced. If we begin with a lode of superficial deposit of iron pyrites, exposed to the action of air and moisture (preferably warm), and situated at such a distance from the sea and at such an altitude that the escaping drainage from the lode would have sufficient fall and sufficient distance to travel; or if it be collected into a pool or lake so as to allow its ferrous salts to be more or less perfectly converted by long exposure into ferric salts, we have all that is required to explain the formation of such a basic sulphate as that of the mineral cyprusite. It is true that the mineral contains sulphate of alumina, but I am inclined to consider this rather as an accidental admixture. Most of the surrounding rocks are highly aluminous,* and from the fact that on the ground, at a short distance from and lower down than these deposits of cyprusite, there occur great incrustations or efflorescences, as noticed by Dr. Reinsch and myself, of soluble sulphate of alumina, one can scarcely doubt that this soluble salt is being slowly dissolved out of the cyprusite deposit, leaving behind the insoluble tribasic ferric sulphate, admixed with organic silica. The further fact that various specimens of the cyprusite, analysed by Mr. Fulton, contained varying proportions of alumina and sulphuric acid confirms this. The sulphate of alumina probably at first came there by spontaneous evaporation of the mother-liquors after the upheaval of the bed, or the drying up of the stream or deposit in which it had collected.

We have therefore only to imagine at first a stream of water issuing or oozing from a pyrites lode, and carrying with it in solution the products of decomposition of the lode and its walls,

* An analysis of the compact dolerite or melaphyre, often altered into wake, of this region, gives 54·90 per cent. of silica, 26·19 per cent. of alumina, and 14·53 per cent. of peroxide of iron as its composition. The percentage of alumina is higher than in any other rock of this class known to me.

ferrous sulphate with aluminic sulphate. As the solution passed over the rocks, or lay exposed *in situ*, the ferrous sulphate would, under the actinic influence of warm sunshine, be more or less completely converted into ferric sulphate, depositing at the same time hydrated ferric oxide. This latter, acted upon by the mixed solution of ferrous and ferric sulphates, will readily form any or all of the possible basic ferric sulphates.

Looking at the cyprusite from a geogenetic aspect, we must admit that depression below the level of the sea and subsequent upheaval at a later period must have taken place to explain its present situation and its contained marine organic remains.

Possibly great fissures, corresponding to the position of the lodes, may have previously existed in the estuaries of streams or bottoms of small lakes or pools. These, for a long time, may have been inaccessible to the sea and to the marine polycistins (Radiolaria), and the ferrous and ferric sulphates may have been subjected to the reducing action of organic matter, restoring them to their original form, disulphide of iron, which would be deposited in the fissures. Once the fissures were so filled up, geological depressions may have admitted the sea with its living organisms, and thus entirely altered the conditions. The reducing agent being removed, the basic ferric sulphates would be deposited above the pyrites, and the polycistins, poisoned by the soluble salts of iron and alumina, would supply the existing organic silica.

The fact of the cyprusite occupying only the upper portion of the deposit is attributable to the fact that alteration of the lode had only progressed to a limited extent at the time of its submersion.

The formation contains tens of thousands of tons, and is certainly a very remarkable one in every respect. It seems unique of its kind in the world, and deserves a more complete study than I could bestow upon it in a flying mule-back visit to the Chrysophou district during the hottest and most trying period of the year, and while engaged on professional work.*

* I forward a few slides of cyprusite for the cabinet of the Society, prepared for microscopical examination, as well as some slides of the insoluble residue after treatment with acids, showing the polycistins; also some of the crude material as well as some of the organic silica washed out of it, for distribution to Fellows interested in this branch of research.

VI.—*List of Desmidieæ found in gatherings made in the neighbourhood of Lake Windermere during* 1883.

By J. P. Bisset.

(*Read 9th January*, 1884.)

Plate V. Figs. 4–7.

In April last Mr. James Bisset, of Yokohama, then temporarily residing at Bowness, sent the writer squeezings from marshy ground in the following localities, viz. :—Moor near the farm of Lindeth, Bowness, and on Brantfell; also from the neighbourhood of Claife Heights and Blea Tarn. These gatherings proved rich in *Desmidieæ*, producing among other interesting forms the beautiful *Micrasterias brachyptera* of Lundell, not previously recorded out of Sweden and Norway. The writer subsequently visited the same district, and made gatherings at Lindeth, through Easedale, and in the neighbourhood of Angle Tarn and Low Tarn. The following list gives the forms detected in the two sets of gatherings, and bears evidence that the English Lake District is likely to be found a very prolific field for these beautiful organisms.

Some particulars and figures are given of supposed new forms found in the gatherings, but which had previously been found in Scotland by the writer and his co-worker, Mr. John Roy, of Aberdeen.

The following authorities are quoted for forms named, or figured, since the publication of the last English work on *Desmidieæ*, viz. by Mr. Archer, in Pritchard's 'Infusoria.'

Archer, Dublin Nat. Hist. Rev. = W. Archer, Dublin Natural History Review 1859.

Archer, Dub. Mic. Club Proc. = W. Archer, Dublin Microscopical Club Proceedings, 1868.

De Not. Desm. Ital. = G. De Notaris, Elementi per lo Studio delle Desmidiacee Italiche. Genova, 1867.

Jacobsen, Desm. Dane. = M. J. P. Jacobsen, Aperçu Systématique et Critique sur les Desmidiacées du Danemark. Copenhagen, 1874.

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Nägeli, Gatt. einzell. Alg. = C. Nägeli, Gattungen einzelliger Algen. Zurich, 1849.

Nords. Desm. Spets. = O. Nordstedt, Desmidiaceæ ex insulis Spetsbergensibus et Beeren Eiland in expeditionibus 1868 et 1870 Suecanis collectæ. Stockholm, 1872.

Nords. Norges Desm. = O. Nordstedt, Bidrag till Kännedomen om Sydligare Norges Desmidiéer. Lund, 1873.

Nords. Desm. Arct. = O. Nordstedt, Desmidieæ Arctoæ. Stockholm, 1875.

Nords. Desm. Bras. = C. F. O. Nordstedt, 18 Fam. Desmidiaceæ, Symbolæ ad Floram Brasiliæ Centralis cognoscendam, edit. Eug. Warming. Kjöbenhavn, 1869.

Rabenh. Fl. Eur. Alg. = L. Rabenhorst, Flora Europæa Algarum aquæ dulcis et submarinæ, Sectio III. Lipsiæ, 1868.
Reinsch, Die Algenflora = Paul Reinsch, Die Algenflora des mittleren Theiles von Franken. Nürnberg, 1867.
Reinsch, Contributiones = P. F. Reinsch, Contributiones ad Algologiam et Fungologiam. Lipsiæ, 1875.
Wille, Fersk. Nova. Seml. = N. Wille, Ferskvandsalger fra Novaja Semlja samlede af Dr. F. Kjellman paa Nordenskiölds Expedition 1875. Stockholm, 1879.
Wille, Norges. Fersk. = N. Wille, Bidrag til Kundskaben om Norges Fersk-vandsalger. Christiania, 1880.
Wittrock, Om Gotlands = V. B. Wittrock, Om Gotlands och Ölands Sötvattens-alger. Stockholm, 1872.

DESMIDIEÆ Kütz.

MICRASTERIAS Ag.

1. *M. angulosa* Häntzch .. .. .. Lindeth and Low Tarn.
2. *M. denticulata* Bréb. .. .. Common.
3. *M. Thomasiana* Archer .. .. .. Lindeth.
4. *M. rotata* Grev. .. .. Ditto.
5. *M. brachyptera* Lundell (Desm. Suec. p. 12, t. i. fig. 4) .. .. Lindeth.
6. *M. papillifera* Bréb. .. .. Brantfell and Lindeth.
7. *M. Crux-Melitensis* Ehrb. .. .. .. Lindeth.
8. *M. pinnatifida* Kütz. .. .. Lindeth and Claife Heights.
9. *M. crenata* Bréb... .. .. Frequent.
10. *M. truncata* Corda .. .. Ditto.
11. *M. mucronata* Dixon .. .. Easedale and Angle Tarn.

EUASTRUM Ehrb.

1. *E. verrucosum* Ehrb. .. .. Brantfell and Lindeth.
2. *E. pectinatum* Bréb. .. .. Frequent.
3. *E. gemmatum* Bréb. .. .. Ditto.
4. *E. oblongum* Grev. .. .. Ditto.
5. *E. crassum* Bréb. .. .. Ditto.
6. *E. ventricosum* Lund. (Desm. Suec. p. 18, t. ii. fig. 2) .. .. Low Tarn.
7. *E. pinnatum* Ralfs .. .. Frequent.
8. *E. affine* Ralfs .. .. Low Tarn.
9. *E. ampullaceum* Ralfs.. .. .. .. Easedale.
10. *E. Didelta* Ralfs .. .. Frequent.
11. *E. cuneatum* Jenner .. .. Lindeth, Blea Tarn, and Easedale.
12. *E. ansatum* Ehrb. .. .. Frequent.
13. *E. sinuosum* Lenorm. (*E. circulare* β Ralfs) .. .. Low Tarn.
14. *E. insigne* Hass. .. .. Lindeth, Easedale, and Angle Tarn.
15. *E. rostratum* Ralfs .. .. Common.
16. *E. elegans* Bréb. .. .. Ditto.
17. *E. erosum* Lundell (Desm. Suec. p. 22, t. ii. fig. 6) .. .. Frequent.
18. *E. binale* Turp. .. .. Common.
19. *E. insulare* Wittrock (Om Gotlands, p. 49, t. iv. fig. 7) .. .. Lindeth and Angle Tarn.
20. *E. venustum* Bréb. .. .. Lindeth, Claife Heights, and Angle Tarn.

COSMARIUM Corda.

1. *C. margaritiferum* Turp. .. .. .. Frequent.
2. *C. reniforme* Ag... .. .. Brantfell, Lindeth, and Claife Heights.
3. *C. latum* Bréb. .. .. Ditto.

4. *C. conspersum* Ralfs .. .. Brantfell and Lindeth.
5. *C. Botrytis* Bory. .. .. Common.
6. *C. ochthodes* Nords. (Desm. Arct. p. 17, t. vi. fig. 3) .. .. Brantfell, Claife Heights, and Easedale.
7. *C. tetraophthalmum* Kütz. .. .. .. Common.
8. *C. Logiense* Bisset n.s. .. .. .. Blea Tarn, Ambleside, Easedale, and Angle Tarn.

Fig. 4.—Frond shaped as figured, sometimes with a wide and very shallow depression at the ends, deeply constricted and rough all over with small pearly granules. Length, 70–73 μ; breadth 47–50 μ; breadth of isthmus, 21-22 μ. Found previously on Deeside, and in Arran, Scotland.

9. *C. Brébissonii* Menegh. .. .. .. Lindeth, Claife Heights, and Easedale.
10. *C. ornatum* Ralfs .. .. Common.
11. *C. punctulatum* Bréb. .. .. Frequent.
12. *C. sportella* Bréb. .. .. Brantfell, Easedale, and Angle Tarn.
13. *C. speciosum* Lundell (Desm. Suec. p. 34, t. iii. fig. 5) .. .. Easedale and Angle Tarn.
14. *C. subspeciosum* Nords. (Desm. Arct. p. 22, t. vi. fig. 13) .. .. Lindeth.
15. *C. Kjellmani* Wille (Fersk. Nov. Seml. p. 42, t. xii. fig. 31) .. .. Ditto.
16. *C. monomazum* Lundell, var. β *polymazum* Nords. (Norges Desm. p. 14, fig. 3) .. .. Ditto.
17. *C. isthmochondrum* Nords. (Norges Desm. p. 12, fig. 2) .. .. Ditto.
18. *C. præmorsum* Bréb. (Liste, p. 128) .. Angle Tarn.
19. *C. cælatum* Ralfs .. .. Frequent.
20. *C. Boeckii* Wille (Norges Fersk. p. 28, t. i. fig. 10) .. .. Lindeth.
21. *C. crenatum* Ralfs .. .. Common.
22. *C. undulatum* Corda .. .. Lindeth, Claife Heights, and Low Tarn.
23. *C. Nymannianum* Grunow (in Rabenh. Fl. Eur. Alg. p. 166; Lundell, Desm. Suec. t. iii. fig. 1) .. .. Angle Tarn and Low Tarn.
24. *C. Phaseolus* Bréb. .. .. Frequent.
25. *C. pachydermum* Lundell, var. β *minus* Nords. (Norges Desm. p. 18, fig. 7) .. .. Common.
26. *C. homalodermum* Nords. (Desm. Arct. p. 18, t. vi. fig. 4) .. .. Brantfell and Lindeth.
27. *C. pyramidatum* Bréb. .. .. .. Common.
28. *C. pseudo-pyramidatum* Lundell (Desm. Suec. p. 41, t. ii. fig. 18) .. .. Lindeth and Low Tarn.
29. *C. variolatum* Lundell (Desm. Suec. p. 41, t. ii. fig. 19) .. .. Angle Tarn and Low Tarn.
30. *C. granatum* Bréb. .. .. Brantfell and Lindeth.
31. *C. tetragonum* Nägeli (Gatt. einzell. Alg. p. 119, t. vii. A, fig. 5) .. .. Ditto.
32. *C. pygmæum* Archer .. .. Frequent.
33. *C. Meneghinii* Bréb. .. .. Ditto.
34. *C. angulosum* Bréb. .. .. Ditto.
35. *C. bioculatum* Bréb. .. .. Ditto.
36. *C. Jacobsenii* Roy (*C. moniliferum* Jacobsen, Desm. Dane. p. 200, pl. viii. fig. 24) .. .. Brantfell and Claife Heights.
37. *C. connatum* Bréb. .. .. Brantfell, Lindeth, and Claife Heights.
38. *C. pseudo-connatum* Nords. (Desm. Bras. p. 214, t. iii. fig. 17) .. .. Brantfell and Lindeth.

39. *C. orbiculatum* Ralfs .. .. Frequent.
40. *C. Portianum* Archer.. .. .. .. Common.
41. *C. amœnum* Bréb. .. .. Ditto.
42. *C. annulatum* Näg. (Gatt. einzell. Alg. p. 111, t. vi. F.) .. .. Brantfell, Lindeth, and Easedale.
43. *C. Thwaitesii* Ralfs .. .. Frequent.
44. *C. quadratum* Ralfs .. .. Ditto.
45. *C. anceps* Lundell (Desm. Suec. p. 48, t. iii. fig. 4) .. .. Easedale.
46. *C. Holmiense*, var. *β integrum* Lundell (Desm. Suec. p. 49, t. ii. fig. 20) .. Lindeth.
47. *C. parvulum* Bréb. .. .. Blea Tarn, Easedale, and Angle Tarn.
48. *C. cucurbita* Bréb. .. .. Frequent.
49. *C. turgidum* Bréb. .. .. Lindeth.
50. *C. de Baryi* Archer .. .. Ditto.
51. *C. cucumis* Corda .. .. Common.
52. *C. Ralfsii* Bréb. .. .. Easedale.
53. *C. cyclicum* Lundell (Desm. Suec. p. 35, t. iii. fig. 6 *d*) .. .. .. Angle Tarn.

ARTHRODESMUS Ehrb.

1. *A. convergens* Ehrb. .. .. Frequent.
2. *A. Incus* Bréb. .. .. Ditto.
3. *A. octocornis* Ehrb. .. .. Ditto.

STAURASTRUM Meyen.

1. *S. muticum* Bréb. .. .. Common.
2. *S. orbiculare* Ehrb. .. .. Ditto.
3. *S. brevispina* Bréb. .. .. Brantfell and Lindeth.
4. *S. mucronatum* Ralfs .. .. Brantfell.
5. *S. dejectum* Bréb. .. .. Common.
6. *S. apiculatum* Bréb. .. .. Brantfell.
7. *S. cuspidatum* Bréb. .. .. Brantfell, Lindeth, and Claife Heights.
8. *S. Dickiei* Ralfs .. .. Brantfell, Claife Heights, and Easedale.
9. *S. pterosporum* Lundell (Desm. Suec. p. 60, t. iii. fig. 29).. .. .. .. Angle Tarn and Low Tarn.
10. *S. O'Mearii* Archer .. .. Brantfell.
11. *S. avicula* Bréb. .. .. Ditto.
12. *S. brachiatum* Ralfs .. .. Claife Heights.
13. *S. læve* Ralfs .. .. Claife Heights, Easedale, and Angle Tarn.
14. *S. levispinum* Bisset, n. s. .. .. .. Low Tarn.

Fig. 5.—*a*, front view; *b*, end view. Frond as figured. Length, 28–30 μ; breadth, 32–35 μ; breadth of constriction, 9 μ. First found in 1882 in Arran, Scotland.

15. *S. tricorne* Bréb... .. .. Brantfell and Lindeth.
16. *S. asperum* Bréb... .. .. Brantfell, Lindeth, and Easedale.
17. *S. Kjellmani* Wille (Fersk. Nova. Seml. p. 50, t. xiii. figs. 50–53) .. .. Blea Tarn, Easedale, and Angle Tarn.
18. *S. hirsutum* Ehrb. .. .. Brantfell, Blea Tarn, and Easedale.
19. *S. Pringsheimii* Reinsch (Die Algenflora, p. 172, t. x. fig. 4).. .. .. Lindeth.
20. *S. alternans* Bréb. .. .. Brantfell and Claife Heights.
21. *S. margaritaceum* Ehrb. .. .. .. Angle Tarn and Low Tarn.
22. *S. Brébissonii* Archer.. .. .. .. Lindeth and Low Tarn.
23. *S. teliferum* Ralfs .. .. Frequent.
24. *S. nitidum* Archer (Dublin Nat. Hist. Rev. p. 3, pl. i. figs. 3, 4) .. .. Lindeth.

25. *S. Meriani* Reinsch (Die Algenflora, p. 160, t. xii. fig. 1) .. .. .. Blea Tarn and Ambleside.
26. *S. capitulum* Bréb. forma *Spetsbergensis*, Nords. (Desm. Spets. p. 39, t. vii. fig. 25) .. .. Blea Tarn.
27. *S. monticulosum* Bréb. .. .. .. Brantfell, Lindeth, and Easedale.
28. *S. maamense* Archer (Dub. Mic. Club Proc. p. 282, vol. i. 1868); *S. pseudocrenatum* Lundell (Desm. Suec. p. 65, t. iv. fig. 4, 1871) .. .. Lindeth.
29. *S. furcatum* Ehrb. .. .. Blea Tarn and Low Tarn.
30. *S. inflexum* Bréb. .. .. Lindeth and Claife Heights.
31. *S. polymorphum* Bréb. .. .. .. Common.
32. *S. Reinschii* Roy ("St. spec." Reinsch, Contribut. p. 86, t. xvii. fig. 5) .. Blea Tarn and Angle Tarn.
33. *S. oxyacantha* Archer.. .. .. .. Lindeth.
34. *S. aculeatum* Ehrb. .. .. Frequent.
35. *S. vestitum* Ralfs.. .. .. Lindeth and Claife Heights.
36. *S. gracile* Ralfs .. .. Ditto.
37. *S. paradoxum* Meyen .. .. Lindeth, Claife Heights, and Low Tarn.
38. *S. tetracerum* Kütz. .. .. Brantfell, Lindeth, and Claife Heights.
39. *S. furcigerum* Bréb. .. .. Brantfell.
40. *S. tumidum* Bréb. .. .. Lindeth, Claife Heights, and Blea Tarn.

XANTHIDIUM Ehrb.

1. *X. aculeatum* Ehrb. .. .. Low Tarn.
2. *X. fasciculatum* Ehrb... .. .. Brantfell.
3. *X. antilopæum* Bréb. .. .. Lindeth, Claife Heights, and Low Tarn.
4. *X. cristatum* var. β *uncinatum* Bréb... Brantfell.
5. *X. Smithii* Archer .. .. Brantfell, Lindeth, and Easedale.
6. *X. armatum* Bréb. .. .. Common.

TETMEMORUS Ralfs.

1. *T. Brébissonii* Menegh. .. .. .. Common.
2. *T. granulatus* Bréb. .. .. Ditto.
3. *T. lævis* Kütz. .. .. Frequent.

CLOSTERIUM Nitzsch.

1. *C. didymotocum* Corda .. .. .. Frequent.
2. *C. striolatum* Ehrb. .. .. Ditto.
3. *C. intermedium* Ralfs... .. .. .. Brantfell, Lindeth, and Claife Heights.
4. *C. Cynthia* De Not. (Desm. Ital. p. 65, t. vii. fig. 71) .. .. Claife Heights.
5. *C. costatum* Corda .. .. Frequent.
6. *C. angustatum* Kütz. .. .. Lindeth and Low Tarn.
7. *C. juncidum* Ralfs .. .. Common. Forms α and β at Lindeth.
8. *C. Lunula* Müller .. .. Ditto.
9. *C. Ehrenbergii* Menegh. .. .. .. Brantfell.
10. *C. turgidum* Ehrb. .. .. Lindeth and Low Tarn.
11. *C. lineatum* Ehrb. .. .. Brantfell.
12. *C. attenuatum* Ehrb. .. .. Brantfell, Lindeth, and Low Tarn.
13. *C. Leiblcinii* Kütz. .. .. Common.
14. *C. Dianæ* Ehrb. .. .. Frequent.
15. *C. Jenneri* Ralfs .. .. Brantfell, Lindeth, and Easedale.
16. *C. rostratum* Ehrb. .. .. Brantfell, Lindeth, and Low Tarn.
17. *C. setaceum* Ehrb. .. .. Brantfell, Lindeth, and Claife Heights.
18. *C. acutum* Lyngb. .. .. Common.

CYLINDROCYSTIS Menegh.

1. *C. Brébissonii* Menegh. .. .. .. Frequent.
2. *C. diplospora* Lundell (Desm. Suec. p. 83, t. v. fig. 7) .. .. Brantfell and Claife Heights.

PENIUM Bréb.

1. *P. Digitus* Ehrb... .. .. Common.
2. *P. lamellosum* Bréb. .. .. Brantfell and Lindeth.
3. *P. interruptum* Bréb. .. .. Frequent.
4. *P. closterioides* Ralfs .. .. Ditto.
5. *P. Navicula* Bréb. .. .. Ditto.
6. *P. margaritaceum* Ehrb. .. .. .. Brantfell, Lindeth, and Claife Heights.
7. *P. cylindrus* Ehrb. .. .. Lindeth.
8. *P. polymorphum* Perty .. .. .. Common.
9. *P. minutum* (*Docidium minutum*) Ralfs Ditto.
10. *P. lagenaroides* Roy n. s. .. .. .. Brantfell, Lindeth, and Claife Heights.

    Fig. 6.—Frond shaped as figured. Endochrome in well-marked fillets, five of which are generally seen in front view. Membrane rather sparsely punctate. Length, 95 μ; breadth, 45 μ. Previously found on Deeside and in Arran, Scotland.

11. *P. cucurbitinum* Bisset n. s. .. .. Lindeth and Blea Tarn.

    Fig. 7.—Frond shaped as figured. Endochrome in fillets, three of which are usually seen in front view. Membrane sparsely punctate. Length, 85–90 μ; breadth, 32–35 μ. This form is not uncommon on Deeside, Scotland.

DOCIDIUM Bréb.

1. *D. Baculum* Bréb. .. .. Lindeth and Claife Heights.

PLEUROTÆNIUM Näg.

1. *P. Trabecula* Ehrb. .. .. Frequent.
2. *P. clavatum* Kütz. .. .. Brantfell and Lindeth.
3. *P. truncatum* Bréb. .. .. Brantfell.
4. *P. nodulosum* Bréb. .. .. Ditto.

SPIROTÆNIA Bréb.

1. *S. condensata* Bréb. .. .. Frequent.
2. *S. obscura* Ralfs .. .. Brantfell and Easedale.
3. *S. parvula* Archer .. .. Lindeth.

SPHÆROZOSMA Corda.

1. *S. excavatum* Ralfs .. .. Frequent.

HYALOTHECA Ehrb.

1. *H. dissiliens* Smith .. .. Common.

BAMBUSINA Kütz.

1. *B. Brébissonii* Kütz. .. .. Common.

DESMIDIUM Ag.

1. *D. Swartzii* Ag. .. .. Brantfell, Lindeth, and Claife Heights.
2. *D. aptogonum* Bréb. .. .. Brantfell and Lindeth.

GONATOZYGON De Bary.

1. *G. Ralfsii* De Bary .. .. Brantfell.
2. *G. Brébissonii* De Bary .. .. .. Brantfell, Lindeth, and Claife Heights.

VII.—*On the Formation and Growth of Cells in the Genus Polysiphonia.*

By George Massee, F.R.M.S.

(*Read 12th March*, 1884.)

Plate VI.

If the growing point of *Polysiphonia* is examined under a low power, a plano-convex apical cell containing a nucleus is seen, the convex side being uppermost; below this—depending on the rate of segmentation of the apical cell—from two to four thin disk-like segments are superposed; further away from the growing point, as the segments increase in breadth, each is seen to be surrounded by a row of cortical cells, the so-called "siphons," these latter appearing to be absent from the youngest segments lying immediately below the apical cell.

EXPLANATION OF PLATE VI.

Fig. 1.—Portions from growing point of *Polysiphonia urceolata*, showing the protoplasmic threads connecting superposed segments. The cell-walls have been removed. ×750 diam.

Fig. 2.—Transverse section through the stem of *P. urceolata* at the point where the protoplasm of the cortical cells is continuous with the protoplasm of the axial cell. ×500 diam.

Fig. 3.—Diagrammatic representation of the protoplasmic portion of the growing point of *P. urceolata*.

Fig. 4.—Transverse section through the stem of *P. fastigiata* at the point where the axial cell is connected with the cortical cells; *a*, tetragonidium; *b*, two cortical cells produced from the tetragonidium by gemmation. The cell-walls have been removed. ×500 diam.

Fig. 5.—Vertical section through the growing point of *P. urceolata*, showing the ingrowth, by degrees, of the transverse walls. The protoplasm has been removed. ×750 diam.

Fig. 6.—Perforated plates of cellulose removed from the openings left in the transverse septa of the axial row of cells in *P. fastigiata*. ×1000 diam.

Fig. 7.—Portion of axial cell of *P. fastigiata*, showing the perforation through the transverse wall at *a*, from which a perforated disk of cellulose similar to fig. 6 has been removed; *b*, minute holes in the cell-wall, through which protoplasmic threads pass from the axial to the cortical cells, as shown in figs. 8 and 9.

Fig. 8.—Transverse section through an axial cell of *P. fastigiata* at the point where the protoplasm is giving off rays, *a*, to the cortical cells. The cell-wall is thickened and stratified. ×750.

Fig. 9.—Vertical section of axial cell of *P. fastigiata*, showing stratified cell-wall and protoplasm giving off rays, *a*, to cortical cells. ×750.

Fig. 10.—Vertical section through a branch of *P. urceolata* a short distance from the apex; the cells have grown considerably in a radial direction, but very little vertically. ×750.

Fig. 11.—Vertical section through a branch of *P. urceolata* at some distance from the apex, showing vertical growth of cells. ×750.

Fig. 12.—Axial cells from *P. fastigiata* close behind the apical cell, showing the origin of cortical cells by gemmation. ×1000.

Fig. 13.—Young tetragonidia from *P. fastigiata*. ×1000.

Fig. 14.—Growing points of *P. fastigiata*, showing method of segmentation of apical cell for formation of a dichotomy.

To understand clearly the structure of the growing point, it is necessary to examine specimens from which the cell-walls have been removed: this can be accomplished by soaking for several hours in a solution of nitro-picric acid. If this material is stained and examined under a high power, it will be seen that the protoplasm of each cell is in perfect continuity with the next above and below, being connected by a narrow neck of protoplasm. In addition to this central string, which is comparatively thick and strong, much finer threads may sometimes be seen springing from one of the masses of protoplasm just within its margin, and joining on to the next mass in the same position.

These marginal strings were for some time a source of much perplexity, as owing to their extreme tenuity they rarely survived, unbroken, the treatment necessary for the removal of the cell-walls, and, if broken, the protoplasm contracts so much, that not a trace of the torn ends remain. (Pl. VI. fig. 1.)

If a small amount of pressure, combined with a rotatory movement, be applied to the thin glass cover protecting the specimen under examination, the segments of some of the growing points will be separated from each other. Examined in detail, these segments in *Polysiphonia urceolata* present the following appearance. The first below the apical cell resembles a thin circular disk with an unbroken margin; the second working backwards from the apex is slightly thicker than the preceding, and the margin has four notches at equal distances; these notches, in the third segment, reach about half-way from the centre to the circumference of the disk, which thus presents the appearance of a Maltese cross; in the segments further back, the four lobes are more or less quadrate in form, and each is joined to the central mass of the segment by a narrow neck of protoplasm (fig. 2). The central mass of the segment developes into the axial cell of one joint of the stem, and the four outgrowths form the four cortical cells. The slender threads, alluded to as springing from near the margin of the disk, are in *P. urceolata* four in number, and unite the superposed cortical cells of adjoining segments. The cortical cells are thus connected with each other by vertical protoplasmic threads, each one again communicating with the axial cell by a horizontal thread, while the axial cells, as already shown, are connected by vertical threads (fig. 3). This mode of formation of the cortical cells, as also their connection with each other and with the axial cell, is the same in all the species of *Polysiphonia* that I have had an opportunity of examining.

The tetragonidia originate in precisely the same way as the cortical cells; in *Polysiphonia fastigiata* they occupy a space equal to two of the latter, from which they are readily distinguished, even in the earliest stages of development, by their more spherical form, and by the presence of two prominences on the peripheral margin, which

develope into cortical cells (fig. 4); thus the tetragonidia are imbedded in the substance of the thallus, being in communication, by means of a neck of protoplasm, with their mother-cell on the axial side, and with the two cortical cells on their peripheral side, these last being daughter-cells of the tetragonidium. These outgrowths from the tetragonidia originate by the method of cell-division known as gemmation, appearing as minute papillæ, which increase in size and become constricted at the point of attachment with the mother cell. The cortical cells and tetragonidia that originate from an axial cell are also the results of gemmation. It will thus be seen that the increase in size of a *Polysiphonia* is the result of two distinct methods of cell-formation; the axial row of cells, by which the plant increases in length, being the result of fission or segmentation of the apical cell, whereas all increase in thickness is due to gemmation from the axial cells. The manner in which the continuity of protoplasm between adjacent cells is kept up varies with the age of the cells. When a segment is cut off from the apical cell, the partition wall is formed gradually (fig. 5), but before reaching the centre its growth ceases, so that a circular opening is left through which the contracted neck of protoplasm passes unbroken. This opening increases in size with the growth of the cell, being much larger in old than in young cells. After the openings have reached a certain size, they are closed by the growth of a cellulose plate, to the margin of which the protoplasmic sac or "primordial utricle" is attached; this plate is perforated with minute holes through which slender threads of protoplasm pass. The attachment of this plate to the margin of the original large opening is not very firm and it can be readily removed, when it presents the appearance of a flat or convex disk (fig. 6).

The first increase in size of the cells is in a radial direction, the stem attaining its full thickness at a short distance behind the growing point (fig. 10); afterwards the cells rapidly increase in length by acropetal and basipetal growth, the rate of each being shown by the relative length of the cell above and below the neck of protoplasm connecting it with the axial cell, which may be looked upon as a fixed point (fig. 11). After the cell has reached its full development, the protoplasm disappears, leaving the empty contracted protoplasmic sac; the cell-wall at the same time increases in thickness, stratification being in most species very distinct (figs. 8, 9).

The method of branching is dichotomous, segments being cut off from the apical cell by inclined septa (fig. 14), the axis of growth of the branch being at right angles to the septum which cuts off the first cell of the branch from the apical cell.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Development of the Optic and Olfactory Organs of Human Embryos.†—A. Kölliker has had the opportunity of examining four human embryos, the smallest and youngest of which was 8 mm. long and 4 weeks old, the largest and oldest 21 mm. and 8–9 weeks. The earliest had the lens-pit still open, and the two layers of the secondary optic vesicles were not fused; the proximal of these layers consisted of at least two layers of cells, and showed in its anterior two-thirds fine, round, and proportionately large pigment-granules, and there was a double limiting membrane; the distal or retinal layer consisted of subequal elongated cells, arranged in from four to six layers, its limiting membrane passed directly into the upper of the above-mentioned limiting membranes of the pigment-layer. The lens appeared to consist of two or three layers of elongated cells, while the epidermis was uni-laminate. The vitreous body had the appearance of a well-developed transparent layer richly provided with cells; these were all stellate or spindle-shaped. Sections of the hinder regions showed that the choroidal fissure advanced from below and forwards.

In the next embryo the lens was constricted off, though in size that embryo was only 8·5 mm. long; in some points it showed an advance, and in others it lagged behind the rather smaller embryo, so that it seems that the early developmental stages of the eye vary somewhat in rapidity. After describing the characters of this rudimentary organ the author gives a very useful enumeration of the seven well-observed cases of eyes in embryos not exceeding 8·5 mm.; he then passes to the third embryo, in which the lens-substance is

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Verh. Phys.-med. Gesell. Würzburg, xvii. (1883) pp. 229–57 (4 pls.).

beginning to be developed; it presents a stage in formation which has never yet been recorded. The distal layer of the optic cup now exhibits the first indications of striation, and an inner thinner layer of cells with more rounded nuclei may be distinguished from an outer thicker one in which the nuclei are more elongated; between them lies a clearer zone, poor in cells. The primitive optic nerve is still hollow, though signs of closure are very apparent; it consists partly of the primitive elements of the medullary plate, and partly of very fine longitudinal fibrils which are superficial in position, and extend through the whole length of the nerve. The pigment-layer was intensely brown, and in its thinnest part consisted of two layers of cells. The lens presented the condition in which the lens-fibres had begun to be formed from the cells of the hinder wall of the primitive vesicular rudiment; the capsule was very distinct, and of the same thickness throughout. A distinct cornea was already present, and, in nature, clearly stands in direct contact with the lens-capsule. The mesodermal tissue around the eye was thickened, but was not yet marked off externally.

The oldest embryo had a spherical lens, the anterior aqueous chamber, and eyelids; the optic nerve exhibited no sign of any cavity, and consisted only of the network of stellate cells derived from the primitive nerve, and very fine non-nucleated optic fibrils; the lens had lost all cavity within, the retina consisted anteriorly of elongated cells, and here and there zones poor in or free of nuclei could be made out. The uvea and sclerotic were not yet distinctly differentiated, but formed only a somewhat thick tissue around the eye. The cornea was remarkably delicate. There were no signs of lachrymal glands, but the ducts and canaliculi were well developed.

In the youngest embryo the uppermost end of the olfactory pit formed already a blind sac, the true olfactory blind-sac, which becomes later on the uppermost part of the olfactory region; in the oldest, the olfactory pits were connected with the primitive buccal cavity by ducts—nasal ducts, the labial and mandibular clefts were seen to be closed, but the palatal cleft was still open. A study of this specimen shows that the network of stellate cells of the olfactory lobe is converted, either partially or completely, into a nucleated network of fine bundles of the finest olfactory fibrils; that the network of cells grow out from the olfactory lobe either before or simultaneously with its conversion into fibrils; it gives rise to buds of cells which project into the mucous membrane of the nose, while behind these buds it continues to be converted into a fibrillar network. The nucleated fibrillar bundles found in the embryo are the predecessors of the nucleated pale olfactory fibres of the adult. If this description is exact it will follow that the fibres of the olfactory nerve are comparable to the axis-cylinders of other nerves, and their nuclei to the nuclei of nerve-cells. For man, as for other forms, embryology shows that the olfactory lobe is a part of the brain, that the point of origin of the nerves is to be found in the primitive olfactory lobes, that the nerves grow out from the lobes, or from parts derived therefrom, and that the olfactory tract and radices are secondary commissural

systems which connect the bulbs with the more distant parts of the brain, and, partly also, with one another.

From the rich possession of nerves by Jacobson's organ in an eight-week old embryo, and their disappearance in older embryos, we may conclude that the organ is now in a rudimentary condition, as compared with what it was in ancestral forms.

Eggs of Birds.*—Prof. Tarkhanoff records a very interesting inquiry into the structure of the eggs of birds.

He finds that albumen of the eggs of the Insessores (ousel, canary, pigeon, &c.) notably differs from that of the autophagous birds (hens, ducks, geese, turkeys). When boiled it remains translucid; it is fluorescent; its rotation-power on the plane of polarization is feebler; when diluted with much water it does not give a white deposit, but only gives a feeble opalescent coloration to the water; finally it has a stronger basic reaction than the white of the eggs of the hen. It may, however, be transformed so as to become like it by various means, namely, the addition of neutral salts, or of bases, or of concentrated acetic and lactic acids, or even of carbonic acid. The most remarkable fact, however, is that the same result is also arrived at by incubation, and Prof. Tarkhanoff considers that the modifying agency in this case is the yolk; when moderately heated with yolk in closed vessels, during twenty-four hours or more, it is transformed into albumen like that of a hen's egg. As to the manner in which the yolk acts on it, it still remains unsettled; the supposition that the diffusion of salts is the cause of the change proved not to be true; and the cause must be searched for perhaps in the diffusion of gases. The interesting question, as to the albumen of hens' eggs not also undergoing the same stages of development within the ovarium, cannot yet be solved satisfactorily; but during his experiences M. Tarkhanoff observed once the most interesting fact that a small ball of amber introduced into the upper part of the ovarium occasioned the deposition of albumen around the ball, and the formation of a shell, that is, the formation of a quite normal egg with its chalazæ, and other particulars of structure. This observation would thus strongly support the mechanical theory of the formation of the parts of an egg around its yolk.

Chemical Composition of the Egg and its Envelopes in the Common Frog.†—P. Giacosa, to isolate the envelope, placed the eggs for some hours in lime water, whereupon the envelope dissolved while the yolk settled down to the bottom. The filtered solution, treated with acetic acid of 10 per cent., yielded a flocculent precipitate, which, after repeated washing with acetic acid and pure water, gave by analysis 52·71 per cent. C., 7·1 H., 9·33 N., 1·32 S., and 0·42 ash, whence the author infers the presence of a mucin. This substance resists putrefaction, and does not reduce copper salts till after boiling with dilute sulphuric acid. The author intends to study the products of this decomposition, but as he has not been able to detect the

* Mém. Soc. Nat. St. Petersburg, xiii. (1883). See Nature, xxix. (1884) p. 461.
† Journ. Chem. Soc.—Abstr., xlvi. (1884) pp. 198–9, from Gazetta, xiii. p. 171.

presence of any other bodies, he concludes that the enveloping membrane of frogs' eggs consists of pure mucin. From the oviduct of the frog he also succeeded in extracting a mucin, which though differing from the preceding in centesimal composition, nevertheless agrees with it in all other characters.

Zoonerythrine and other Animal Pigments.*—C. de Mereschkowsky gives the results of recent researches on zoonerythrine and other animal pigments. A list of the species in which that naturalist has noted the presence of zoonerythrine includes several members of each of the following, Cœlenterata, Echinodermata, Vermes, Crustacea, Bryozoa, Tunicata, Mollusca, and Pisces, in all 117 species. Zoonerythrine is usually found in the superficial layer, but in some species it occurs in the muscular tissue. Various phanerogamous and cryptogamous plants also contain it. Numerous other pigments are enumerated. One group of these is characterized by the ease with which they can be transformed into zoonerythrine under the influence of certain chemical or physical conditions, such as elevation to the boiling-point, or the addition of a drop of acid; while another group is characterized by the impossibility of transforming them into zoonerythrine.

Commensalism between a Fish and a Medusa.†—Referring to G. Lunel's paper ‡ on the union of *Caranx* and *Crambessa*, in which he speaks of the commensalism of fishes and Medusæ as something doubtful and unknown, W. Macleay points out that the fact was well known to the Commissioners on the Fisheries of New South Wales, who in their report written nearly four years ago, alluding to the Yellow-tail, *Trachurus trachurus*, say :—"The very young fry have a most extraordinary and ingenious way of providing for their safety and nutrition at the same time; they take up their quarters inside the umbrella of the large Medusæ, where they are safe from their enemies, and are, without any exertion on their part, supplied with the minute organisms which constitute their food, by the constant current kept up by the action of the curtain-like cilia of the animal."

B. INVERTEBRATA.

Annelid Commensal with a Coral.§—J. W. Fewkes records the fact of an annelid commensal with the coral *Mycedium fragile*. The worm occupies a calcareous tube, which, for the greater part of its length, is firmly fixed to the lower side of the coral. In a normal coral colony, the tube opens near the edge of the cupuliform disk of the young coral; the growth of the edge imprisons the worm-tube which, in time, becomes completely surrounded by the living coral. The worm and its tube grow also, and as the tube remains free at its orifice, the worm within is in free communication with the surrounding

* Bull. Soc. Zool. France, viii. (1883) pp. 81–97. Cf. Amer. Natural., xvii. (1883) pp. 1301–2.

† Abstr. Proc. Linn. Soc. N. S. Wales, 27th December, 1883, p. iii.

‡ See this Journal, *ante*, p. 35.

§ Amer. Natural., xvii. (1883) pp. 595–7.

medium. Sometimes the coral covers in the mouth of the tube, and then the worm perishes: this, however, seems to happen very rarely. The presence of the worm causes an abnormality in the form of the coral, which, when alone, retains throughout life the discoid form of the young. *Porites* is another example of a coral with which worms live and its interior may be often seen to be perforated with worm-tubes.

Mollusca.

General Account of the Mollusca.*—E. Ray Lankester has an exhaustive article on the Mollusca, which he arranges as follows:—

Phylum Mollusca.

Branch A. Glossophora.
Class 1. Gastropoda.
Br. *a*. Isopleura,
e. g. Chiton, Neomenia.
Br. *b*. Anisopleura,
e. g. Limpet, Whelk, Snail, Slug.
Class 2. Scaphopoda, e. g. Tooth-shell.
Class 3. Cephalopoda.
Br. *a*. Pteropoda, e. g. Hyalæa, Pneumodermon.
Br. *b*. Siphonopoda, e. g. Nautilus, Cuttles, Poulp.

Branch B. Lipocephala.
Class 1. Lamellibranchia.
e. g. Oyster, Mussel, Clam, Cockle.

After a general account of the Mollusca as a phylum of the Cœlomata, the author describes a "schematic mollusc"; it has a head on which are placed a pair of short cephalic tentacles; the apertures of a pair of nephridia are seen to the right and left of the anus; the most characteristic organ is the foot (*podium*) which is probably genetically connected with the muscular ventral surface of the Planarians, and with the suckers of Trematoda. On the dorsal surface is the visceral hump or dome, protected by a shell, which is single, cap-shaped and symmetrical; the integument of the visceral dome forms a primary shell-sac or follicle. The wall of the body forms a flap or skirt—this is the mantle. Underlying this are the ctenidia or gill-combs, to which it is well to give a non-physiological name. Near the base of the stem of each ctenidium is a peculiar patch of modified epithelium, which tests the respiratory fluid and is persistent in its position and nerve-supply throughout the Mollusca; it is the olfactory organ of Spengel and may be definitely known as the *osphradium*. The term "gonad" is applied to the ovaries or spermaries, and it is pointed out that, at present, we cannot say whether the gonad was primitively median, or paired. The disposition of the nerve-cord is highly characteristic. A general sketch of the phenomena of development follows.

The systematic review commences with pointing out the importance from a classificatory point of view of the radula. The Isopleura are divided into the Polyplacophora (Chitons), Neomeniæ, and Chætoderma; the two latter must be associated with the Chitons now that

* Ency. Brit., xvi. (1883) pp. 632–95 (152 figs.).

Hubrecht has discovered that *Proneomenia* has a radula and odontophore. In the division of the Anisopleura, Spengel's group of Streptoneura, or those in which the nerve-cords share in the torsion of the body, is adopted, and it is divided into the Zygobranchia, in which the organs of the left side do not undergo atrophy—such are the limpet (with regard to whose anatomy much information is given), *Haliotis*, and *Fissurella ;* the second order is that of the Azygobranchia in which the left ctenidium and nephridium are atrophied; they are either creeping forms (Reptantia) like *Turbo*, *Turritella*, *Cyclostoma*, *Dolium*, *Conus*, and *Buccinum*, or Natantia like *Atlanta* and *Pterotrachea*. Spengel's name of Euthyneura is also adopted for those Anisopleura in which the tension of the visceral hump does not affect the nerve-cords; here we have the Opisthobranchia and the Pulmonata.

Although the different members of the group of the Cephalopoda differ very greatly among themselves, they are all characterized by the "encroachment of the fore-foot so as to surround the head, and by the functionally important bilobation of the mid-foot. Following the example of his predecessor (Owen) Lankester enters into great detail as to the structure of the Pearly Nautilus.

Various observations of general interest occur throughout the article; the most important is perhaps the description of the nature of the so-called proboscids; the different forms are described and supplied with characteristic designations; indeed the whole essay teems with suggestions of new terms.

It will be noticed that the author now removes the Polyzoa and Brachiopoda from the Mollusca, being led especially by the observations of Caldwell on *Phoronis* to think that the supposed agreement of structure is delusive.

Intertropical Deep-Sea Mollusca.*—P. Fischer, working at the collections lately made by the 'Talisman,' finds Arctic molluscs at great depths in the intertropical regions of the Atlantic, and points out that the difference between the superficial and the deep fauna is such that the genera are different, that their reciprocal associations have no relation, and that if the remains of these faunæ, although contemporaneous, were to be fossilized, we should say that they belonged to different epochs or represented the population of two distinct seas. With the northern species are found forms that are unknown at present in the northern seas.

As Lovén suspected would be the case, it was found that the bathymetrical limits of the northern forms increased as the equator was approached, and it would appear, therefore, that the temperature of the water has more to do with the distribution of marine animals than the intensity of light.

A number of forms hitherto supposed to be peculiar to the Mediterranean, were found off the coast of Africa; and we may conclude that the number of species confined to that sea are small.

The great depths of Antarctic seas must now be investigated.

* Comptes Rendus, xcvii. (1883) pp. 1497–9.

New Cephalopoda.*—A. E. Verrill, in a supplement to his 'Blake Report' describes, among others, the representatives of two new genera. *Nectoteuthis* is allied to *Stoloteuthis*, but he weakens the effect of his discovery by remarking that "some of the peculiar features of the arms and suckers may be only sexual." *Opisthoteuthis* is most remarkable for the posterior opening of the siphon and branchiæ, which is in correlation with the union of the head and body with the brachial membrane. Both of these new genera are founded on single specimens, and in neither case was the sex of the individual absolutely certain.

Two new species of *Octopus*, *O. punctatus* and *O. bimaculatus*, are described in a succeeding communication; with regard to the former the observations of Mr. Dall are of great interest. "When angry, the horn over the eye is erected, the arms coil together, the eye dilates, and the body quivers with rage. The muscles keep up a squirming motion, but I have never seen any approach to the dark colour figured by Chenu as characteristic of the angry *Octopus vulgaris* of the Mediterranean, nor any such elevated longitudinal ridges. The suckers project or are retracted according to the mood of the animal; their outer edge expands when about to seize hold, and contracts after getting hold of anything. . . . It never willingly turns its mouth up, and when forced to do so clenches its arms, like a fist, over it. With death comes flaccidity and flattening. One with a body 8 in. in diameter had the arms 16 ft. long. They shrank much in alcohol." The second species, as represented by its largest known male, has the dorsal arms 325 and 390 mm. long from the mouth; the second pair 540 and 450 mm.; the ventral arms 500 and 490 mm. The diameter of the larger suckers of the lateral arms was 11 to 14 mm.; the body was 70 mm. long, and where broadest, 75 mm.

Operculum of Gasteropoda.†—M. Houssay has investigated the question as to what part of the foot of gasteropods excretes the substance of the operculum, and how the growth of that organ is effected. The term *columellar border* is applied to that portion of the operculum which is found near the columella of the shell, and that of *parietal border* to the opposite edge. The internal and external surfaces of the operculum are not formed in the same way. In the latter there is a small transverse cleft, the walls of which are lined by a special epithelial layer, which soon dries in air and becomes of a horny consistency. The cells of the layer secrete a structureless material which gives rise to a hyaline membrane; this escapes by the cleft and becomes added on to the operculum; as these are successively laid down the outer face of the operculum is striated. The inner surface is clothed by an apparently homogeneous layer. The spiral form of the operculum seems to be due to the slight rotation to which it is subjected as the shell grows, and the consequent alteration in position of the columellar muscle. The organ in question is produced by a part only of the epithelium of the foot, and, while it has

* Bull. Mus. Comp. Zool., xi. (1883) pp. 105–24 (6 pls.).
† Comptes Rendus, xcviii. (1884) pp. 236–8.

apparently no relations to the byssus, it is still more different from the second valve of a Lamellibranch shell.

Anatomy of the Stylommatophora.*—A. Nalepa has been chiefly engaged with *Zonites algirus*, but has also investigated *Limax cinereoniger*, and *Helix pomatia*. The large mucous glands which are so often enormously developed in the integument of land pulmonates are proportionately only feebly developed in, and are indeed absent from parts of the skin of *Zonites*. Transverse sections of the edge of the mantle of *Helix* show conclusively that the *tunica propria* of the mucous glands is continued between the epithelial cells. *Zonites* has no winter operculum, and the absence of this may explain the rare presence of calcareous glands. The author thinks that Simroth's criticism of the supposed olfactory function of the foot-gland is justified by its structure, for maceration shows that it is an agglomeration of unicellular glands. As to the nervous system of the foot, it is to be noted that there are not two primary trunks, inasmuch as the diameter of what have been so regarded is often surpassed by that of their lateral branches.

The different reports that have been made on the distribution of a ciliated epithelium in the enteric canal, are partly, at any rate, to be explained by such facts as that the whole stomach is ciliated in very young Helices, while, in the adult, wide tracts are devoid of cilia. The salivary glands of *Helix* are loose, but in *Limax* and *Zonites* compact masses, which in the former lie like a saddle on the short œsophagus, and in the latter form a pretty broad closed ring; they are made up of a number of unicellular glands, and each cell is surrounded by a membrane of connective tissue, which, at its side, is continued into a narrow and generally very long efferent duct. The cells have either finely granular or hyaline contents, and have a different reaction with osmic acid. Each salivary gland receives a strong nerve from the buccal ganglion, and there is a general distribution of the large ganglionic cells, which are characteristic of the sympathetic system.

The arteries are continued into capillaries with definite walls, lined by a distinct endothelium, but the veins are more lacunar in character, and endothelial cells are absent from their walls. The characters of the circulatory system are described in detail, and attention directed to the discussion as to the closed or lacunar condition of the vascular system of Molluscs. It is believed that the differences in the results obtained depend not only on the imperfection of certain methods of investigation, but also on the vagueness of the ideas of some as to what is meant by a lacuna and a sinus. Although the arteries end in vessels which are comparable to the capillaries of vertebrates, they do not enter into a continuous connection with venous vessels of similar histological constitution; are the continuations lacunæ (or sinuses), or are they modified capillaries? If by "lacunæ" we mean spaces which, in a histological sense, have no wall, then there are lacunæ; but if by the expression we mean to

* SB. K. Akad. Wiss. Wien, lxxxvii. (1883) pp. 237–301 (3 pls.).

speak of wide-branched cavities in the tissues, the walls of which are merely formed by connective substance, and which have been individualized and made independent of the tissues of the organs, then there are not here lacunæ.

In addition to the contractions of the heart, the author has observed rhythmical contractions in the pulmonary vein and its branches. The ventricle is expressly stated to be innervated from a nerve-plexus, which supplies also the aorta, while the auricle appears to be innervated by a pulmonary nerve; after great trouble Nalepa was able to demonstrate nerves in the musculature of the auricle.

After some account of the lung, attention is directed to the kidney, and it is shown that Meckel was in error in supposing that there was a true cameration of the organ, and that the chambers communicated by lateral orifices with the ureter; it seems rather that folds project from its upper and lower walls, but that there is a common central cavity, which, at the tip of the kidney, communicates with the ureter. The lamellæ are ordinarily largely connected by transverse folds, and the spaces thus formed are lined by a secretory epithelium; the uric acid excreted appears to be partly free and partly united with other bodies to form guanin.

The penis of *Zonites* and *Limax* is distinguished from that of *Helix* by the absence of a flagellum; and there are certain differences in the vascular supply. The papillæ of stimulation found in the penis of *Zoonites* consist largely of cells of connective substance, imbedded in intercellular substance, and bounded by the epithelium of the inner surface of the penis. The organ is richly supplied with nerves, as may be well seen in chloride of gold preparations of *Limax;* the ganglionic cells are arranged in groups, are rounded, and have very large nuclei. A glandular mass in the wall of the vagina of *Zonites* corresponds to the digitated mucous glands of the Helicidæ; it consists of tubular follicles which open separately into the vagina, and are lined by a high glandular epithelium. With these the follicles of the bursa copulatoria agree in structure and form.

Segmental Organs and Podocyst of Embryonic Limacinæ.*—S. Jourdain finds that at the time of the formation of the stomodæal invagination, there appears on either side a *labio-tentacular* thickening, placed in front of the pallial plate. There is a prepallial swelling formed of a central nucleus of granular matter, which the author regards as true post-embryonic yolk-material, destined to make up for the insufficient quantity of primitive yolk. The segmental organ is paired, and is siphonate in shape, the convexity being superior or dorsal; it consists of a membrane lined by polygonal cells with a large granular nucleus, and with very fine cilia; the external orifice is funnel-shaped. It has no relation to the permanent kidney, which is developed independently. The fate of the segmental organ, no vestiges of which are to be found in the adult, has not been determined. The term "podocyst" is applied to the contractile appendage of the hinder part of the mouth, which is either short, as in *Limax agrestis*, or elongated

* Comptes Rendus, xcviii. (1884) pp. 308–10.

and spiral, as in *Arion rufus*. Its walls are formed by a layer of mesodermal cells with a large nucleus, surrounded by a contractile irregularly stellate protoplasm, the branching processes of which unite with one another. Externally to this layer is a finely ciliated ectoderm; the contained cavity, which exhibits diastole and systole, communicates with the body-cavity, and receives from it and returns to it fluid. Shortly before the young slug leaves the egg the podocyst is completely absorbed. In considering the function of this embryonic organ, we have to note that it is in direct contact with the inner surface of the shell, so that it occupies a very favourable position for the exchange of the necessary gases between the blood and the surrounding air; on the other hand, it is in direct relation to the reserve of material which is used up by the embryo. From a physiological point of view, then, it seems to be comparable to the allantois of the higher Vertebrata.

There does not appear to be any good reason for thinking that the prepallial swelling is a contractile sac, which acts antagonistically to the podocyst; all the mesodermal tissues alike distend when the podocyst contracts, and it is only in consequence of the looser texture of the swelling that its movements of dilatation and contraction are more marked and more easily visible.

Spicula Amoris of British Helices.*—C. Ashford contributes a comprehensive paper on the "darts" found in connection with the reproductive apparatus in certain *Helices*.

The dart is contained in a short ventricose pouch opening into the lower part of the vaginal tube, a little above the common vestibule, on the right side of the neck. There is usually one: if two are present, the second sac is on the opposite side of the tube from the first. The sac may be simple or bilobate. At the bottom of the cavity of the sac is a conical papilla, which serves as a basis for the dart, which is attached to it by its posterior end. The apparatus is a development of adult life, and especially of pairing time, but this is indifferently present or wanting in species otherwise closely allied. The dart itself is a tubular shaft, of carbonate of lime, tapering to a solid, transparent, sharp point, enlarging at or towards the base, where it assumes the form of a subconical cup. The sides of the shaft are sometimes furnished with blade-like longitudinal buttresses, which serve to strengthen it. They are rapidly formed, may be secreted in six days, and differ in form in different species. They are supposed to serve the purpose of inducing, by puncture, the excitement preparatory to pairing. They are too fragile to do more than prick the tough skin of these molluscs, but sometimes penetrate the apertures of the body, and are found within. A new weapon is formed after the loss of the old one. It is best extracted for study by boiling the sac in caustic potash.

Anatomy of Pelta and Tylodina.†—A. Vayssière gives an account of these small and incompletely known molluscs. The presence of

* Journ. of Conch., July 1883. Cf. Science, ii. (1883) p. 803.
† Ann. Sci. Nat. Zool., xv. (1883) Art. 1, 46 pp. (3 pls.).

a gill on the right side of the body of *Pelta*, though difficult to demonstrate, proves that that animal is related to the Pleurobranchiata; other characters of its organization justify us in establishing for it a distinct family.

Around the buccal depression there open a large number of mucous glands, not, as in some allied forms, consisting merely of a simple vesicle, but giving rise to mulberry-like masses of racemose character. Each of these masses or aggregates is provided with an excretory duct of some length, and they sometimes not only surround but enter to some extent into adhesion with the nervous centres. The radular apparatus within the buccal bulb does not agree in structure with that of the true Pleurobranchs, and another point of disagreement with them is to be found in the characters of the stomach, which call to mind the arrangements which obtain in the Bullidæ; there are in it four large horny plates, the walls are very muscular, and the whole seems to have the function of a gizzard.

The gill of *Pelta* is not well developed, and possesses only three or four respiratory lamellæ; it is connected with the heart by means of the branchial vein; while the heart and its two aortæ could be made out, the remainder of the circulatory system baffled the investigator. The same remark applies also to part of the reproductive system, but it is of interest to note that the author was able to make some observations on a subject which is just now attracting so much attention—the development of the spermatozoa. He finds that the male vesicles present the appearance of a cell with a nucleus, in which one may distinguish several hyaline granulations; at the periphery of the male cells there are a certain number of granulations, similar to those of the nucleus. This observation leads to the supposition that here, as in *Helix* (Duval), there is an endogenous formation of nuclei. Free from these mother-cells we see a large number of "polyblasts" more or less developed; in one in an advanced stage, each bud or "spermatoblast" is seen to be only connected with the primitive cell by a delicate peduncle which, later on, forms the anterior part of the spermatozoon. The spermatoblasts continue to elongate, until at last we have a large number of spermatozoa which are attached by their heads.

The œsophageal nerve-collar is formed by three pairs of ganglia which are connected with one another by short commissures; of these the cerebroid ganglia are of a pale orange colour, while the pedal and the visceral are more deeply orange. Tentacles being absent, it is possible that olfactory organs are present, but the author was not able to convince himself of this; the eye has the ordinary Opisthobranch structure, while the otocysts are of some size, one only being present in each auditory cell.

The author's investigations lead him to concur in the suggestion of J. E. Gray, that the family *Peltidæ* should be instituted for the reception of this form.

Tylodina is next dealt with, and its relations to *Umbrella* are particularly insisted on; differences in the number and form of the teeth of the radula were observed to obtain with age; the stomach is

provided with a chitinous triturating apparatus; the commissures connecting the nerve-centres are excessively short, and the cerebroid ganglia are proportionately large, owing possibly to the complete absence of visceral ganglia.

Absolute Force of the Adductor Muscles of Lamellibranchs.*—F. Plateau has commenced a series of researches on the absolute force of the muscles of invertebrates by an investigation on certain Lamellibranchs. The name of absolute or static force was given by Weber to the force measured by the weight which exactly equilibrates the contraction of a muscle; in other words, if a muscle is fixed by one end, and a weight suspended at the other, the absolute force is measured by the maximum weight which the muscle in action can carry without either elongating or contracting. Hitherto observations seem to have been confined to the frog and to man.

After a notice of the work of preceding investigators into the physiology of Lamellibranch muscles, the author points out that in most of this group the adductor muscles may be found to consist of a transparent (generally the largest) and an opaque portion; the latter appears to be formed of smooth, the former of transversely striated fibres. The experiments of Coutance show that in Pectens the two muscular portions have different functions: while the transparent muscle contracts rapidly, the opaque smooth muscle does so slowly.

Plateau has experimented on twenty different species, but finally limited his researches to *Unio pictorum*, *Cyclas rivicola*, *Artemis exoleta*, *Tellina incarnata*, and *Pandora rostrata*. A full account of the modes of experiment is given, together with elaborate tables of the results; these cannot be reproduced here, and it must suffice to say that it has been found that the only way of usefully comparing the muscular force of Lamellibranchs with that of the higher animals is to discover the absolute force of the muscles for each square centimetre of transverse section. When the comparison is thus made it is found that the absolute force of the adductors of Lamellibranchs is analogous to that of vertebrates. To the objection that molluscan muscles are smooth, and that vertebrate muscles are transversely striated, the only possible answer at this moment is that the author has also made some investigations on the muscular force of Crustacea, which will shortly be published and in which he hopes to explain the apparent anomaly.

Water-pores of the Lamellibranch Foot.—H. Griesbach has maintained † the existence of *pori aquiferi* in the Lamellibranch foot, while J. Carrière held ‡ the contrary view. J. T. Cattie § has studied a considerable number of species, and does not find the least trace of aquiferous pore; and T. Barrois ‖ arrives at the same results. He discusses the work of Carrière and himself, and finds that they have studied most of the forms where the presence of aquiferous pores has

* Bull. Acad. R. Sci. Belg., vi. (1883) pp. 226–59 (1 pl.).
† See this Journal, iii. (1883) p. 353.
‡ Ibid., p. 639.
§ Zool. Anzeig., vi. (1883) pp. 560–2.
‖ "Private imprint from Lille, dated October 30th, 1883." Cf. Science, iii. (1884) pp. 130–1.

been claimed, and in every case finds pores absent, or in such position that it seems they are either connected with the functional byssogenous organ, or, where such is absent in the adult, with the remnant of the same. Barrois sums up his views thus:—No pores exist for the introduction of water into the circulation; the only pores of the foot are those connected with the byssus organ, which never communicates with the interior of the foot. The blood may have water introduced into it, but this may be effected by osmosis, or in some manner not discussed.

Visual Organs in Solen.*—B. Sharp, referring to his recent communication † on the visual organs of *Solen ensis*, states that he had since determined the presence of similar organs in the mantles of the clam, the oyster, and the sand-clam. Their presence was made evident by the retraction of the mantles when shadows are passed over them. The structure of the peculiar cells supposed to be primitive eyes, was the same as that of the cells before described in the siphon of *Solen*, including the presence of the transparent portion at the end of each.

Molluscoida.

Egg and Egg-membranes of Tunicata. ‡—H. Fol finds that the mature ovum of a Tunicate is composed of a granular yolk, containing a female pronucleus, with two polar globules at the surface. A gelatinous layer, containing a very large number of non-nucleated corpuscles, surrounds both the yolk and the globules, while the surface of the whole is occupied by a layer of nucleated cells, which forms the follicle; sometimes this envelope is double, when the outer layer is composed of flattened cells united to form a continuous membrane. The polar globules and the pronucleus are derived from the germinal vesicle, in which a nucleolus, a nuclear plexus, and an envelope could be detected. The corpuscles of the larval testa are homogeneous, and inclose a certain number of large yellowish granulations; at first they are of a vesicular character, but at no time have they a true nucleus; they owe their origin to the superficial portion of the yolk, and arise from it about the time when the egg has attained to half its permanent size. In a *Molgula* these corpuscles were found to be replaced by nucleated cells, which were distended by the homogeneous masses which they contained. The overlying nucleated cells are, in a majority of cases, largely vacuolated, but this appearance is not to be made out before the layer is complete and the cells have been for some time superficial in position; their nucleus arises as a small solid or hollow bud from the germinal vesicle, while the body of the cell is derived from the yolk: when these cells are long in appearing the germinal vesicle is apparent for the whole period; when, on the other hand, they arise rapidly and in large numbers simultaneously,

* Proc. Acad. Nat. Sci. Philad., 1884. See Science, iii. (1884) p. 237.
† See this Journal, *ante*, p. 39.
‡ Recueil Zool. Suisse, i. (1883) pp. 91–160 (2 pls.).

the vesicle rapidly disappears. There is no relation whatever between these constituents of the follicle and the larval test, either as to the time of their appearance, or as to their histological constitution. The granular corpuscles and the gelatinous layer have no relation to the mantle of the adult Tunicata, but form a provisional or larval organ of protection, which in the genus *Doliolum* takes on a fusiform shape, which is at first soft and applied to the body of the larva, but, later on, becomes rigid, and swells out so that it is separated by the gelatinous layer from the contained larva.

The author postpones for the present a consideration of the views of Sabatier, who, as the readers of this Journal know, has been a great deal occupied with the same subject.

Simple Ascidians of the Bay of Naples.*—P. A. Traustedt gives a list of the species of simple Ascidians found in the Bay of Naples: in addition to the bibliography and description of the species and genera, there is a classification of the four genera of the Phallusiidæ and of the Cynthiidæ. The new forms described are the *Phallusia quadrata*, *oblonga*, *malaca*, *pusilla*, and *ingeria*; and *Polycarpa mayeri*.

Urnatella gracilis, a Fresh-water Polyzoan.†—A paper on this polyzoan, by Professor J. Leidy, has been recently published. It was originally discovered in 1851, and briefly noticed in the same year, and also in 1854, 1858, and 1870. It was found in the Schuylkill River at Philadelphia, but has not been seen elsewhere, except a dried specimen on the shell of a *Unio* from Ohio.

Urnatella is a most beautiful form, living in association with *Plumatella* and *Paludicella*, and having similar habits, but is very different from them or any other known fresh-water polyzoan. It is most nearly related to the marine genus *Pedicellina*. It is found attached to the under side of stones beneath which the water can flow. As commonly observed, it consists of a pair of stems divergent in straight lines, or rather gentle curves, from a common disk of attachment. The stems slightly taper, and are beaded in appearance, due to division into segments alternately expanded and contracted. The segments commonly range from two to a dozen, proportioned to the length of the stem, which, when longest, is about the eighth of an inch or a little more. The stems terminate in a bell-shaped polyp, with an expanded oval or nearly circular mouth slanting to one side, and furnished with about sixteen ciliated tentacles. The stems also usually give off a pair of lateral branches from the second segment succeeding the polyp, and frequently likewise from the first segment. The branches consist of a single segment or pedicle supporting a polyp, and usually give off similar secondary branches. The first and second segments are cylindroid, highly flexible, and mostly striated and colourless, and appear mainly muscular in structure. The succeeding segments are urn-shaped; the body of the urn being commonly pale brown, ringed with lines, and marked with dots of darker brown.

* MT. Zool. Stat. Neapel, iv. (1883) pp. 448–88 (5 pls.).

† Sep. Repr. Journ. Acad. Nat. Sci. Philad., ix. (1883) 16 pp. (6 figs. and 1 pl.). Cf. Science, ii. (1883) pp. 789–90 (2 figs.).

The neck pedicles of the urns are black. The different colours give the stem a beaded and alternately brown and black appearance. Through the lighter coloured body of the urns a central cord can be seen, extending through the length of the stem. The urn-shaped segments exhibit lateral pairs of cup-like processes, which correspond in position with the branches from the terminal pair of segments of the stem, and apparently indicate branches which have separated from the parent-stem to establish themselves elsewhere as new polyp-stocks.

A series of specimens of *Urnatella*—from such as consist only of a simple cylindrical flexible pedicle, supporting a polyp, to those with long stems, consisting of a dozen segments—indicates the urn-shaped segments to be formed through segmentation of the originally single simple pedicle. The segments, therefore, do not correspond with what were polyps; but the terminal polyp is permanent, and the segments originate by division from its neck, very much as the segments of the tape-worm arise from its head. After the destruction of the head, the segmented stem remains persistent; but what becomes of it ultimately has not been determined. Probably the segments may serve the purpose of the statoblasts of other fresh-water Polyzoa. A common mode of propagation of *Urnatella* appears to be by budding, the formation of branches with their terminal polyps, and the detachment of these branches to establish stocks elsewhere. The different specimens apparently indicate this process, though it was not actually observed.

Though the stem of *Urnatella* is invested with a firm chitinous integument, it still retains its flexibility; so that when the polyp is disturbed, it not only closes its bell and bends its head, but the entire stem bends, or even becomes revolute. Sometimes the polyps suddenly twist the stems from side to side, as if they had become wearied of remaining longer in the same position.

Structure and Development of Argiope.*—A. E. Shipley, after an account of the external characters of the two species of this Brachiopod—*Argiope neapolitana* and *A. cuneata*—which he has been able to study at Naples, describes the structure of the shell, and discusses the nature of the mantle papillæ which make their way into its cavities, the chief function of which appears to be the nutrition of the shell. It is believed that the protrusion of the tentacles is probably effected by the forcing in of a perivisceral fluid, but that their retraction and curling movements are occasioned, in all probability, by the muscular fibres which lie in their interior. There is no anus, and the ileo-parietal band (Huxley) is so feebly developed as to lead to the belief that it cannot afford any support to the intestine; the liver consists of two branched glands, the secreting surface of whose tubules is increased by the elevation of their inner walls into a number of wedge-shaped ridges. Like other recent observers, the author has been unable to find anything like a circulatory organ, or the system of arteries and "accessory pulsatile organs" which have

* MT. Zool. Stat. Neapel, iv. (1883) pp. 494–520 (2 pls.).

been described by Hancock; the vessels appear to be only slits in the tissue; the blood-corpuscles are large in comparison with the other cells of *Argiope*, "which, like all Brachiopod cells, are extremely small." Respiration appears to be effected by the mantle, and especially in the region of the perforate shell, where a large area is constantly exposed to the currents of water which are set up by the action of the ciliated tentacles.

After describing the muscular and nervous systems, the author comes to the female organs, no male having been found by him. There are two pairs of ovaries, one of which is not constantly present; each appears to be formed of a membrane continuous with the body-wall, and covered by epithelium continuous with that of the body-cavity; each ovum is surrounded by a very delicate nucleated capsule. The ripe eggs fall into the body-cavity, where they are taken up by the inner end of the oviduct, whence they pass into the brood-pouches. These last are invaginations of the lateral body-wall. By invagination three cavities are formed in the embryo, which at first communicate at the end near the blastopore, but subsequently become shut off from one another. The central cavity, which is enteric, is, throughout the larval life, without a mouth or anus. The two lateral cavities give rise to the body-cavity, and their walls form the muscles and other mesoblastic structures; sometimes these walls are so much in contact that the body-cavity is obliterated in many places. The embryo becomes divided into two segments, of which the anterior soon becomes again divided; four symmetrically arranged eye-spots now appear, and four bundles of small bristles are soon afterwards developed on the second segment. The stalk of the adult is formed from part of the third segment. A little later the larva escapes from its mother and swims about by the aid of cilia; the setæ and the red colour have probably a protective function.

The author discusses the views of Morse and Kowalevsky, that the Brachiopoda form an order of Vermes closely allied to the Chætopoda, against which he points out that the "segments" of the larva do not seem to have the value of true metameres, but to be due simply to the formation of the shell from the central region of the body; there is no trace of any segmentation of the mesoderm, and no organ exhibits serial repetition. The Brachiopod differs from the Chætopod larva in having an alimentary canal which is not curved, nor divided into three regions, nor provided with mouth or anus; the body-cavity is but feebly developed, and there is no provisional renal organ. Brooks adopts the view of Huxley and Hancock that the Brachiopoda are allied to the Polyzoa; but Shipley points out that (*a*) Balfour has already rendered very doubtful the homologies of the lophophore; (*b*) that the characteristic position of the nerve-ganglia of Brachiopods which remain in the ectoderm, is without parallel in the Polyzoa; (*c*) there are no proper resemblances between their larvæ; and (*d*) the Polyzoa become fixed by the præoral, the Brachiopods by their aboral extremity.

Van Bemmelen would ally the Brachiopods to the Chætognatha, basing his views chiefly on resemblances in histological structure;

to this, however, Shipley attaches little importance, while as to the origin of the mesoblast, he points out that a similar history is found in Echinoderms, Enteropneusta, Chordata, and probably *Peripatus*.

The author does not think that the Brachiopoda and Polyzoa form together a natural phylum; he would rather follow Gegenbaur in making a "primary class" of the Brachiopoda, allied to Mollusca, but more nearly to Vermes.

Arthropoda.

a. Insecta.

Genealogy of Insects.*—This paper, by Dr. A. S. Packard, jun., commences with a diagram illustrating the author's views on the phylogenetic relations of the various groups of insects to each other. The lowest group is that of the Thysanura, and the genus *Scolopendrella*, with its abdominal true legs, probably comes nearest to the hypothetical ancestral form. The Dermatoptera, Orthoptera, and Pseudoneuroptera present in the larval condition more or less close resemblances to Thysanuran genera, and have probably originated from some such forms. The origin of the Coleoptera may probably be traced to some form like *Campodea;* and the arguments for this view are the form of the larvæ of the carnivorous beetles, especially of the Carabidæ, Dytiscidæ, and Staphylinidæ, which display on the whole a more primitive type than those of other beetles; in the phytophagous larvæ the mouth-parts become more aberrant, and often show a tendency to become aborted; and in the weevils the head, mouth-parts, and legs undergo a gradual degradation and atrophy; the phytophagous forms are therefore evidently more specialized and less like the ancestral form than the carnivorous species. The first larva of the oil-beetle (*Meloe*) is very like a *Campodea;* the second larval stage closely resembles a larval Carabid; the third larval stage is again closely similar to the larva of one of the lamellicorn beetles; and, finally, the fourth stage with aborted mouth-parts and legs recalls the larva of the weevils. The metamorphosis of this insect is a kind of shortened epitome of the development of the Coleoptera from some *Campodea*-like ancestor, and the resemblances of its four larval stages to the larvæ of the other Coleopterous genera are stated in a tabular form in Dr. Packard's memoir. Palæontological data are, however, not quite in harmony with this view, since the earliest known beetle is a weevil (the most specialized type) from the carboniferous rocks.

It is also possible that some metabolous Neuropteron may have been the ancestor of the Coleoptera, and the close resemblance of the larva of *Gyrinus* to the larva of *Corydalis* and other Sialidæ favours this view. The three higher orders, Diptera, Lepidopter and a Hymenoptera, had probably a common origin in the Neuroptera; the larvæ of saw-flies and the caterpillars of Lepidoptera are both very like Panorpid larvæ; and the maggots of Diptera, especially the

* Amer. Natural., xvii. (1883) pp. 932–45 (2 figs.).

more perfectly developed Culicidæ and Tipulidæ, show considerable affinities to the larvæ of Lepidoptera.

The embryo bee has a pair of temporary appendages on each segment, as also have the embryos of Coleoptera and Lepidoptera, which points to an early *Scolopendra*-like ancestor, which in its turn indicates a still earlier *Peripatus*-like ancestor from which the Myriopoda and Insecta, at least, if not the Arachnida, have been derived.

Development of Antennæ in Insects.*—J. Dewitz does not agree with the account of the development of the antennæ of insects given by Graber, who thinks that the point of insertion of the antennæ moves from the ventral to the dorsal aspect of the head. Dewitz finds that if we make a longitudinal section through the head of a half-grown caterpillar, we find an elongated saccular structure at the base of each tentacle; these, which lie below the sutures of the clypeus, are the rudiments of the antennæ of the butterfly. The sac in question is formed by the invagination of the matrix at the base of the caterpillar's tentacle into the interior of the head; the sac is double-walled, and in young caterpillars the two walls are of the same thickness and lie close to one another. Later on, the outer becomes thin and transparent, while the inner becomes folded, as it grows. The orifice of the invaginated sac is at first wide, but later on becomes narrower. Tracheal and other tissues grow into the cavity of the sac, and it is at their expense that the antenna is formed. Between the two walls there is a layer of chitin, which, though very delicate, consists of two lamellæ. The author has not yet been able to determine exactly how the antennæ become free.

Experiments with the Antennæ of Insects.†—C. J. A. Porter details some experiments which he has made on the antennæ of insects with the view, if possible, of determining their function, and as the result of these experiments he has been led to the following conclusions:—

1st. The antennæ are not the organs of any one of the so-called five senses, or of any combination of them. It is true that insects often seem to be able to tell the difference between good and bad tasting things brought into contact with the antennæ, but the author does "not think we have any reason for saying that insects taste with their antennæ, because they dislike to have such things as pepper-sauce poured on them, than we would have for concluding that a man tastes with his nostrils simply because he would object to having them filled with the same fluid. But on the other hand, this apparent sense of taste is, in many instances, nothing more than the insect's desire to clean off whatever may be put on its antennæ." They are mostly kept very clean by the insect, and are, as a rule, of all parts of the body most free from extraneous matter. They seldom notice anything put to them unless it be of a nature to adhere to them. But as soon as anything, even pure water, sticks to them, they immediately draw them through the mouth-parts, and if it be anything palatable,

* Biol. Centralbl., iii. (1883) pp. 582–3.
† Amer. Natural., xvii. (1883) pp. 1238–45.

as sugar, for instance, they begin to suck at it. But the very fact that often when they get anything distasteful they begin to spit and clean the mouth, is enough to show that they did not get a taste of it before they put it in the mouth. Aside from all this, who ever saw an insect use its antennæ to taste with? Butterflies and similar insects, when probing the deepest flowers, hold them nearly erect. Of many others, such as the bee, wasp, &c., they scarcely reach to the lower part of the head, not to take into account the length of the extended tongue.

2nd. It does not appear that the power of direction is in the antennæ. It is true that some insects seem to have lost the power of directing their flight when the antennæ are cut off. But besides the fact that many others are not so affected, we know that many of those that are, soon recover and are able to move about as well as ever.

3rd. He is inclined to adopt the opinion of Trouvelot that the antennæ are the organ of some sense not possessed by us, though not one supplementary to that of sight. True, it seems in many cases as though insects deprived of their antennæ are somewhat blind, but in vastly more instances they do not seem so.

Epidermal Glands of Caterpillars and Malachius.*—The following are the principal results obtained by S. Klemensiewicz.

(1) The eighth and ninth segments of the larvæ of *Liparis*, *Leucoma*, *Orgyia*, and *Porthesia auriflua*, have each a little protuberance on the median dorsal line, with the opening of a gland at the summit. The secretion is clear and odourless; the skin is invaginated at the top of the papilla to form a pendent sac, at the base of which are inserted two muscles running obliquely backwards; and there also open two glands by a common duct. The external surface of the glands is smooth, but in their interior each gland-cell forms a separate bulging mass; the appearance thus presented is singular. The lumen of the duct is very small; its thick walls are formed by two large cells, much like those of the gland proper. In *Leucoma salicis* there are quite similar glands on the fourth and fifth segments. (2) The exsertile horns of *Papilio Machaon*, larva, are described. They are really developments of the tegument. The epidermal cells of their walls are large, and contain numerous rod-shaped bodies; but the cells at the base of the horns are much smaller and glandular (their secretion being probably discharged through pores of the adjacent cuticula). It may be assumed that the odorous secretion accumulates in the invaginated horns, and is freed by their exsertion. (3) The caterpillar of *Harpyia vinula* has a gland in the first segment, opening ventrally. The gland is flask-shaped, the neck acting as duct, and opening into a large transverse fissure; the body of the flask is the gland proper, and is lined by polygonal epithelial cells, with irregularly shaped nuclei; the epithelium rests upon a thin tunica propria. (4) A similar organ to the last mentioned was described in *Vanessa larvæ* by Rogenhofer.† It is an invagination of the skin on the ventral side

* Verh. Zool.-Bot. Gesell. Wien, xxxii. (1883) p. 459. Cf. Science, ii. (1883) p. 632.

† Ibid., xii. p. 1227.

of the first segment; its cuticula is thin, and forms numerous little cups, under each of which is a thin epithelial cell. (5) The orange-coloured fleshy warts on the sides of the thorax and abdomen of *Malachius* are also glandular. The epidermis presents no special features in the warts, except that it bears scattered unicellular glands of the form typical for insects; they are flask-shaped, with a coiled cuticular duct in their interior, the duct being continuous with a pore-canal through the general cuticula of the wart. In the lower and larger end of each cell lies the round nucleus.

Classification of Orthoptera and Neuroptera.*—Dr. A. S. Packard, jun., in a preliminary notice abstracted from the forthcoming 3rd report of the U.S. Entomological Commission, considers "the position of the Orthoptera in reference to allied ametabolous insects." The four orders, Neuroptera, Pseudoneuroptera, Orthoptera, and Dermatoptera are united into a "super-order" Phyloptera, the name implying that these insects are closely allied to the primitive form whence all the higher insects (Lepidoptera, &c.) have been derived. The main characters of the Phyloptera are as follows:—mouth-parts free, adapted for biting; mandibles toothed: first maxillæ separate, second maxillæ united to form a labium. This primitive condition of the mouth-parts is also to be seen in larvæ of Coleoptera. The prothorax is generally large, the meso- and metathorax equal in size. The wings are usually net-veined, the hind-wings being often larger than the front pair. The abdomen has ten segments and the rudiments of an eleventh. Metamorphosis is incomplete except in the highest order Neuroptera. The lowest of the four orders are the Dermatoptera and the typical genus *Forficula* combines many characters of the higher group: thus the elytra and hind-wings anticipate those of the Coleoptera, and the larva resembles the Thysanuran *Japyx*; its metamorphosis is even less complete than in the Orthoptera. The next highest group is that of the Orthoptera, and the metamorphosis, though more marked than in the last mentioned, is less marked than in the Pseudoneuroptera, which form the next group. The author divides the Pseudoneuroptera into three sub-orders: (1) Platyptera (Termitidæ, Perlidæ, &c.); (2) Odonata (Libellulidæ); (3) Ephemerina (Ephemeridæ). In the last group the Neuroptera-metamorphosis is complete; this order is divided into two sub-orders, Planipennia (Hemerobiidæ, &c.), and Trichoptera (Phryganeidæ); in the Trichoptera the mandibles are nearly obsolete, thus suggesting or anticipating the Lepidoptera.

The paper concludes with a tabular arrangement of the hexapodous insects divided into super-orders, orders, and sub-orders.

Sucking Organs of Flies.†—K. Kräpelin commences with a description of the "proboscis" of *Musca*, in which he points out that the second pair of maxillæ give rise to a conical piece, which has thin walls and can be withdrawn into the firmer parts of the head capsule; the retractile portion may be spoken of as the "cephalic cone," and

* Ann. and Mag. Nat. Hist., xii. (1883).

† Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 684–719 (2 pls.).

the lower lip, upper lip, and hypopharynx as the proboscis proper. The former is, superiorly, provided with a pair of simple palps, which appear to be the remnants of the mandibles, the latter has on upper side a deep longitudinal groove, in which lie, one above the other, the two unpaired chitinous stilets.

The upper of these appears to be the direct prolongation of the superior and anterior edge of the cephalic cone; the free portion can be bent, but the basal part is connected with the head. The hypopharynx is a longitudinally compressed hollow cone, and its groove, opposite to that of the upper lip, unites with it to form a tube which opens into the digestive canal; it is traversed internally by the ducts of the thoracic salivary glands, which open at its tip; the true mouth-opening may be regarded as being placed at the anterior end of the small chitinous capsule, and at the point where the upper lip and the hypopharynx are inserted. The lower lip does not, as in other Diptera, or in Hemiptera, form the true sucking tube, but is a support for it. After describing in great detail all the accessory points, the author passes to the musculature and the mode of action of the proboscis.

The proboscis is drawn into the head by two pairs of muscles, and these, in retracting, cause also a flexion of the lower lip; these strong muscles are aided by two pairs which are less well developed, and one of these seems to effect the double folding which is to be noticed in the basal membrane of the cone. While the action of the above-mentioned muscles is not difficult to understand, it is less easy to see how the protrusion of the proboscis is effected. What is wanted in the way of fulcrum for the muscles seems to be made up for by the disposition of the tracheal system of this region; the limbs which enter the head swell out into (apparently two) large vesicles, which, when the proboscis is protruded, occupy the whole of the internal cavity, so far as this is not occupied by the nerve-centres, optic nerves, and cephalic vesicle. When these contract, room is made for the inpressing fulcrum, without any disturbance of the surrounding organs.

Special movements appear to be confined to the upper lip; it is straightened out by a delicate pair of muscles, which are opposed by another pair, whose chief function would appear to be to bring into contact the two halves of the sucking groove. The movements of the labella are next described, and then the process of sucking is taken up; a fly is not only able to take in fluid, it can also feed itself on solid matters suspended in liquid. This injection of material appears to be effected on the method of the suction-pump, the movable piece being represented by the upper plate of the base of the fulcrum, which, as it is drawn up, carries the fluid into the fulcral canal; the depression of this plate drives the nutriment to either side, unless the anterior portion of the plate has descended first and so formed a kind of safety-valve, in which case the fluid passes backwards into the œsophagus.

Solid substances are dissolved by the action of three pairs of

glands, which, in a loose way, are spoken of as salivary; the largest and the best known of these lies in the thorax, and its secretion passes into two ducts, which unite with one another in the head. This unpaired duct passes along the lower side of the fulcrum, traverses the hypopharynx, and opens at its tip. Just before it passes into the hypopharynx the duct is provided with a simple valvular arrangement, which regulates the supply of the fluid; there is not, however, any reservoir in connection with this valve, as was imagined by Meinert, nor is there any pump-like arrangement, such as is found in the Hemiptera. A second pair of salivary glands lie at the base of the knob of the proboscis, and form large-celled rounded spheres; the ducts of these glands have, notwithstanding the investigations of Graber, Meinert, and Becher, never yet been discovered; after much trouble the author was able to find their common orifice at the tip of the superior plate of the lower lip; each gland gives off a bundle of fine canals, which finally open into a common efferent duct. The third set of glandular cells which lie near the œsophagus are not provided with a common duct; they open by numerous canaliculi into the œsophagus.

Where the proboscis is not covered by thick chitinous plates it has very thin and short hairs, which are mere projections of the chitinous investment, and are neither hollow nor provided with nerves. In addition to these there are tactile hairs, glandular setæ, and gustatory organs.

The hairs are chiefly developed on the upper edge of the labellar cushions, and have the form of delicate hollow hairs provided with a fine nerve which arises directly from a multicellular ganglion. With these hairs Kräpelin would associate the hairs which have been described by previous authors, and which are placed in two longitudinal rows on the upper lip and pharynx. They do not appear to have, as has been supposed, the function of gustatory organs, but are rather means by which the firm particles that are sucked in may be felt and retained.

The glandular hairs are especially well developed on the outer surface of the labella, and are distinguished by their enormous size; they are cylindrical in form, and have at their base a pyriform thin-walled structure in which a number of rounded cells are inclosed as in a sac. The author cannot agree with Künckel or Gazagnaire in ascribing a nervous character to these bodies, inasmuch as the deep grooves which are found on them speak rather to their glandular and excretory function.

The gustatory organs are placed on the inner face of the labellar cushions, and each forms two pale concentric rings which do not project above the integument, and cannot, therefore, have any tactile function; nerve-fibres, with a contained transparent axial cord, could be made out in thin sections, and the relations of this demonstrated clearly that it was a sensory organ that had to do directly with chemical stimuli. The nerves which supply all the labellar organs form two large limbs in the lower lip. The author hopes to extend his investigations to other forms among the Diptera.

Visceral Nervous System of Periplaneta orientalis.* — M. Köstler, after a detailed notice of the work of preceding anatomists, commences with the unpaired visceral nervous system, which can be best studied by the method of sections: he finds in it (1) a frontal ganglion; (2) the nerve on the œsophagus and crop; (3) the large triangular ganglion on the crop; and (4) the two nerves thence given off with their accessory ganglia. In the first of these we find the so-called central dotted substance, and it is surrounded by a layer of ganglionic cells; these last are traversed by a special supporting substance such as Dietl has found in the cerebrum; from the neurilemma surrounding the ganglion fine connective cords pass off in all directions towards the central mass; the ganglionic spheres are always of a larger size than they ever are in the brain; they are rarely pyriform in shape, and never have any investment; the protoplasm is collected into nuclear masses of some size, and a concentric disposition of the layers is easily seen. The spheres are almost always unipolar, bipolar cells being very rare, and multipolar only once observed, and this may have been due to an optic illusion.

The unpaired visceral nerve has exactly the same structure as that of the commissures of the ventral ganglionic chain, and the grey granular fibres call to mind the sympathetics of the Vertebrata. The large ganglion on the crop has a very similar constitution to that of the frontal ganglion.

With this unpaired system there is correlated a paired visceral system of nerves; the development of one standing in opposition to that of the other. It consists of a number of small oval ganglia which lie on either side of the median unpaired nerves, and are connected with the brain; they have the usual fibrillar structure, and have a few elongated ganglionic nuclear masses imbedded in them. Their chief function appears to be to innervate the large salivary glands.

The true sympathetic nerve can be seen by removing the ventral ganglionic chain, and treating it for a short time with the vapour of osmic acid; two sets of nerves will then be distinguished, for the ventral chain will be found to have taken a distinctly dark coloration, while between the longitudinal commissures much lighter nerves are to be seen. Almost in the middle of every such commissure, alternating now to the right, now to the left, there will be seen passing off a fine nerve; at the level of the ventral ganglia this nerve divides into two parts, each of which swells out into a small spindle-shaped ganglion, and then passes into the lateral nerve given off from the ganglion, its own pale fibres mixing with the cerebro-spinal, and taking the same course as the peripheral nerves.

The author thinks that when we make a general comparison between the visceral nervous system of Arthropods and of Vertebrates we can have no doubt that the true sympathetic of the one is that also of the other. Its relation to the ventral chain is reversed indeed. The unpaired nerve is cerebral and corresponds to the vagus, and its grade of development is dependent on that of its possessor, so that in

* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 572–95 (1 pl.).

the larval stage, when the organism needs more food, it is larger than it is later on. Differences are to be seen in the disposition of the appended ganglia, but the great ganglion frontale is perhaps a separated portion of the cerebrum, which owes its special position to the development of the anterior portion of the digestive tract.

Pulsating Organs in the Legs of Hemiptera.* — Conflicting opinions have been held regarding the pulsating organs that have from time to time been observed in the legs of certain Hemiptera. W. A. Locy records some observations which enable him to say that these organs are distinct from the muscular system of the legs, and that they influence circulation. Their automaticity was also observed. Specimens for examination were chosen with reference to the transparency of their legs, as it is upon this point the success of observation depends. Both larval and adult forms of the genera studied were used, but the best results were uniformly obtained with the larval forms, for the above reason. In some cases special methods were necessary to render the legs transparent enough for observation. For this purpose the integument of the legs was scraped very thin. The organs can be demonstrated in this manner, even in the thick legs of the adult Belostomæ. They are most easily seen in the legs of *Notonecta* and *Corixa*, but are not so large and pronounced as in the legs of the Nepidæ. In the more transparent individuals not only are the organs readily seen, but the circulation of the blood can be watched with a power high enough to bring out the corpuscles.

γ. Arachnida.

Vitelline Nucleus of Araneina.†—A. Sabatier adopted the following method in his investigation into the structure of the ova of spiders. The animals were opened while alive in a few drops of alcohol, so as to harden and fix the eggs at once; sometimes, though rarely, osmic, picric, or acetic acid was used. The eggs were stained with Beale's carmine or picrocarminate of ammonia; after washing, they were placed in phenicated glycerine.

The vitelline nucleus was observed in all the Araneids examined; its presence is ordinarily marked by its affinity for the colouring matters which are taken up by the yolk. Sometimes, indeed, its presence is only revealed by the existence on its surface of refractive granules which mark out its spherical form. In *Tegenaria agrestis* it is often very distinct.

This nucleus arises in the neighbourhood of, or even in contact with the germinal vesicle under the form of a mass, which, speaking generally, differs from the yolk by being more finely and evenly granular, by a greater affinity for colouring matters, and sometimes by higher refractive power. It has a massive and not vesicular structure; when it does not undergo stratification it consists of a spherical mass of protoplasm, without membrane or nucleolus, and with no chromatin-plexus, though it probably has some chromatin

* Amer. Natural., xviii. (1884) pp. 13–9 (1 pl.).
† Comptes Rendus, xcvii. (1883) pp. 1570–2.

diffused through it. It is possible, but the question must still remain an open one, that it is merely a massive nucleus. It gradually separates itself from the neighbourhood of the germinal vesicle, and passes to the periphery of the yolk; it becomes more granular, and undergoes disintegration; its elements, divided into small globules, independent of one another, are in parts absorbed by the yolk, or gradually become merged in the superficial granular protoplasm. The vitelline nucleus may, therefore, be looked upon as a centrifugal element, which tends to eliminate itself or to lose its "autonomy." Sabatier regards it as an element of male polarity, which is destroyed as such to accentuate and complete the sexuality of the female cell.

Restoration of Limbs in Tarantula.*—H. C. McCook recently exhibited a tarantula which had been kept in confinement nearly a year, fed during winter on raw beef and in summer on grasshoppers. In the spring it cast its skin by a laborious process, in the course of which it lost one foot and two entire legs. Last summer again, during the latter part of August, the animal moulted; the moult being a perfect cast of the large spider—skin, spines, claws, the most delicate hairs all showing, and their corresponding originals appearing bright and clean upon the spider. The moulting occurred during Dr. McCook's absence, but was just finished when he returned. When the cast-off skin was removed it showed, as might be supposed, the dissevered members to be lacking. But on looking at the spider itself, it was seen that new limbs had appeared, perfect in shape but somewhat smaller than the corresponding ones on the opposite side of the body. The dissevered foot was also restored. The loss of the opportunity to see the manner in which the legs were restored during moult was greatly regretted; but we have some clue from the careful and interesting studies of Mr. Blackwall. Several spiders whose members had been previously amputated, were killed and dissected immediately before moulting. In one of these the leg which was reproduced was found to have its tarsal and metatarsal joints folded in the undetached half of the integument of the old tibia. Another like experiment was made with an example of *Tegenaria civilis*. The reproduced leg was found complete in its organization, although an inch in length, and was curiously folded in the integument of the old coxa, which measured only 1/24 in. in length. Dr. McCook's tarantula had lost both legs close up to the coxæ, and in the moult the hard skin formed upon the amputated trunks was wholly unbroken, showing that the skin had been cast before the new leg appeared. We risk nothing in inferring that, as in the case of Blackwall's *Tegenaria*, the rudimentary legs were folded up within the coxæ, and appeared at once after the moulting, rapidly filling out in a manner somewhat analogous to the expansion of the wings in insects after emerging.

Morphology of Plumicolous Sarcoptidæ.†—E. L. Trouessart and P. Mégnin have a second note on this subject, in which they

* Proc. Acad. Nat. Sci. Philad., 1883, pp. 196-7.
† Comptes Rendus, xcvii. (1883) pp. 1500-2.

point out that, though most plumicolous Sarcoptids are oviparous, some are viviparous (e. g. *Fryana*); the covering of the egg is sometimes tubercular and sculptured, and in *Analges fuscus* has a double row of cells, comparable to the ring of certain sporangia, and forming an organ of dehiscence. The dorsal tegumentary plates are not always granular, as in the species studied by Robin; they are often perforated or reticulated. The nymphs are sometimes found under two forms, which differ in size. The curious red-coloured vesicles which are found on the flanks of a species of *Pterolichus* may be regarded as secondary sexual organs; the female has two, the male one pair. When highly magnified they have the appearance of a flattened uniform plate, formed of a large number of tubes which open into an excretory canal, the orifice of which is lateral or posterior. The red colour is due to a liquid which fills the tubules. They appear to be modified segmental organs, but their function is still unknown.

δ. Crustacea.

Sexual Characters of Limulus.*—B. F. Koons has been puzzled by the fact that no cast-off shells of *Limulus* bearing the characteristic modified claw of the male have been found; he now sees that this is to be explained by the young male having the claws of the second pair of appendages similar to those of the female; as no large exuviæ have been found it is probable that the fully grown *Limulus* does not shed his integument. Howsoever young specimens may be, the sexes are to be distinguished by the transverse slits of the oviducts, and the papillæ with terminal circular orifices in the male. Females are larger than males, and the carapace of large specimens is overgrown with algæ, and appears rusty and aged, while those of smaller examples are bright and clean, pointing to their being frequently shed; indeed the covering appears to be shed several times during the first year. While the entire length of the exuvia may be only 4·0 mm. the escaped young measure 7·1 mm.: an exuvia of 7·0 mm. has a naked young of 10·7 mm., while when the shed integument is 29 mm. the escaped young have been found to be as much as 40 mm. in length. Corresponding differences obtain in the different parts of the animal.

Evidence of a Protozoea Stage in Crab Development.†—There is great interest attached to speculations as to the probable ancestry of the Decapods, owing to the value which the conclusions have in enabling us to interpret palæontological facts. There have been quite a number of theories advanced as to the original stem from which the Decapods have been derived, two of which claim especial attention. One is the theory of Müller, who finds such a stem form in the zoea. Another, suggested by Claus, or in a different form by Brooks, considers the protozoea as the ancestral stem. It is of great importance in understanding the Crustacea to decide between these two views, inasmuch as by the first view Crustacea are supposed to have descended from a form without a thorax, while according to the

* Amer. Nat., xvii. (1883) pp. 1297–9.
† Johns-Hopkins Univ. Circulars, iii. (1884) p. 41.

second, the thorax was present in the original Decapod stem. Some work done by H. W. Conn, during the last summer, upon the larval cuticle of crabs, indicates conclusively (it is claimed) that the latter view is the correct one, or that at least Fritz Müller's view is incorrect. The larval skin, particularly the telson of a large number of crab zoeas, was studied with the following results.

The larval skin is not in different crabs alike, nor is it in any case exactly similar to the inclosed zoea. There is always an indication more or less complete, of some previously existing stage. There has been shown in the various forms studied a gradation from the larval skin, with little difference from the zoea inclosed, to a larval skin which is utterly unlike the zoea, but which possesses a forked tail with fourteen long feathered spines. This gradation is complete, and a study of the different embryonic telsons shows that all have been derived from the form shown by *Panopeus*, which has a forked tail with fourteen spines. Now, such a larval skin is to be considered simply as the cast-off skin of some stage immediately preceding the zoea. It has been shown by Paul Meyer that the study of the skin of Macroura leads to a similar result, that a forked tail with fourteen spines is also seen in the early history of this group. If, therefore, a form can be found which shows these peculiarities, we have reason for accepting it as the stem form of the higher Crustacea. Now a study of the different protozoea forms which occur in the ontogeny of various Macroura shows that we have in this form a stage which fulfils the conditions. It has the forked tail with fourteen spines and has large swimming antennæ, another peculiar characteristic of the crab larval cuticle. If the various larval skins of crabs and Macroura be compared with each other, it will be seen that they are all to be considered as modifications of a tail much like that present in the larval skin of *Panopeus;* and if this tail be compared with the protozoea tail of *Peneus*, the likeness will be seen to be very striking. We have, therefore, in the comparative study of the larval cuticle of crabs, good reason for accepting as the stem form of the Decapods a form which had resemblance to a protozoea.

Gastric Mill of Decapods.*—F. Albert has studied the digestive or gastric mill of Decapod Crustacea in great detail, in the descriptions of which he makes use of the nomenclature proposed by Nauck.

The simplest arrangements of the hard parts in the gastric wall of Decapoda are to be found in the prawn-like forms, where, however, there is not so much a primitive type, as well-developed characteristics which it is sometimes difficult to bring into association with the majority of forms, owing to the absence of certain intermediate links. Among the Natantia we find, on the one side, forms in which the cardiac apparatus, and others in which the pyloric part of the organ is best developed. In both cases the same plan has been followed; two paired and lateral teeth have entered into a physiological connection with an unpaired median process. At the end of one line of

* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 444-536 (3 pls.).

development we find a superomedian tooth with superolateral structures, and in the other the tooth of the inferomedian pouch is well developed, with its tooth-like lateral processes. The Alpheinæ, Palæmoninæ, Crangoninæ, and Gnathophyllinæ are in common characterized by the fact that the inferomedian and inferolateral regions of the cardiac and pyloric portions are alone provided with hard structures of characteristic form; the inferomedian cardiac process evidently consists of three distinctly differentiated longitudinal portions; of these the median one has few or no setæ, while the lateral portions have short setæ, of various forms and arranged in groups, which look towards the middle line; with this are placed longer setæ which form a continuous fringe, and, when the gastric musculature is well developed, this fringe is provided with special muscles. The effect of this arrangement is to confine the food-particles to the median line, and to drive them along it into the thoracic region of the stomach. Bearing this in mind, we can understand that the loss of the peristaltic action of the stomach is due to the reduction of the cardiac process and the great development of the pyloric superomedian process.

The author concludes from his elaborate survey that the hard structures of the stomach of the higher Crustacea are most important aids in the classification of these forms; and his own results coincide with those arrived at by v. Boas. The Natantia form the lowest groups, and the Eucyphotes may be defined as Decapods without a cardiac dorsal mill, and the Penæidæ as Decapods provided with one. The Atyinæ appear at present to be isolated forms, but a connecting link may perhaps be found in *Troglocaris*. The Sergestidæ are to be placed with the Penæidæ, as are also the *Cerataspis* forms, which are often associated with Schizopoda. The well-defined group of the Homaridæ may be divided into the Homarinæ and Astacinæ, as Boas has suggested. The Anomala (in the sense of De Haan) do not form a definitely separated group.

The type of gastric mill found in the Decapoda may be continued into the Squillidæ, Mysidæ, and Cumaceæ, where almost all the corresponding parts are to be found. The median inferomedian pyloric process forms a crest-like longitudinal invagination, and passes through very interesting gradations; in *Diastylis* it has one, in *Mysis* two, in *Gammarus* three, and in the higher Malacostraca a number of fringes of longitudinally-set setæ; indeed, the number increases as the form possessing them stands higher in a systematic classification.

Spermatogenesis in Hedriophthalmate Crustacea.* — G. Herrmann finds that the spermatogenesis of hedriophthalmate is effected on a different plan to that of the podophthalmate Crustacea. The male cells are of large size, and, soon, come to have a number of nucleoli, around which the nucleus seems to undergo segmentation. This is followed by a stage in which there is a group of smaller nuclei, irregular in form, more or less definitely arranged round the periphery of the sperm-cell ("ovule"). This latter divides into equal parts, and soon small cell-elements, with a nucleus, but without a

* Comptes Rendus, xcvii. (1883) pp. 1009–12.

nucleolus, appear. The cephalic nodule is now formed, as a small cup-shaped disk, attached to the surface of the nucleus. As in the Vertebrata, the spermatic filaments are developed at the expense of the spermatoblasts, but the cephalic nodule, which in all other animals has an important function, is here only secondary. A little later the spermatozoid is found to consist of three segments—a cephalic, which incloses the spermatoblast and its nucleus, a median segment which is scarcely visible, and a caudal segment or filament. Later on, the nucleus becomes ovoid in shape, with its long axis in an antero-posterior direction; after it has elongated, its hinder extremity separates from the cell-body of the spermatoblast, and it finally leaves the cell. The flagellum becomes of proportionately great size. Eighty to one hundred spermatic filaments are united into bundles, which are placed in the grooves of the epithelial cells which line the walls of the tubes. Isolated spermatozoa have only been found in the oviducts of the female.

With the exception of its cephalic nodule, the spermatozoon of a hedriophthalmate crustacean has very much the same history as that of the Selachians, and it is to be noted that these spermatozoa exhibit a more complete type than those of the Podophthalmata, inasmuch as in the latter they may be reduced to the single cephalic segment.

Vermes.

Structure and Division of Ctenodrilus monostylos.* — M. Zeppelin gives a full account of this new species of marine annelid. It is about 3 or 4 mm. long, and 0·2 wide, and consists of 20–25 well-marked segments, and is of a yellowish-brown colour. It is remarkable for the possession of a protrusible proboscis which is quite independent of the enteric canal. The only pair of segmental organs is found in the head. The buccal cleft is ciliated, as are also the œsophagus and the rectum. All the segments but the last have setigerous sacs, with two or three setæ apiece. They move very slowly. Sexual reproduction has not yet been observed, but only transverse division. The habitat of the worm is not known, the specimens examined having been found in an aquarium at Freiburg.

The cuticle is thin and homogeneous, the hypoderm thick and made up of polygonal cells with scattered pigment-spots. The musculature is of a very primitive character, the dermomuscular tube consisting of a simple layer of longitudinal fibres which extend uninterruptedly to the end of the body; in this point *C. monostylos* has a striking resemblance to *Polygordius*. Although metamerism is very distinctly expressed externally, it is not so well marked internally as in most forms, the enteron, for example, not being constricted by the dissepiments. The setæ are very regularly distributed over the body, and are either thin and sharp, or stronger and shorter; the two last metameres which are not so well differentiated as the rest, have, as a rule, no setæ. The enteric canal is a little longer than the

* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 615–52 (2 pls.).

body, and is for a great part ciliated; the ciliation resembling exactly that of *Æolosoma quaternarium*.

The blood-vascular system exhibits a very low degree of development, consisting of a dorsal and ventral trunk, which extends through the whole length of the animal; the former gives rise, in the first segment, to a short transverse trunk, from which arise two lateral trunks. The blood is yellow and non-corpusculated; the walls of the vessels are formed by a fine structureless membrane in which nuclei are imbedded. Distinct pulsations could not be detected, though there was a regular current. A structure, comparable to the solid cord of cells in the interior of the dorsal vessel, described by von Kennel in *Ctenodrilus pardalis*, is here also present; both these may be compared with the darkly-coloured organ found by Claparède in *Cirratulus*, *Terebella*, and others.

The head is made up of the cephalic lobes and oral segment, and is distinguished from the metameres which succeed it by its relatively greater length and the possession of the very characteristic proboscis, of the tentacle, and of the segmental organs. The cœlom, as in *C. pardalis*, extends into the cephalic lobes. The whole of the ventral surface of the head is ciliated, and these cilia serve to drive currents of food to the mouth of the worm. The author regards the head as essentially different from all the succeeding segments. The proboscis lies beneath the mouth, and consists of a solid, muscular, broad plate; it opens into a chamber common to it and the mouth and has apparently the function of a locomotor organ.

The resemblances to *Polygordius* which this new form exhibits are emphasized by the possession of a single tentacular organ, the fellow of which seems to have been lost in the course of time. It arises just below the proboscis, and is capable of doubling its length; owing to the possession of a special musculature, it can also become considerably diminished. It is distinguished from the tentacle of *Polygordius* by the absence of a diverticulum of the cœlom; it is marked externally by a ciliated groove, the cilia of which work towards the body; it appears to be not only a tactile organ, but also to bring food to the mouth. Individuals with two tentacles are not rarely seen.

Like *C. pardalis*, *C. monostylos* has only one pair of segmental organs, and these are placed in the head; they are coiled, finely granular tubes, and the cilia around the cœlomic orifice are very delicate. In the nervous system the new species considerably resembles the already-described species of the genus; the dorsal ganglion is placed in the cephalic lobes, and its central mass is dotted; the ganglionic cells are only indistinctly separated from the surrounding epithelial cells; the ventral cord is not provided with metamerically arranged ganglia, but forms a simple well-developed cord, which extends through the whole length of the body; in very thin sections indications of a fine median membrane were occasionally detected, but no peripheral nerves could be made out. The nervous system remains in the hypodermis. Cells of peculiar character, and apparently of mesodermal origin, are to be found floating in the cœlom.

The author next describes the processes of division, which seem to be of a much more primitive character than in *C. pardalis;* all individuals which consist of twenty or more segments are capable of division; there are no preliminary phenomena of gemmation, no zone of gemmation as in *C. pardalis*, but only a slight constriction of the integument, which gradually becomes more and more pronounced; the two daughter forms are at first without any head or anus respectively, and it is only some time after the constriction that these organs begin to be formed. They may give off fragments of one to three segments which have neither head nor anus, and are no longer capable of division, or pieces of five or six segments which may again divide and give rise to fragments similar to those already mentioned. Lastly, the daughter form with the primary head is capable, after the production of a secondary anus, of giving off the terminal portion, but it is not known whether the other half of the parent form is capable of a similar action. After discussing the phenomena of division which he has observed, and comparing them with what is known in other forms, the author passes to the affinities and systematic position of *Ctenodrilus.* He regards it as a "collective type" which stands near the point of union of the Oligochæta and Polychæta, but, as in the case of *Polygordius*, we can hardly, as yet, assign to it a definite and fixed position in the zoological system. While it has, no doubt, an alliance with the Polygordiidæ, it has some special affinities to the Oligochætous Naids, and other characters in which it as much resembles the Polychæta as the Oligochæta.

Manyunkia speciosa.*—Under this barbarous name, J. Leidy describes a new fresh-water annelid closely allied to *Fabricia.* The tube is composed of very fine particles, cylindrical, sometimes feebly annulated. The tubes are formed separately, or a few together, and they measure from 2 to 4 lines in length, and 1/5 to 1/4 of a line in width. The mature worm is 3 to 4 mm. long, and 1/4 mm. in breadth, and consists of twelve segments, including the head; it is of a translucent olive-green colour; the head is surmounted by a pair of lateral "lophophores," which support the tentacles. The seventh segment is twice as long as any of the others, and has an abrupt expansion at the fore-part, which suggested the production of a head prior to the division of the worm; gemmation, however, has not been observed. The number of tentacles varies with the age of the worm, but there are generally eighteen on each "lophophore" in a mature specimen; they are ciliated, and in all respects bear a close resemblance to those of the Polyzoa; they have various functions, and may be as justly called tentacles as cirri. At their base are six or more brownish pigment-spots, which resemble but have not the constitution of eyes. The segments behind the head are provided with a fascicle of locomotive setæ, some of which are shorter than the rest; there are from four to ten in each fascicle. The setæ have the form of a long straight rod, with a blade which terminates in a long filament; some of the posterior segments have

* Proc. Acad. Nat. Sci. Philad., 1883, pp. 204–12 (1 pl.); and see E. Potts, ibid., January 22, 1884.

also a fascicle of "podal hooks," which vary not only in corresponding segments of different individuals, but on either side of the segments of the same individual.

The intestinal canal is a simple median tube dilated in each segment; the mouth is unarmed, funnel-like, and capacious. There is a well-developed eye on the head at the side of the gullet, but there does not appear to be any trace of posterior terminal eyes, such as are found in *Fabricia*. The ova appear to be laid and hatched within the tube, so that the young are cared for by the parent till sufficiently developed to provide for themselves.

The paper concludes with some observations on the species of *Fabricia*, to which *M. speciosa* is most closely allied; the simple eyes were observed to vary in different individuals, and on the different sides of the same individual.

Parasitic Nematode of the Common Onion.*—J. Chatin describes an apparently new species of *Tylenchus*, which infests the bulb of the common onion. In its larval stage, it penetrates into and disorganizes the central tissue, converting the fibro-vascular bundles into a brownish pultaceous mass. Growth goes on and the sexual organs become matured; the fertilized ova give rise to claviform larvæ, which are able to escape owing to the destruction of the bulb; these, if the ground is moist enough, wander about on it, but if it is dry they remain quiescent until damp weather comes. They then enter a healthy onion, and the cycle recommences. If the nematoid enters an animal host it passes out with the fæces, and does not undergo in its intestine any further development, nor does it become encysted. On the whole it has a close resemblance to the *Anguillula* of wheat, but it is not so capable of resisting desiccation. The best remedy against it is to burn all the affected onions.

New Myzostomata.†—L. Graff gives an account of the new species of Myzostomata which were collected by Dr. P. H. Carpenter off the Crinoids of the 'Hassler' and 'Blake' expeditions; of the 22 species, 21 are new; of those 14 are peculiar to the American collections, while the others have been found elsewhere also. Postponing all details to his 'Challenger' Report, the author here merely describes the species, which may be divided into two groups: the members of the first of these are hermaphrodite, ectoparasitic, and produce no deformity on their host; all but one species are provided with suckers: in the second group the animals have the sexes separate, and live by pairs in cysts of their hosts; they have no suckers. The entoparasitic forms produce various abnormalities, merely widening the pinnulæ, or at the same time converting them into a spiral coil, or they produce pyriform outgrowths of the pinnules, or various kinds of cavities in the arms. Cysts are sometimes formed by calcareous deposits, which are found on the arms as well as on the disk.

Bucephalus and Gasterostomum.‡—H. E. Ziegler gives an account of these two parasites. After an historical review and an account of the

* Comptes Rendus, xcvii. (1883) pp. 1503–5.
† Bull. Mus. Comp. Zool., xi. (1883) pp. 125–33.
‡ Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 537–71. (2 pls.).

external form, the description of the integument is entered upon, and it is pointed out that if we look upon the tegumentary layer of the Trematodes as having the same structure as that ordinarily described as obtaining in the Cestoda, we must regard the parenchymatous-like cellular layer which succeeds the muscular as being of an epithelial nature, for its fine processes pass out between the muscular fibres, fuse above it, and secrete the "cuticle"; if this view of the nature of the parts be the correct one, it is clear that all that has been said about the presence of nuclei in the cuticle must rest on erroneous observations.

The movement of the body of *Gasterostomum* is described as being effected in the following fashion: the body is narrowed and elongated by the contraction of the circular muscles, the head is then protruded, the sucker widens and deepens, and at the same time the muscles in the upper lip of the sucker, aided by others, bring about a flattening of the anterior surface of the body and the formation of a dorsal ridge by the aid of which the body fixes itself; by the contraction of the longitudinal muscles the body is drawn after the sucker.

In both *Bucephalus* and *Gasterostomum* it was impossible to detect the limits of the cells of the parenchyma, but in the latter they were clearly seen to be of two forms; some elongated or branched, which were of a connective or muscular nature, and others rounded and less coloured, which seemed to take a part in the osmotic distribution of the nutrient material. The nervous system is briefly described.

In *Bucephalus* we find at the last third of the body a small tubular depression of the integument, which leads into the pharynx; this can suck in fluid by enlarging and then undergoing a peristaltic contraction. The œsophagus is formed by a homogeneous layer. In the intestine there are large yellowish cells; if the animal has been for a long time in water the intestine is found to have fluid contents in which float greenish yellow spherical concretions. The intestine may seem to be produced into two processes, which appear to owe their origin to the compression, on the ventral wall of the body, of the ventral sucker.

The arrangement of the muscles of the pharynx is the same in *Bucephalus* as in *Gasterostomum;* in the latter the stomach has an oval contour, while the intestine has in form, position, and structure a considerable resemblance to that of the Rhabdocœlida. The author is the first who has detected the presence of a distinct œsophagus in *Gasterostomum.*

The quantity of water which passes through the water-vascular system of *Bucephalus* is so great that it may well be supposed to have a respiratory as well as an excretory function.

In *Bucephalus*, cells with nuclei which colour intensely, are to be seen in the last fourth of the body; these are probably converted into the penial sheath; somewhat more anteriorly and dorsally there are several groups of closely appressed cells, the nuclei of which are very intensely coloured; these are supposed to be the indifferent rudiments of the reproductory elements. The generative apparatus of *Gasterostomum* is described, and a hypothetical account of the mode of action of the copulatory organ is given. By the action of the longitudinal

musculature of the penial sheath a part of the ductus ejaculatorius is evaginated, until at last the cirrus projects from the genital sinus; this is probably approximated to the orifice of the genital canal. Self-impregnation through the uterus would appear to be possible.

After an account of the remarkable "tail" of *Bucephalus*, the author passes to the life-history of the two forms. The embryo which, by unknown means, reaches the *Anodonta* or *Unio*, becomes there several centimetres long, and gives off lateral branches; the body-wall is thin, and comparable to the parenchyma of the body; within are found *Bucephali* of various stages of development, and arranged in groups. The *Bucephali* escape from the mussel by the anal siphon. After swimming about for some hours, the cercariæ sink to the bottom, and, to undergo further development, they must now enter a suitable host; in the neighbourhood of Strassburg this is ordinarily *Leuciscus erythrophthalmus* (the Rudd); the cysts lie in the connective tissue under the skin, and the containing capsule appears to be very thin and elastic. During the period of encapsulation the animal grows, its water-bladder becomes swollen out and filled with highly refractive spherules, which are probably the final products of metabolism, the stomach becomes relatively smaller, and the anterior sucker and generative organs are developed; the spines become larger and more distinct. If the host fish is eaten by another fish the encysted animals are set free and become sexually mature in the intestine of their new host; but experiments are still wanting to complete this part of the life-history of these parasites.

Development of Dendrocœlum lacteum.*—J. Jijima finds this Planarian to be sexually mature once only during its life; the ova contain an immense quantity of yolk-cells, and 24 to 42 embryos are to be found in one cocoon, whereas Metschnikoff only found 4 to 6 in *Planaria polychroa*. The ova appear to remain for a month or six weeks in their cocoon; this much longer period, as compared with the ten days of *P. polychroa*, is thought to be due as much to differences in temperature as to those of species. The segmentation is total; the solid morula has a peripheral layer of cells which seemed to be fused together, and an internal mass in which the form of the blastomeres is still recognizable; as these latter multiply the bounding layer increases in thickness, while the free nuclei become more abundant; in fact, there appears to be a process of proliferation. When the embryo is 0·2 mm. in diameter the ectoderm may be seen to be formed by a certain number of flattened cells, and the yolk-cells are then separated from the embryo. The author agrees generally with Metschnikoff in his account of the formation of the pharynx. From the fifteenth to the eighteenth day the yolk-cells inclosed in the cocoon are absorbed by the embryo, which may now be one millimetre in diameter; the pharynx undergoes degeneration and its place is taken by the cavity of the proboscis; a short time before it leaves the cocoon an oral orifice is developed. Like Metschnikoff, Jijima

* Zool. Anzeig., vi. (1883) pp. 605–10. Also Bull. Sci. Dép. Nord, vi. (1883) pp. 100–5.

could not satisfy himself as to the ectodermal origin of the nervous system. The enteric epithelium is formed of cells which are filled with a finely granular protoplasm, or small masses of fat-drops. These appear to owe their origin to the breaking-up of the yolk-cells, and it is in this region only that the cells have fatty contents. The author cannot agree with his predecessor in thinking that the yolk-cells are transformed into the epithelial cells of the intestine; he finds, rather, that these yolk-cells lose their individuality and become transformed into irregular masses, while no trace is left of their nuclei.

Rotatoria of Giessen.*—K. Eckstein commences with a review of the genera and an account of the fifty species of Rotatoria found in the neighbourhood of Giessen.

Treating of *Floscularia appendiculata* he discusses the question whether the long cilia are stiff and immobile, or whether they form currents which carry the food to the mouth, as in other Rotifers. Although never able to observe that the cilia act as described by Ehrenberg, he has been able to convince himself that they are capable of voluntary movements and react to external stimuli. The long, thin, finger-like process which lies among them has probably a sensory function. No distinct ganglion could be detected, but sensory organs were obviously represented by a process on the dorsal surface, lying just behind the wheel-organ, which carried a tuft of setæ. Two red eye-spots were seen at the margin of the orifice, when the animal was in a contracted condition. In the young the wheel-organ consists of a circlet of not very long cilia placed on the edge of the oral funnel. In *Ptygura melicerta* the foot is provided with large glands, by the secretion of which the animal is able to attach itself to water-plants; its blood-corpuscles are of a comparatively large size. *Philodina roseola* is to be distinguished from *P. citrina* by the regular distribution of its coloration, which is not absent from the first and last joints as in the other. In most of his specimens of *Rotifer vulgaris* Eckstein was able to recognize a lens in the eye; in many cases he found that one or both eyes were divided into two or three, or even into ten or twelve, red corpuscles. In addition to the cephalic ganglion there were detected a large spindle-shaped cell, lying on either side of the rectum, and exactly comparable to the nerve-cells found by Leydig in *Lacinularia socialis*. In *Notommata aurita* the ganglion consists of two layers, of which the inner is homogeneous and the outer granular. The mode of locomotion of *N. lacinulata* is described, as are the voracious habits of *Eosphora lacinulata*, the differential characters of which, as compared with *Triophthalmus dorsalis* are pointed out, and it is shown that the latter is not the young of the former. The tail of *Scaridium longicaudatum* is of great assistance in the execution of rapid movements. *Diurella rattulus* swims about with its dorsal surface downwards and executes with it movements to the right and left, while the head and tail form fixed points.

In *Monostyla lunaris* fixed points are obtained by the better deve-

* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 343–443 (6 pls.).

lopment of the carapace in certain regions. A new genus *Distyla* is defined as having the carapace depressed, open anteriorly and closed behind; the foot is one-jointed and has two long "toes." The carapace is ridged in the region of the foot, the wheel-organ is feebly developed. *D. gissensis* and *D. ludwigii* are the new species.

In *Euchlanis dilatata* the central organ of the nervous system consists of a number of lobes, and carries one large red eye; it is connected by fine filaments with a pit of tactile function. At the hinder end of the body there are two organs, which appear to be the chief ganglia of the nervous system, for they are long and spindle-shaped, and pass anteriorly and posteriorly into fine filaments. *Squamella bractea* has four eyes, of which the anterior are somewhat larger than the hinder pair, and distinctly contain a refractive body. Behind there is a small tactile tube, which is beset at its end with setæ. In *Pterodina* the foot has not, as in other Rotifers, the function of an attaching organ, but serves as the hind-gut (?); it can be contracted, but not retracted.

In the second half of this essay Eckstein enters into a general biological, anatomical, and developmental history of the Rotatoria. He finds that there is no true segmentation of the body, and that the jointing of the integument is dependent on the firmness of this layer. The apparent, or rather externally radial form of some (*Stephanoceros*, *Floscularia*) is due to their fixed mode of life.

A short comparative account of the wheel-organ is given. The colourless muscles are (1) quite homogeneous, each being formed of a single fine fibre, or (2) have in their centre a chain-of-pearl-like band of clear nuclei, or (3) they are distinctly transversely striated. Where, as in *Scaridium*, there is great muscular activity, all the muscles of the body are striated. There appears to be still much to learn with regard to the nervous system, Leydig, for example, refusing to recognize a central organ in *Lacinularia*, and describing, as chief ganglia, the four nucleated spindle-shaped swellings which lie by the mastax and the rectum. The eye-spots may lie on, behind, or in front of the central ganglion; a convex transparent lens is present in some, though not in all; the eyes may be paired or unpaired, or two may be fused into one. Other red spots, without refractive bodies connected with them, are sometimes found on the wheel-organ. The organ taken by Huxley for an otocyst is rather the calcareous pouch, which is an appendage to the ganglion, and lies either in front of or behind it. It has a spherical or reniform shape, and consists in some cases of irregular aggregations of calcareous granules; it is often continued forwards as a fine granular cord, or as a broad sac-like organ, attached at one end, and by the other projecting freely into the cœlom; further observations are necessary to determine the function of this apparatus.

In all Rotatoria (*pace* Huxley) the anus lies on the neural side; the excretory system has a contractile vesicle formed of a fine structureless membrane, bounded by a system of delicate and almost invisible muscular fibres, which suddenly contract its lumen; the vesicle enlarges again slowly by the elasticity of its walls, or by the pressure of the inflowing fluid. The canal on either side may be

followed up to the neighbourhood of the wheel-organ; the transverse canal described by Huxley in the cephalic region of *Lacinularia* has not been detected by any subsequent observer. The author describes the ciliated infundibula as having their thinner end attached to the canal, and their broader one hanging freely into the cœlom. From the upper end a broad cilium projects into the lumen of the funnel, and moves either rapidly or slowly; Eckstein does not think that the swellings are funnels—that is, he does not regard them as open at their free end, but as being completely closed by a hemispherical operculum, to the middle of which the long cilium is attached. Below this operculum there is an orifice, which in the smaller species is small and round, but is generally large and oval; at this hole there commences a very short tube, which leads at once into the lateral canal. By the action of the cilium the waste products of the body are forced into this canal, and so make their way by the contractile vesicle to the exterior. The differences from this typical arrangement which are found in various Rotifers are pointed out, and the resemblances to what Fraipont has found in the excretory organs of the Trematoda are indicated.

The club-shaped pedal organs are next considered, and the tendon by which they are kept in place alluded to; these organs are glands with finely granular contents, and in their middle a line of greater transparency may often be detected, which is probably the optical expression of a groove, in which the secretion of the glands is collected, and by which it is conveyed to the exterior. Sometimes the secretion appears to serve as a means by which the foot may be glued down, in other cases it gives rise to a fine filament; the function, however, of this secretion is not so much to fix the animal down for a time as to attach it until the third joint of the foot is firmly affixed, when the first and second joints being retracted, a vacuum is formed. Respiration appears to be effected through the skin, and this appears to be the function of the pores of *Brachionus plicatilis*. There is no circulatory system developed. The author is unable to explain the office of the "renal organs" discovered by Leydig in the young of *Floscularia*, *Stephanoceros*, &c. (Cohn has already objected to Leydig's view of the renal function of the organ in question); nor can he say anything as to the organ found near the intestine in *Squamella*, or the body which lies dorsally to the intestine, with which it is connected, in all species of the genus.

Eckstein next discusses the well-known phenomena of the dimorphism of the sexes, and the structure and characters of the reproductive organs; in the Philodineidæ the ovum passes through the earlier stages of development in the uterus, but, owing to the movements of the body, this apparently useful arrangement is of no advantage to the student. Like some later observers, the author would call the winter ova lasting ova, as they are by no means developed in the winter season only, but are rendered safer by the possession of a firm shell. As in other divisions of the animal kingdom, parasitic habit has its effect on the organization of the parasitic form, such as *Seison*, or *Albertia*.

The Rotatoria are divided (1) into those in which the female always has, and those in which it has not an anal orifice to the intestine; (2) the former into (α) those that are permanently fixed, and (β) those that are free-living; (3) the former of these into (i.) separate, (ii.) colonial forms; the latter into those in which (i.) the body is rounded and apparently unsegmented, and (ii.) the body is saccular or flattened with apparent segments. Into the further details of this somewhat artificial classification we have not the space to follow the author.

After reviewing the opinions of previous writers as to the systematic position of the Rotatoria, Eckstein points out that their direct alliance with the Annelida is opposed by the early appearance of segmentation in those forms; the view of Korschelt and Metschnikoff that the Rotatoria are allied to the Turbellaria by *Dinophilus* is affected by Graff's belief that that genus is a true Rotifer. The author would associate with the Rotifera the Gastrotricha, but, in truth, their systematic place is even more indefinite than that of the Rotifera themselves.

Rotifer within an Acanthocystis.*—Dr. A. C. Stokes' account of an observation of a rotifer living within the rhizopod *Acanthocystis chætophora* is not perhaps written with any severity of scientific style, but it is evident that any abstract we could give of it would fail to convey a correct idea of the original. It is also the first instance of which we are aware, of astronomical time being applied to microscopical observations.

"Recently one of these spinous creatures [*Acanthocystis*] appeared under my Microscope. It seemed to be alive and well, but within it near the armoured surface, was a semi-transparent moving something that was too active to have a right there. As the motions of this foreign body became more impulsive, it turned completely over and showed itself to be one of the rotifers. In size it equalled not more than one-third the *Acanthocystis*' diameter, but dwarfish stature was amply compensated by nimbleness.

With a leap, prodigious for so small a creature, the rotifer dashed against the wall and hurled the rhizopod down the field, while the silicious spines snapped and flew. If the scene was exciting to the spectator, what must it have been to the *Acanthocystis*, with that jumping Jonah leaping among its vitals? It was no joke to either party. A struggle for life was going on under my very eyes. The rhizopod, with every particle of its jelly-mass surrounding the rotifer possessing digestive power, seemed calm, perhaps with the calmness of despair, but the rotifer—oh how she plunged! Not a moment did she rest, not a muscle did she leave unused, not a manœuvre untried. The situation appeared a bad one for that rotifer, since she bade fair to be digested. She stretched herself and forced out the spinous armour until it seemed on the point of rupture; the *Acanthocystis* simply flattened the opposite side and waited, digesting. The rotifer leaped, she turned, she pushed with her two sharp toes against the wall; the

* The Microscope, iv. (1884) pp. 33-5.

rhizopod rolled over the field, the spines were loosened and fell off, yet that rotifer remained in the corner where she first appeared, pressed down by the *Acanthocystis*' body-mass, although her efforts were continually nothing less than frantic. For six hours the struggle lasted; from 14 to 20 o'clock the microscopic creatures were under uninterrupted observation. Finally, after a short rest on the rotifer's part, there occurred one of the most amusing exhibitions of intelligence in these lowly organisms that I have ever seen. It was indeed a most masterly piece of strategy. *The rotifer began to eat!* Protoplasmic jelly, chlorophyll-corpuscles, half-digested food-particles, everything the *Acanthocystis* contained streamed down into the rotifer's transparent stomach. With short intervals, which she improved by butting against the wall, she ate until she arrived at the central nucleus, when, apparently perceiving that her object was accomplished, she stopped, and then—it really did seem as if she was celebrating her victory—then she laid an egg!

The rhizopod once dead and half empty, the brave rotifer selected the spot at which she intended to leave, and left. It is a curious fact that, having chosen the place for exit, she continued to beat against that point only, until the basal plates were forced aside, and she was free. Circling once or twice around the dead *Acanthocystis* she darted from the field, followed by applause, and a few remarks of approval from the spectator.

By 24 o'clock the ovum that had been extruded in my presence as well as in prison, which I had seen rolling down the half-empty *Acanthocystis*' sac, had accomplished a part of its internal changes, but an awkward movement displaced the cover-glass, and ruined all.

Did that unhappy rhizopod in an absent-minded moment take in an egg, and did that egg eventually take in the rhizopod? Was the development of the egg so far advanced that the rotifer was hatched before it could be digested?"

Cœlenterata.

New Alcyonarians, Gorgonids, and Pennatulids of the Norwegian Seas.* — J. Koren and D. C. Danielssen have published another of their beautifully illustrated works on the fauna of the Northern Seas; they describe a new genus *Duva*, in which they place three new species, and the *Gorgonia florida* of J. Rathke, which is not the same form as the *Gersemia florida* of Marenzeller. The other new genus is *Göndul*, for which it is necessary to establish a new family of Pennatulids—*Gönduleæ*—characterized as having the rachis fixed, with developed bilateral pinnules, and furnished with long calcareous spicules. The stalk in *Göndul* has a canal in its centre, which is divided by four valves into as many longitudinal canals. The genus *Cladiscus* is removed from the family Protocaulidæ, where it was placed by Kölliker, to the Protoptolidæ, in consequence of the presence of well-developed "cells." A number of new species are

* 4to, Bergen, 1883, xvi. and 38 pp. (13 pls.).

described, but, unfortunately, only the diagnoses are given in English, the full details being described in Norwegian. There is, however, a brief description of the plates in English.

Origin of Coral Reefs.*—Prof. A. Geikie sums up a considerable amount of evidence which has accumulated since Charles Darwin's theory on this subject was put forth, tending to show that the theory (essentially that of growth of coral in connection with subsidence of the sea bottom) is by no means universally applicable. Semper and Rein supposed that in some cases raised masses of sand or deep-water corals are formed which afford resting places for surface-growing corals; the form of the islands, Semper held, is caused by the death of the inner parts of the colonies of corals, and by the action of the tides. Mr. J. Murray, from observations made on the 'Challenger,' considers that volcanic cones, such as form most oceanic islands, tend to be reduced to submerged banks by the action of the waves; also that the raising of the sea bottom to such a height as to favour the growth of corals, is due to the unusually rapid accumulation near the shore of calcareous débris derived from dead pelagic organisms. These are so abundant as probably to represent upwards of 16 tons of carbonate of lime in suspension in the uppermost 100 fathoms of every square mile of the ocean. In the deepest water these appear to be dissolved before reaching the bottom, but they accumulate on shallow bottoms, and thus furnish foothold for sponges, various Cœlenterates, &c., which in return die and bring up the bottom to the level of reef coral growth. This, taking place on a submerged bank, would produce the atoll form of island, which would tend to widen by death inside, and by the consequent solution of the dead coral by the carbonic acid of the sea-water. Special cases, such as elongate chains of atolls, e. g. the Maldives, or submerged banks, as the Chagos, fall in with the theory. Barrier reefs are similarly explained as due primarily to growth upon accumulations of débris around land.

Porpitidæ and Velellidæ.†—We have here a notice of the work of A. Agassiz on these little known Hydrozoa. *Velella mutica*, of the coast of Florida, is much larger than the Mediterranean *V. spirans*, and not unfrequently reaches 4 in. in length. It is exceedingly common in Key West Harbour, which it visits in large schools. Feeding is chiefly effected by the large central polypite of the system, and this, together with the smaller polypites, is connected at its base with the general vascular system, through which, as in the polypites, the fluid is rapidly propelled by the lining cilia. At the base of the polypite are the medusoid buds, and these, it is interesting to note, early become provided with the yellow cells which are characteristic of the free Medusæ. The young present a striking resemblance to certain Tubularian Medusæ, being provided with a row of lasso-cells which extend from the base of the tentacles to the abactinal pole.

The Floridan species of *Porpita* (*P. linneana*) is, similarly, larger than the Mediterranean *P. mediterranea;* unlike *Velella* it has a

* Nature, xxix. (1883) pp. 107–10.

† Mem. Mus. Comp. Zool., 1883. See Nature, xxix. (1884) pp. 262–3.

considerable power of control over its own movements, and is by no means so much at the mercy of the winds or waves. If upset in the water it returns to its original position by bringing its tentacles together over the disk, and throwing up the free edge of the mantle in a given direction, then expanding the tentacles of one side far over in the opposite direction beyond the central part of the disk; thus, it readily changes the centre of gravity and tilts the overturned disk back again. Medusæ are to be found at all stages of development.

Prof. Agassiz suggests that *Porpita* is allied to the Hydrocorallinæ, and he bases this suggestion on the possession of the so-called white plate, the peculiar structure of which reminds him of the corallum of *Sporadopora*, *Allopora*, and *Millepora;* there are large pits, and the whole mass is spongy from being riddled with passages and openings; but there are not, of course, the regular horizontal floors which are seen in *Millepora*.

The value of the paper is greatly increased by the twelve plates, two of which give coloured full-sized representations of the two species described.

Porifera.

Physiology of Gemmules of Spongillidæ.*—To this subject, which is now exciting considerable interest, Dr. W. Marshall contributes some arguments and observations which should be compared with those given by Dr. Vejdovsky (see below). The wall of the gemmules of *Spongilla nitens* (as of *S. carteri*) consists of a system of closed spaces or cells. In *S. nitens* they form six-sided columns with their long axes tangential to the central mass; they diminish in size towards the interior of the gemmule; the outer cells are hollow and in the dry state filled with air, the innermost are solid. These cells are not histological cells, but of cuticular character; their walls are strongly refractive, and resist combustion stubbornly; fluoric acid destroys their refractive power and brittleness, so that it appears not improbable that they contain a large proportion of silica; the inner layer of spined spicules is attached to this cellular layer with more firmness than to the subjacent horny layer. *S. nitens* has an air-space, formed by the chitinous layer, as in *S. carteri*, which enables the dry gemmules to float for from 8 to 10 days in water. The elaborate envelopes which cover the abundant starch which accompanies the germinal matter provide in the most satisfactory manner for the protection and welfare of this material. Various arguments are advanced in favour of the aerostatic character of the cellular coat of the gemmule, viz. the smallness and, owing to the great relative development of this layer, the lightness of this body in *S. nitens*. In the districts where the sponge occurs it must often be left dry by evaporation and the gemmules subsequently set free may be carried long distances by the wind, and eventually germinate if they meet with fresh water again. Thus, of Ehrenberg's figures of organisms found in trade-wind dust, about 24 per cent. refer to sponges, and of these fragments about 16

* Zool. Anzeig., vi. (1883) pp. 630–4, 648–52.

per cent. (4 per cent. of all the organic remains) are whole or fragmentary amphidisks of *Spongillidæ;* the absence of entire gemmules is explained by the distance which Ehrenberg's dust had travelled, viz. to Europe from (probably) North-west Africa.

By experimenting directly on gemmules of *Spongilla lacustris* and *nitens*, by drying them for 8 days, piling 50 of each species together into one heap on a smooth plate, and blowing at them with a bellows, it was found as the result of this operation, repeated six times, that the gemmules of *S. nitens* were scattered to a greater distance than those of *lacustris*, viz. 75 per cent. beyond a radius of 5 centimetres, as against the 64 per cent. of those of the other species which stayed within this radius.

The gemmule of the South American species *Parmula Brownii* has a very compact spicular shell, the spicules show a tendency to radiate from points at which the capsule is in contact with the true envelope of the gemmule: the latter envelope is covered with conical eminences which fit loosely against the outer capsule while dry, but come closely against it after soaking for some time in warm water—probably showing that it is a special arrangement to allow of the expansion of the germ, the outer capsule having no opening. The shield-like spicules overlap and cover all the surface of the inner envelope except the eminences just described. The outer capsule is usually firmly united to the surrounding skeleton. The sponge is known to affect, as its rooting places, stones which are alternately wetted and left dry. Thus, the close connection of the skeleton with the capsule secures it from being detached when dried, and the overlapping arrangement of the shield-like spicules prevents excessive collapse of the tender underlying envelope.

The heaviness of the gemmules of *Spongilla lacustris*, and their projecting spicules (like the hooks of Polyzoan statoblasts) tend to anchor them and prevent undue rapidity of transportation by currents. The gemmules of the allies of *S. fluviatilis* are heavier than those of *lacustris* and allies, and hence are less mobile and better adapted to rapid streams. The three layers of amphidisks in the gemmule of *Meyenia mirabilis* Retzer (a recently described species) are perhaps an adaptation to very rapid waters.

Marshall thinks it not inconceivable that external circumstances (e. g. long sojourn in still water) might transmute *Spongillæ* (*Euspongilla*) into *Meyeniæ*, and *vice versâ;* of the present occurrence of these changes perhaps *Euspongilla jordanensis* var. *drulicformis* Vejdovsky affords an example in the transitional characters of its gemmule spicules.

European Fresh-water Sponges.*—Dr. F. Vejdovsky supplements his former study of this subject† by some additional observations: firstly he establishes the new species *Ephydatia amphizona* for the form previously described by him as *Eph. Mülleri forma B.*, reserving

* Abh. Böhm. Gesell. Wiss., 1883. See Ann. and Mag. Nat. Hist., xiii. (1884) pp. 96-8 (1 pl.).

† See this Journal, iii. (1883) p. 858.

Lieberkühn's name *Eph. Mülleri* for his own var. *astrodiscus*. The Bohemian *Eph. fluviatilis* is identical with the British *Spongilla fluviatilis*. Turning to the different layers of the wall of the gemmules, he finds the new species to be distinguished by possessing two concentric layers of birotulate spicules; of these the outer layer project from the external parenchymatous layer by their shafts and outer disks, the inner disks lying in the subjacent parenchyma; a thick parenchymatous layer is now found (as we pass inwards), containing on its inner aspect the internal layer of birotulate spicules, whose inner disks are in apposition with the brown chitinous membrane, which immediately incloses the germinal corpuscles. *Trochospongilla erinaceus*, from the Elbe, shows the following characters in its gemmules. The layer which represents the parenchymatous layer of other *Spongillidæ* is modified to form a mass of five- to six-sided long prismatic columns, whose long axes are perpendicular to the surface of the gemmule; they are divided transversely into air chambers; the walls are firm and glistening, and probably consist of chitin. Beneath this layer come the amphidisks, lying on the very stout and laminate chitinous membrane. The parenchymatous layer, as here modified, probably acts as an aerostatic apparatus for the transportation of the gemmule, and corresponds exactly to the natatory rings of the statoblasts of many fresh-water Polyzoa. Dr. Vejdovsky has hitherto been unable to discover a similar arrangement in the nearly allied North American *Meyenia Leidii*.

New Genus of Sponges.*—G. C. J. Vosmaer gives an account of *Velinea gracilis*, a new genus or species of sponge found in the Bay of Naples. A study of this form has convinced him that the water which enters a sponge, having once passed a ciliated chamber, does not enter another, but is carried away. The skeleton is very remarkable; it consists of a rather regular network of horny fibres, lying in three planes, and the six fibres forming the longitudinal, concentric, and radial systems meet at approximately right angles, so that the contained meshes are nearly square. The skeleton is, speaking generally, solid and hexactinellid.

The author does not feel himself able to speak definitely as to the characters of the epithelial cells, as he was not successful in detecting their limits; a similar kind of epithelial cell is found in all the afferent and efferent canals. The collar-cells are remarkable for their small size.

In discussing the systematic position of *Velinea*, the author enters in detail into the characters of the allied families Aplysinidæ, Aplysillidæ, Spongidæ, and Hircinidæ; placing it in the family of the Spongelidæ. Useful differential characters are given for these five families.

Protozoa.

Bütschli's 'Protozoa.'—Parts 20–25 of this work have been published with plates xxxix.–l. They deal with the Mastigophora, Diesing's name being applied to what are now more often called the Flagellata.

* MT. Zool. Stat. Neapel, iv. (1883) 437–47 (2 pls.).

The organisms placed in this division are characterized by the fact that the motile stage forms the chief period of their lives; and this stage is not only that which is relatively the longest, but that also in which the organism best exhibits its nutrient and growing activity. The objection that it is often impossible to separate the Mastigophora from certain of the simpler Sarcodina, as well as from certain simpler vegetable organisms, such as the Protococcoid Algæ, the Myxomycetes, and the Chytrideæ is to be met by the reflection that all these forms have a common origin.

The Mastigophora may be divided into four subdivisions or orders: (1) Flagellata, or forms which have flagella without either superadded cilia or "collars"; this is the largest and most varied group. (2) Choano-flagellata have a collar at the base of the single flagellum, which calls to mind the collared or so-called endodermal cells of sponges. (3) Cystoflagellata have a retiform structure of their protoplasm, not unlike that which is seen in plants; and they are, further, characterized by their peculiar form, and, possibly also, by their reproductive phenomena. The (4) Cilio-flagellata have cilia as well as flagella.

An interesting historical review is followed by the citation of 206 separate works or essays. The Flagellata are divided into the (1) Monadina, which are of simple structure and have one flagellum, or two small ones; there is no special oral orifice, or it is simple and is not continued into a well-developed pharynx. (2) Euglenoidina: these are better developed forms of some considerable size, ordinarily provided with one, but in some cases with a second small or large flagellum. The so-called mouth at the base of the flagellum is constantly present, and often leads into a distinct pharynx. (3) Isomastigopoda, with two or, more rarely, four or five subequal flagella; mouth rarely developed, and nutrition very ordinarily effected as in plants. (4) The Heteromastigopoda have two flagella at the anterior end, which are equal or unequal in size, and are respectively directed forwards and backwards.

The structural and developmental characteristics are entered on, and treated of in detail, but the arrangement of the genera and species is not yet begun.

New Infusoria.—D. S. Kellicott describes* a *Cothurnia*, a parasite of the crayfish in America, to which he gives the specific name of *variabilis*, as he finds it to vary so much. The lorica is about twice longer than broad. Seen from the side, it is strongly ventricose, and uniformly convex posteriorly. The neck is narrow, its width being less than half that of the carapace; the laterally compressed orifice is set very obliquely, sometimes quite vertically, with the upper edge produced into a cusp, and with a tooth-like angle in the middle of either margin; the aperture is sometimes awry, turning the cusp to one side of the axis of the shell. The peduncle is short, not exceeding, as a rule, one-fourth the length of the lorica;

* Bull. Buffalo Naturalists' Field Club, i. (1883) pp. 112–4 (5 figs.). Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 105–7 (5 figs.).

it is often less, and the shell apparently sessile. The animal is attached to the bottom of the sheath; the peristome is narrow and is protruded only a short distance beyond the edge of the aperture. The contents of the zooid's body are finely granular; the nucleus of the usual bandlike pattern. The animal is very timid, and very rarely ventures beyond its shield while under observation.

The same author also describes * *Epistylis Niagaræ* n. sp., which occurs on the crayfish of the Niagara, and probably on other convenient supports, although not yet found elsewhere. It fastens upon the antennæ and exoskeleton, forming whitish, mucilaginous patches. The pedicle branches dichotomously, is smooth, attains 1/10 of an inch in length, and bears many zooids. So far the characters are closely those of *E. plicatilis* or *E. Anastatica*, both abundant in the same river. The zooids are elongate, more than three times as long as broad, slightly gibbous, much attenuated at the lower extremity. The body is constricted below the peristome border, which is thickened or collar-like. The ciliary disk is continued above the peristome as a prominent boss-like granular body. The inclosure is fine granular, the cuticle smooth. The nucleus is flat, twisted, and placed transversely at the upper third of the body. When contracted the ovoid bodies have a snout-like projection which is strongly striate longitudinally. Length of body fully expanded ·0064 in.

Dr. A. C. Stokes describes † several apparently new infusoria from putrid waters, *Heteromita putrina* and *Tillina saprophila* from an infusion made by placing the tail of a dead rat in river water, and *T. inflata* from an infusion of the outer layers of the bulb of a Chinese *Narcissus*.

Dr. A. C. Stokes also describes ‡ a *Pyxicola* which he believes to be new, and names provisionally *P. constricta*. He has also found § *Salpingœca urceolata* S.K. in fresh water, or at least a fresh-water variety of it.

J. Künstler describes || a fifth species of *Nyctotherus*, *N. Duboisii*, which inhabits the intestine of the larva of *Oryctes nasicornis*.

Reproduction in Amphileptus fasciola.¶—Dr. A. S. Parker believes he has observed a method of reproduction not hitherto described in the Infusoria. His attention was attracted by a peculiar oscillating movement, the *Amphileptus* rocking from side to side, the animal remaining stationary, although its cilia were in active motion. In other respects the animal appeared normal, no changes being observed in its nucleus, protoplasmic contents, or contractile vesicle. Shortly afterwards he found that the elongated extremity was breaking up into small masses of protoplasm; these gradually separated from the parent body, and each of them exhibited distinct amœboid movements. Although the cilia seemed to break off with

* Bull. Buffalo Naturalists' Field Club, i. (1883) pp. 115–6 (1 fig.). Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 110–1 (1 fig.).
† Amer. Natural., xviii. (1884) pp. 133–40 (5 figs.).
‡ Amer. Mon. Micr. Journ., v. (1884) pp. 24–5 (1 fig.).
§ Ibid., pp. 25–6 (2 figs.).
|| Journ. de Microgr., viii. (1884) pp. 86–92 (1 fig.).
¶ Proc. Acad. Nat. Sci. Philad., 1883, pp. 313–4.

the small masses, he could not detect any signs of their presence after separation. For about five minutes small protoplasmic masses, exhibiting distinct and independent amœboid movements, continued to be shed.

The rocking movement still continued, but now commenced to show signs of being converted into a movement of rotation. Finally, a rotary motion was established, and the animal commenced to change its position. At the same time was noticed a distinct elongation occurring at the end where the changes described above had taken place, a rounded projection appearing, which gradually elongated, until finally, in the course of about two hours, the individual had assumed its original shape and activity, although apparently somewhat diminished in bulk. Cilia covered the new growth, but they did not seem to be a new formation, but were produced by a simple elongation of the ectosarc, this being carried forward by the growing endosarc. As regards the protoplasmic masses that were shed or discharged, he observed them for about four hours, at which time they were still active, and the parent mass still in active motion. On the following day he was unable to detect them, and as to their subsequent history knows nothing.

To characterize the phenomena as described above, the term "Reproduction by Partial Dissociation" is proposed. Reproduction by fission, gemmation, conjugation, and encystation have all been observed in the ciliated infusoria; and some of the older writers, such as Ehrenberg and others, have described a mode of increase, in which the substance of the body breaks up into a number of fragments, each of which is capable of becoming a distinct individual. This process they called diffluence, but Stein and more recent observers have denied the existence of this process, claiming that it was merely a form of increase from encysted forms. The phenomena, as exhibited by *Amphileptus fasciola*, seem to be quite different from those described as occurring in diffluence, and it certainly was not a case of encystation. Dr. Parker being unable to find any account of reproduction in the Infusoria resembling that described, places the facts on record, in order that the attention of other observers may be directed towards the verification of the phenomena and views expressed above.

Orders of the Radiolaria.*—E. Häckel reports that he has been able to add considerably to the two thousand new species of Radiolaria which, some time since, he was able to announce that he had detected "among the inconceivably rich Radiolarian collection of the 'Challenger' collection." Increase of knowledge has led to a reduction of the proposed seven orders to four, and the complicated system is now "much more comprehensible"; it now seems to be certain that the distinction between the monozoic (solitary) and the polyzoic (social) Radiolaria is not so important as was once imagined, and it has been found that, contrary to the opinion of Hertwig, the central capsule is in all Radiolaria uninuclear at an early and

* SB. Jenaisch. Ges. f. Med. u. Nat., 16th Feb., 1883. Cf. Nature, xxix. (1884) pp. 274-6, 296-9.

multinuclear at a later stage. New Radiolaria have been discovered, which, agreeing in the specific characteristics of the skeleton, are some monozoic and some polyzoic. The Monocyttaria and Polycyttaria of Müller are, therefore, no longer to be regarded as important divisions.

The objections lately raised by Brandt to the importance of the character of the presence of a central capsule cannot be substantiated, and Häckel is of opinion that this author's views have been based on too narrow an area of investigation. On the other hand, yellow cells have not the importance that was once attributed to them; "they are in no way necessary for the nourishment of the Radiolaria, though they may be important agents in the matter."

The four orders now recognized are the Acantharia, Spumellaria, Nassellaria, and Phæodaria; they are distinct monophyletic groups, and Bütschli was right in laying stress on the fact that the complicated phylogenesis of this section, so rich in specific forms, is a strong argument in favour of the doctrine of descent, and that "in this way those painstaking investigations of the microscopic world (which many 'exact physiologists' consider mere morphological trifling) come to be of real importance."

The Acantharia, which never have a true silicious skeleton, correspond on the whole to the Acanthometræ of J. Müller; the ancestral form of the order appears to be *Actinelius* (first described by Häckel in 1865), and it may be supposed to have arisen from *Actinosphærium* by the hardening of the firmer axial fibres in the radial pseudopodia of the latter into radial spicules.

The Spumellaria are equivalent to Hertwig's Peripylea, Thalassicollea, and Sphærozœa, and are all referable to *Actissa*, in which there is neither an extra- nor an intra-capsular alveolus; it is, perhaps, the ancestral form of all the Radiolaria.

The Nassellaria (Monopylea of Hertwig) are characterized by having a simple area of pores at one pole of the axis of the capsule; the ancestor is to be found in *Cystidium inerme*, which is distinguished from *Actissa* by this restriction of the pores.

The fourth group are better called Phæodaria than Pansolenia (Häckel) or Tripylea (Hertwig), as the only character in common is the possession of the peculiar phæodium—a voluminous dark body of pigment, which lies excentrically outside the central capsule, while the latter has a double membrane and a radiated operculum. The ancestor is the skeletonless *Phœodina*.

The systematic survey of the families concludes with a table of the differential characters of the four orders, a "conspectus ordinum et familiarum," and a hypothetical ancestral tree of the Radiolaria.

Bohemian Nebelidæ.*—K. J. Taránek describes the structure of the shell and inner envelopes and of the soft parts of these Rhizopoda. He finds they form a transition in their shell-characters from the *Difflugiidæ* to the *Euglyphidæ*. The shell is always more or less laterally compressed. Besides the species in which the shell is con-

* Abh. Böhm. Gesell. Wiss., xi. (1882) 55 pp. (5 pls.).

stantly colourless, specimens, apparently young, of *Nebela bohemica*, a coloured species, may be found colourless, as occurs in the *Euglyphidæ* and in *Arcella*. In the shell of *Nebela bursella* alone were perforations found, viz. two on each of the narrower sides; their function is, perhaps, to admit water into the spaces inside the shell, between the protoplasmic attachments of the body (called *epipodia* by Taránek), as they occur under similar conditions in *Hyalosphenia*, and the admission of water would have advantages for the animal. Taránek is unable to corroborate Leidy's statement that the smallest tests have the largest chitinous plates. In occasional examples of *Nebela bohemica* and *collaris* the plates are reduced to small granules, scattered over the surface, or they may be absent altogether, and the chitinous membrane left bare, or encrusted with foreign bodies. The plates consist of amorphous silica, as they resist combustion and weak acids and alkalies; strong sulphuric acid dissolves them slightly; they are firmly imbedded in the chitinous membrane, except in *Quadrula*.

With regard to their origin, the author comes to the conclusion that they are formed by the animal itself, from their resemblance to those of the *Euglyphidæ*, which are undoubtedly thus produced. The thickest plates are those of *Lecquereusia*, the thinnest those of *Quadrula*. The chitinous membrane is susceptible of staining, and thus, and from the mode in which foreign bodies are attached to it, evidently itself constitutes the only cementing substance employed; it sometimes projects outside the margins of the plates, and can here attach foreign bodies to itself. The sarcodic body of the *Nebelidæ* has the definiteness of form common to all the *Monothalamia*. As observed in specimens kept without food, the ectosarc is completely hyaline and structure- and colour-less; it is viscous, the outer part more so than the inner, which thus, and by acquisition of granules, gradually passes into the endosarc. The endosarc has usually a pale yellow colour, and contains refractive bodies (microsomata) of two sizes. The nucleus is relatively large, and remains constantly at the back of the body, in the shell; a nucleolus is only occasionally noticed, has a dark or blueish colour, and a globular form; one or more nucleoli (up to five) may occur. A contractile vacuole was always observed, usually one or two; in *Lecquereusia*, *Heleopera*, and *Quadrula* three occur, closely associated. The author frequently finds in *Nebelidæ* chlorophyll masses derived from food, but never showing signs of being produced by the animal itself. The pseudopodia are formed by the streaming forward of the clear ectosarc, which divides into five to nine cylindrical lobes, the body at the same time becoming further removed from the inner wall of the test. The epipodia, when the animal is extended, form long filamentous processes of ectosarc.

The animals live chiefly in peat-moss water, and prefer it when it is low; they either swim, with the mouth downwards, by movements of the extended pseudopodia (five to twelve in number), or creep by means of fewer pseudopodia, which attain the length of the shell, and have a flattened form; they drag the shell after

them. Food is seized by and inclosed in a long pseudopodium, and is ultimately massed into small round nutriment-balls. Encystation takes place from June to September; the sarcode previously becomes almost opaque with nutritive substances, which later are resolved into strongly refractive oily globules of different sizes; the pseudopodia are withdrawn, the epipodia become shortened, the contractile vacuoles disappear, the nucleus becomes invisible, and the body withdraws more and more into the hinder part of the test, extruding various excreta such as diatom-shells, which are massed in the mouth of the test, forming the *diaphragm*, which becomes yellowish, probably from iron oxide.

Taránek fully describes and figures with some classificatory and distributional tables the species obtained in Bohemia: viz. *Nebela collaris; flabellulum; carinata; hippocrepis* Leidy; *bursella* Vejdovsky; *bohemica*, a new species with compressed shell without processes, an oval entire pseudopodial opening, provided with a short neck; *americana*, a new species with a shell not compressed, flask-shaped, and devoid of spines; *Heleopera petricola* Leidy; *Quadrula symmetrica* F. E. Schulze; *Lecquereusia spiralis* Bütschli; and a new generic type called *Corythion dubium*, as yet only known by the test; this is small, has a pale yellow tint, is more or less broadly oval, and the pseudopodial opening is subterminal, roundish or oval to half-moon shaped, resembling that of *Trinema acinus;* it is made up of very small, oval, silicious plates (often round near the opening), arranged irregularly, and imbedded in the chitinous layer.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Living and Dead Protoplasm.*—O. Loew returns to the subject of the different reactions of silver salts on living and dead protoplasm. By a fresh series of experiments he claims to have confirmed his previous results that the albumen of living cells alone has the power of reducing the silver, the death of the cell causing a chemical change in the albumen which deprives it of this power.

Aldehydic Nature of Protoplasm.†—A. B. Griffiths, after reference to the work of Loew and Bokorny, Reinke, and others, as well as to a previous communication of his own,‡ describes his new experiments.

He has examined the protoplasm of living and dead cells of *Spirogyra*, and finds that it reduces alkaline solutions of cupric salts; that crystals are found in it by treatment with weak sodium chloride, and that the addition of absolute alcohol to the cells of the *Spirogyra*

* Pflüger's Arch. f. d. Ges. Physiol., xxx. (1883) pp. 348-68. Cf. this Journal, i. (1881) p. 906; ii. (1882) pp. 67, 361, 440, 522; iii. (1883) p. 225.

† Chem. News, xlviii. (1883) pp. 179-80.

‡ Journ. Chem. Soc.—Trans., xliv. (1883) p. 195.

causes the deposition of crystals of anhydrous *dextrose*. It is therefore probable that the reducing properties of protoplasm are due to this glucose, and that the crystals formed with sodium chloride are $C_6H_{12}O_6$, $NaCl + H_2O$.

This view is supported by the following experiments:—Albumin (white of fresh egg) mixed with a small quantity of a very dilute solution of dextrose, when treated as above described, behaves in a manner precisely similar to the *Spirogyra* cells. Moreover, if the living plant is kept in the dark for a couple of days, and is then examined, none of these reactions are observed. This is evidently due to the dextrose being used up in the dark to nourish the cell-walls and tissues; for, after a short exposure to sunlight, the dextrose reappears, and the usual phenomena are to be observed in the plant-cells. The author concludes with some remarks on the aldehydic nature of dextrose, on the assimilation of carbon by plants, and on the importance of researches on albumin.

Embryo-sac and Endosperm of Daphne.*—K. Prohaska brings forward the structure of the embryo-sac and mode of formation of the endosperm of *Daphne* as an illustration of the law that the polar nuclei do not always coalesce to form a secondary nucleus of the embryo-sac; and that the formation of the endosperm may take place without their assistance.

The mature embryo of *Daphne* exhibits clearly two synergidæ and an ovum; while at its lower end is a group of more than three antipodal cells without any cell-wall. While the upper half of the embryo-sac contains but little protoplasm, its lower portion is filled with a dense mass, in which are two quite distinct nuclei with sharp outline, which can be shown to be the polar nuclei. In certain young states of the flower these nuclei are found in the two poles of the protoplasm, which is clearly detached from both the embryonic vesicles, and the antipodals; the lower nucleus subsequently approaches the upper pole; and still later, both are seen near to the embryonic vesicles forming a double nucleus. This double nucleus now moves gradually to the lower part of the protoplasm, which is no longer distinctly separable from the embryonic vesicles; protoplasm collects round it, and the number of antipodal cells increases after fertilization from 2 or 3 to 20. This double nucleus, therefore, corresponds to the secondary embryo-sac nucleus of other plants. It is therefore quite evident that a secondary embryo-sac nucleus is not formed after fertilization by the coalescence of the polar nuclei; but that, while this double nucleus remains, the formation of endosperm commences in the parietal layer of protoplasm by the free formation of nuclei.

The following details are obtained from a number of preparations of *Daphne Cneorum* and *Blagyana*. The parietal protoplasm is often thickened in longitudinal threads, and contains moniliform strings of vacuoles both before and at the beginning of the formation of the endosperm. In it are seen small usually circular or elliptical portions of denser protoplasm filled with minute granules, shown by the

* Bot. Ztg., xli. (1883) pp. 865–8 (1 pl.).

application of pigments to be chromatin structures, and which develope into the nucleoli of the endosperm-nuclei. The nucleoli contain a very thin finely granular border of protoplasm; its granules, apparently grouped into short threads, surround the central nucleolus in a radial manner. The layer of protoplasm thus formed becomes gradually detached from the surrounding protoplasm of the embryo-sac, loses its radial framework, and forms at length a clear zone round the nucleolus containing only a few scattered granules.

The nuclei in the parietal layer are sometimes formed separately, whether in the lower or upper part of the embryo-sac; sometimes in groups.

Constitution of Albumin.*—From the reaction of superosmic acid O. Loew argues that the leucin and tyrosin compounds do not occur ready formed in the molecules of albumin; but that they are readily produced—especially the benzol-nucleus of tyrosin—when albumin undergoes decomposition. The basis of the formation of albumin he considers to be a process of condensation rather than one of complicated synthesis.

Fertilization of Sarracenia purpurea.†—F. Hildebrand describes the mode of pollination in *Sarracenia purpurea*, where the male and female organs are mature at the same time, but their relative position is such that fertilization is almost impossible without the assistance of insects, and self-fertilization is even then rendered very difficult.

He also describes the arrangements for self-fertilization in a water-plant, *Heteranthera reniformis*, and for cross-fertilization in *Salvia carducea*, which differs from other species of the genus in the immotility of its stamens.

Sexual Relations in Monœcious and Diœcious Plants.‡—F. Heyer has carried out a number of experiments with the view of determining the causes of the differentiation of sex in unisexual plants. As regards diœcious plants, the result of experiments with 21,000 specimens of *Mercurialis annua* and 6000 of *Cannabis sativa* was that external conditions have no influence on the production of seedlings of one or the other sex. The number of seedlings of each sex is very nearly the same; in the former species the proportion of male to female individuals was about as 105·85 to 100; in the latter, about as 86 to 100. Both species exhibit also secondary sexual differences in the vegetative organs.

A second series of experiments to determine whether external conditions of temperature and soil caused any difference in the proportion of male and female flowers in monœcious plants (*Urtica urens*, *Atriplex*, *Spinacia*, *Xanthium*, Cucurbitaceæ) yielded also only negative results.

The general conclusion is that the sex of the individual is determined at an earlier period than the ripening of the seed; whether before or after fertilization cannot at present be said.

* Pflüger's Arch. f. d. Ges. Physiol., xxx. (1883) pp. 368–73.
† Ber. Deutsch. Bot. Gesell., i. (1883) pp. 455–60 (1 pl.).
‡ Ber. Landwirthsch. Inst. Halle, Heft v. See Bot. Ztg., xli. (1883) p. 873.

Corpuscula of Gymnosperms.*—J. Goroschankin has investigated the structure of these organs, chiefly in the Cycadeæ, the species examined being *Zamia pumila*, *Ceratozamia robusta*, *Lepidozamia Peroffskyana*, *Encephalartos villosus*, and *Cycas revoluta*. The cell-wall of the young corpusculum is always thin and quite homogeneous. In flowers (of *Ceratozamia*) about four months old, thin places have made their appearance in it in the form of roundish dots. When the ovules are mature (before fertilization) it is strongly thickened, and furnished with a number of conspicuous pits. The cell-wall is at all ages coloured blue by chloriodide of zinc, and is therefore composed of cellulose. Connected with each pit is a small canal, without any trace of the septum apparent; and the protoplasm of the corpuscula is distinguished by a number of protuberances equal in length to the canals.

By treating the fresh endosperm with very dilute sulphuric acid, after the lapse of a day it becomes somewhat softened, and the corpuscles with their thick cell-walls can be easily removed; and, on addition of chloriodide of zinc, the pits in the latter can be very well made out.

Tangential sections in alcoholic preparations of the corpuscula distinctly showed sieve-plates in the pits, by staining with chloriodide of zinc, or better with hæmatoxylin. The sieves were not all alike. In smaller pits they formed a uniform very thin network; in larger pits, besides the network, a coarser striation of the membrane was seen, which, however, passed gradually into the network. The sieve-plates are extremely thin, and require, to make them out, a very careful focusing of Hartnack's objective No. IX. Tinging with hæmatoxylin under very high powers shows that these plates are actually perforated. This can also be seen in longitudinal sections of fresh ovules treated with strong sulphuric acid, and then with iodine or eosin. The sulphuric acid causes a strong and rapid swelling of the cell-wall of the corpuscula, and a rupture of the threads of protoplasm that pass into the canals, the broken ends of which may be readily made out after treatment with iodine.

These observations on the Cycadeæ prove, therefore, that the cell-wall of the corpuscula consists of cellulose; and it appears to be thickened only on that side which faces the protoplasm of the corpuscle. It contains a large number of pits, furnished with true sieve-plates, through which the protoplasm of the cells of the adjacent layer of endosperm is in open communication with the protoplasm of the corpusculum.

Similar sieve-plates were observed in the cell-wall of the corpuscles of a number of Coniferæ belonging to the Abietineæ and Taxineæ; but in the Cupressineæ examined no trace of these pits could be detected.

Comparative Structure of the Aërial and Subterraneous Stem of Dicotyledons.†—J. Constantin has made a comparative study of the stem above and below ground in a large number of dicotyledonous

* Bot. Ztg., xli. (1883) pp. 825–31 (1 pl.).

† Ann. Sci. Nat. (Bot.), xvi. (1883) pp. 5–176 (8 pls.).

orders. The uniformity of the results in particular genera of widely separated orders shows that the differences in question are the result of external conditions rather than of hereditary tendencies; the following are the more important points in which the tissues become modified by being buried in the soil.

The epidermis, when present, is modified. Suberin attacks first of all its external wall, and may even form a very thick layer; it ascends only slowly into the lateral and internal walls. The cortex increases, either by increase of the size or number of its cells. The collenchyma either diminishes or disappears altogether, especially when this tissue is enveloped in the angles of the aërial stem. There is a tendency towards the early production of a suberous layer, which appears at different points of the epidermis, in the cortical parenchyma, in the endoderm, in the peripheral layer, and in the liber. This layer is sometimes a substitute for a ring of fibres which is often found outside the liber-bundles in the aërial stem. The underground stem sometimes contains a few fibres, but they are much less numerous.

In the greater number of perennial plants examined the liber-bundles of the aërial stem are closed, being shut up in this ring of fibres; while in the underground stem they are open. The activity of the formative layer is very variable; but lignification almost always takes place irregularly in the woody bundles. The pith is less developed in proportion to the cortex than in the aërial parts. Food-materials, especially starch, exist in it in great abundance. The angles of the aërial stem, when projecting, tend to disappear.

The following phenomena in the underground stem may therefore be attributed to the influence of the environment:—The great development of protective tissues, such as a suberous layer and a suberized epidermis; the reduction or disappearance of the means of support, collenchyma, liber-fibres, &c.; the great development of cortex and relative reduction of pith; feeble lignification; and the production of reserve food-materials.

The proportion of perennial plants increases with the altitude above the sea-level; and the same species is sometimes annual at low altitudes, perennial at high altitudes. The duration of a plant, therefore, and the presence of a rhizome or other form of underground stem, are to a certain extent dependent on external circumstances.

Junction of Root and Stem in Dicotyledons and Monocotyledons.*—M. C. Potter draws the following comparison between the passage from root to stem in these two classes of plants:—In the procambium of the root the protoxylem or spiral vessels and the protophloem or bast-fibres are first differentiated, the differentiation in each bundle proceeding from without inwards, and thus the separate xylem and phloem bundles are produced. In the stem each bundle consists of xylem and phloem. The protoxylem is first differentiated at the most external part of each bundle, and the differentiation proceeds from within outwards, while the protophloem is first differentiated

* Proc. Camb. Phil. Soc., iv. (1883) pp. 395-9 (1 pl.).

at the most external part of each bundle, and the differentiation proceeds from without inwards.

In Dicotyledons the transformation from the arrangement of the bundles in the stem to that of the root generally takes place in the tigellum; while in Monocotyledons the root arrangement of the bundles continues nearly as far as the point of insertion of the cotyledons in *Phœnix dactylifera*, or of the scutellum in *Zea Mais*.

Suberin of the Cork-oak.*—A. Meyer gives the general results of some investigations made by Kügler as to the nature of the suberin of *Quercus suber*. The micro-chemical reactions of suberin show that it is nearly allied to the fatty oils. Its molecules are so closely associated with those of cellulose, that boiling chloroform, while extracting the whole of the crystallizable cerin, removes only about 25 per cent. of the suberin. It is, however, completely extracted by treating first with chloroform and alcohol and then with an alcoholic potash-ley. Kügler regards it as a fatty oil, composed chiefly of stearin $(C_{18}H_{35}O_2)_3C_3H_5$ and the glycerin-base of a new acid, phellonic acid $C_{20}H_{42}O_3$, with melting-point 96° C. Forty per cent. of the mixture of these acids, and 2·5 per cent. glycerin was obtained from cork.

Suberin is therefore closely allied to the tallows, and especially to Japan tallow, which, besides palmitin, contains the base of an acid with high melting-point 95° C., obtained from the parenchyma-cells of *Rhus succedanea*, a substance apparently identical with that which causes the suberization of the cell-walls.

Influence of Pressure on the Growth and Structure of Bark.†—A. Gehmacher finds that pressure exercises a considerable influence on the growth of bark, the separate elements being altered as definitely as those of the wood.

As regards cork, the greater the pressure the fewer cork-cells are formed, and the less the pressure the more numerous are they. The radial diameter of the cells is also affected by the pressure.

The cells of the primary cortical parenchyma undergo a similar change; but they appear to be compressed not only radially, but also laterally, becoming more or less angular towards those cells which were formed under less tension and have a more nearly globular form. The intercellular spaces disappear entirely with increased pressure, increasing perceptibly in size with its decrease. The sclerenchymatous elements are least affected by change of pressure. The bast-fibres increase considerably in number with diminution of pressure; when the pressure is very great very few bast-fibres or none at all are formed. Both the wood-fibres and bast-fibres increase in size with diminished pressure.

Relation of Transpiration to Internal Processes of Growth.‡—According to P. Sorauer, transpiration results from two sources, viz. the water derived from processes of oxidation within the plant, and

* Ber. Deutsch. Bot. Gesell., i. (1883); Generalvers. in Freiburg, xxix.–xxx.

† SB. K. Akad. Wiss. Wien, lxxxviii. (1883) (1 pl.).

‡ Forsch. aus d. Geb. der Agriculturphysik, vi. (1883) p. 79. See Naturforscher, xvi. (1883) p. 470.

that which serves as a mechanical transport of material and passes unchanged through the plant. It may therefore be compared to the perspiration of animals, and is intimately connected with the process of oxidation within the plant.

It results from this hypothesis that the transpiration from the leaf per unit of surface must be less, the less active the internal activity of growth, or, in other words, the larger the amount of surface which goes to the production of a given weight of dried substance. The correctness of this view was proved by the following experiments:—Young seedling cucumbers, 10 cm. long and of an average weight of 1·5 g., were each placed on June 14 in a vessel of two litres capacity, containing 1700 g. of leaf-mould, and 400 g. water. On July 17, the plants had an average leaf-surface of 1700 g., and had transpired 454 g. water. Five fully developed leaves were now removed from one plant, having a superficies of 525·2 sq. cm., and a weight of 9·42 g. These plants, from which one-half of the leaf-surface had now been removed, maintained the same amount of transpiration as the uninjured ones, showing that the surface which remained must have performed a portion of the work of the leaves that had been removed. On August 3 a still further quantity of leaves with a superficies of 88·8 sq. cm. and a weight of 8·2 g. was removed. Since the first denudation the plant had grown very quickly, having formed 10 leaves with a superficies of 1121·79 sq. cm. At the same time 16·2 g. were removed from a second plant, having a superficies of 264·1 sq. cm. After fourteen days the amount of transpiration was again nearly the same from all the plants. Those which had been denuded showed no decrease of transpiration, the substance removed being replaced by a rapid fresh production of leaf-surface. A second series of experiments gave similar results.

Transpiration was also shown to be dependent on the concentration of the nutrient solutions. Experiments were made on four different species of cereals, with five different concentrated solutions, and the transpiration was found to be less in proportion to the concentration of the fluid. With those solutions in which the plant grew most rapidly, the absolute amount of transpiration was large, as was the general metastasis, but the relative proportion to the weight of newly formed substance was very small.

The following is Sorauer's explanation of these phenomena. A maximum transpiration accompanies the rapid production of substance in an optimum nutrient solution. But for this fresh production a certain quantity of mineral constituents is indispensable, and these are absorbed by the roots out of the fluid. When this solution is very dilute, a larger quantity of water must be carried up; and thus, with the increase of the mechanical water of transpiration, the total quantity of water transpired increases above the optimum with the decreasing concentration of the fluid.

Easily Oxidizable Constituents of Plants.*—It is a well-known fact that the juices of many plants become discoloured on exposure to

* Zeitschr. Physiol. Chem., vi. (1883) pp. 263–79. See Journ. Chem. Soc.—Abstr., xliv. (1883) pp. 880–1.

the air; so, too, sections of stems and roots, of leaves, and fleshy fruits which acquire a brown colour on exposure. Little has been ascertained in regard to the physiology of these changes. They obviously depend upon the oxidation of certain constituents; this is seen, for instance, on exposing grated potatoes to the air, when the uppermost layer assumes a brown colour, which by frequent turning over of the mass may be communicated throughout. The same is seen in the case of the expressed juice of the potato. Putrefaction or fermentation, and reducing agents, such as sulphurous or hydrosulphuric acid, decolorize these fluids. The juice of the white sugar-beet is even more sensitive, becoming on exposure to the air immediately of a dirty wine-red colour, then violet, brown, and finally almost black. These facts indicate the presence in plants of easily oxidizable bodies, and inasmuch as the products of their oxidation do not occur within the uninjured cells, it follows that there is either no free oxygen in the latter, or that these oxidizable substances are accompanied by other reducing substances, which hinder their oxidation, or again, that in the protoplasm oxidation affords other uncoloured products. Upon which of these three factors the colourless state of the protoplasm and cell-sap of living plants depends is not yet decided.

In the study of oxidation processes in the living plant-cell, an important question presents itself, as to whether substances occur in the cell, which at ordinary temperatures unite with atmospheric oxygen without the essential co-operation in this process of the living protoplasm. Difficult as the problem is, the isolation and determination of the constitution of these easily oxidizable substances forms an indispensable preliminary step. It may be conjectured that they belong to the aromatic series. In this connection the numerous hydroxybenzene derivatives claim attention, of which many are known to be easily oxidizable. Pyrogallol in alkaline solutions greedily absorbs oxygen and becomes decomposed into carbonic anhydride, acetic acid, and a brown body of unknown nature. The dihydroxybenzenes (catechol, resorcinol, and quinol) are easily oxidizable bodies, and their methyl derivative, orcinol, is coloured red by the air. As regards derivatives of the anthraquinone series, there is the change of indigo white into indigo blue, and the behaviour of *Boletus luridus*, the colourless section of which becomes at once blue on exposure to the air. Lastly, there is a series of complex plant-constituents, undoubtedly benzene derivatives, although their constitution has not yet been ascertained, which exhibit many analogies to the discoloration of plant-juices. Of these brazilin may be named, the colourless aqueous solution of which becomes first yellow, then reddish yellow in the air.

J. Reinke, in his endeavours to isolate the easily oxidizable constituents of the sugar-beet and potato to which the discoloration of their respective fluids is attributable, succeeded in the first instance in isolating from the beet-root a chromogen which on exposure to the air acquired a red colour. This substance he has accordingly designated *Rhodogen*. The product of its oxidation he terms *beet-red*, and he notes certain remarkable analogies between the

absorption-bands of this substance, and of the colouring matter of *Anchusa tinctoria*, alkanet red, the spectrum of each showing three bands occupying identical positions. These investigations have therefore so far afforded proof of the existence in the colourless cells of the sugar-beet of an easily oxidizable colourless body, capable of isolation, which by itself, without the aid of the living protoplasm of the plant, can split up the oxygen molecule, forming a coloured substance.

The isolation of the chromogen of the potato has not succeeded so satisfactorily. The presence of vanillin in the juice appeared to be shown by the strong odour of vanilla. Vanillin has been detected by Scheibler in raw beet-sugar. A substance resembling catechol, but not identical with it, was also separated. It would seem to be the same body discovered by Gorup-Desanez in the leaves of the Virginian creeper. It is undoubtedly an acid, and, amongst the known aromatic acids, most closely corresponds in its reactions with hydrocaffeic acid. In conclusion, the author suggests the hypothesis that these easily oxidizable bodies belong, in their physiological relations, to the retrogressive series, perhaps originating from the breaking up of albumin, or formed by the synthesis of the products of such decomposition, and that in these features the process is allied to that of respiration.

Action of Light on the Elimination of Oxygen.*—The following are the main results of a series of experiments by J. Reinke on *Elodea*:—

The evolution of oxygen which is dependent on light begins with a mean illumination and increases *pari passu* to a maximum with increasing intensity of light, this optimum corresponding nearly to direct sunlight; any further increase in the intensity of light does not increase the development of gas. Indicating the intensity of ordinary direct sunlight by 1, one-fourth that amount by 1/4, and four times that amount by 4/1, the two lower rows in the following table indicate the number of bubbles given off in 1/4 minute in two different experiments:—

1/1	4/1	16/1	36/1	64/1
30	32	31	26	27
28	31	28	30	29

In light of 800/1, the plant gave off in two minutes the same number of bubbles as in ordinary sunlight; the stream then ceased, the chlorophyll being bleached. In light of from 64/1 to 300/1 intensity, the gases exhaled do not contain more carbonic acid than that produced by the green plant in ordinary sunlight. From all these facts he draws a conclusion unfavourable to Pringsheim's hypothesis that chlorophyll acts as a protecting screen against the light.

Red Pigment of Flowering Plants.†—H. Pick points out that those organs of flowering plants in which carbo-hydrates are present

* Bot. Ztg., xli. (1883) pp. 697-707, 713-23, 732-8.
† Bot. Centralbl., xvi. (1883) pp. 281-4, 311-8, 343-7, 375-83 (1 pl.).

in large quantities, and in which they undergo transport from place to place, are very commonly coloured red. This is especially the case with the young branches of trees and other perennial plants, such as the oak and rose, and with the earliest spring-leaves, the leaf-stalks, and the principal veins of the upper surface of the leaf. But this colouring is, as a rule, confined to those parts which are exposed to the direct action of the sun, and is always directly connected with the presence of tannin. Transverse sections through young leaf-buds of the rose show that the entire epidermis of every leaflet up to the cone of growth is impregnated by a hyaline and strongly refractive mass, as also are those cells which are afterwards distinguished as the conducting cells of the carbo-hydrates, such as the vascular sheaths. This opalescent substance is readily proved to be tannin. As the red tinge developes in these parts, the refringency gradually diminishes, the tannin becoming transformed into the red pigment. With regard to the localization of the tannin which undergoes this transformation, it may occur either almost entirely in the epidermis, as in the hazel, beech, vine, and many other plants, or both in and below the epidermis, as in the horse-chestnut, privet, elder, &c.; less often it is not found in the epidermis, or only in slight traces, as in the different species of poplar and willow.

The conditions under which this red pigment is formed are the direct action of sunlight and a low temperature, but more especially the former, differing in this respect from the red pigment of autumn leaves, the formation of which is due chiefly to a low temperature. If seeds of maize germinate in the dark, the young plant developes without a trace of red colour, which, however, makes its appearance as soon as they are exposed to the sun, especially in the tigellum. The same is usually the case with the veins on the under side of the leaf; and the colour is always most intense on the side of the stem which is most exposed to the sun. The leaves of *Begonias*, and some other plants, form an exception to this rule, the colouring being most intense in the veins on the under side. Plants in which only a very small quantity of tannin is formed, as the Solanaceæ, Oleaceæ, the laburnum, mulberry, &c., display scarcely any red coloration.

The vertical position of the majority of stems removes them to a large extent from the direct light of the sun, and they show, as a rule, but little colour; this is strongly contrasted with the prevalent red colour of the upper side of creeping stems, such as the stolons of the strawberry, species of *Potentilla*, &c. The petioles of leaves, and the separate pedicels of flowers in an inflorescence are, on the other hand, very commonly more or less deeply coloured. In tropical countries the colouring is much more universal and intense than with us.

Spectroscopic analysis of the red pigment shows that it completely absorbs the yellow and green rays from D to *b*, partially those from *b* to a little beyond F, and the ultra-violet. The rest of the spectrum is bright, the brightest portion lying between B and C, and on both sides of G. These are, on the other hand, the most strongly absorbent portions of the spectrum of chlorophyll.

The pigment is readily soluble in cold water, and the effect was

ascertained of growing plants behind a screen of the solution. It was found that the chromatophores turn green, and assimilate under these circumstances, and that the red light is especially favourable to the absorption and transport of starch. This clearly indicates the purpose of the red pigment in the young shoots and other parts of the plant; and the same is the explanation of the red colour of autumn leaves. Different portions of a large leaf of *Ricinus communis* were exposed to (1) light passed through ruby glass; (2) light passed through orange-coloured glass; (3) light passed through an aqueous solution of the red pigment of the red beet. After four hours: in (1) the starch was found chiefly in the conducting tissue; in the palisade-cells there was not a trace of it. In (2) no important result was found. In (3) the starch had transferred itself from the palisade-tissue to the conducting mesophyll of the leaf.

Crystals of calcium oxalate are very commonly found in the palisade-cells and in the underlying mesophyll; and these the author believes to have an important function in connection with the transformation of starch into other substances; which, however, requires further investigation.

Coloured Roots and other coloured parts of Plants.*—F. Hildebrand describes the following parts of plants which are coloured in an unusual manner.

The roots of *Pontederia crassipes*, which hang down in the water, are of a dark violet-blue colour, due, not to any pigment in the cell-sap, but, like those of *Fossombronia pusilla*, to the cell-wall itself being coloured. The under side of the floating leaves is provided, which is very unusual, with stomata, the colour being also here in the cell-wall of the guard-cells and adjoining epidermal cells. Hildebrand suggests that the purpose of this colouring may be to render the parts in question less visible to animals.

Wachendorfia thyrsiflora has bright red roots due to a coloured fluid substance in the cells; and presents the very remarkable phenomenon of the pigment being formed even in absolute darkness.

The bright red colour of the fruit of *Rivina humilis* is produced, like that of the bracts of *Euphorbia fulgens*, by the superposition of cells containing different pigments, orange and violet-red.

In relation to the above paper, P. Ascherson † gives a description of the instances known to him in which coloured roots occur in plants belonging to the orders Pontederiaceæ, Hæmodoraceæ, and Cyperaceæ.

Starch in the Root.‡—A. Tomaschek finds that the starch-containing cells of the root are confined to the layer of meristem between the root-cap and the body of the root, the remaining tissue of the apex of the root not exhibiting a trace of starch. Shortly after the first roots had emerged from the seed and taken a geotropic direction, the starch had already disappeared from the apex of the root, or was found in only a very few cells.

* Ber. Deutsch. Bot. Gesell., i. (1883); Generalvers. in Freiburg, xxvii.–xxix.
† Ibid., pp. 498–502.
‡ Oesterr. Bot. Zeitschr., xxxiii. (1883) pp. 291–3.

Proteids as Reserve-food Materials.*—M. C. Potter has examined a large number of leaf-buds, rhizomes, tubers, corms, and bulbs, with a view to determine the presence of proteid-granules or crystalloids. In none of them, with only one exception, did he find any, although starch was present in abundance; but this may have been due in some cases to their having already germinated. The exception was in bulbs of *Narcissus poeticus*, where proteid-granules were formed of relatively large size, and apparently only one in each cell. They consisted of an outer hyaline and an inner opaque part, the latter being soluble in dilute potash. They were insoluble in ether, alcohol, acetic acid, or solution of sodium chloride, and were stained orange yellow by iodine. They disappeared soon after the bulb had commenced to grow.

Leucoplastids.†—A. F. W. Schimper, replying to the opposite view of A. Meyer,‡ reaffirms his theory that the protoplasm of leucoplastids is itself used up in the formation of starch, supporting it by the statements that in many plants the leucoplastid crystals occur only in the epidermis where no formation of starch takes place; and that the crystals eventually entirely disappear in those cells where abundance of starch is formed. That it is the albumen itself which crystallizes, he argues from the fact that protein-crystals are often found in leucoplastids, and from various other considerations.

Cleistogamous Flowers.§—T. Meehan describes cleistogamous flowers in *Nemophila maculata*, *Impatiens pallida*, and *Viola sarmentosa*, all of which produce abundance of seeds, no perfect corollas being observed on any of them. *Opuntia leptocaulis* produced a number of small flower-buds, some of which opened. These resulted in fruits which took a full year to mature, becoming a bright rosy red, but containing no seeds.

Cultivation of Plants in Decomposing Solutions of Organic Matter.||—V. Jodin chose for his experiments vegetable débris, or pulverized plants, which were dissolved in distilled water; on the surface of these were placed the grains of experiment; as decomposition went on the grains germinated and fructified, by assimilating part of the mineral elements and some of the nitrogen of the solution. At the end of three or four months the liquid was found to be limpid and odourless; on evaporation it left a residue of potash, which appeared to be united to a brown organic body; on calcination nitric acid could be detected.

The author gives a table of the weights of material used, from which it is seen that of the primitive nitrogen 35 or 36 per cent. has disappeared; and concludes by suggesting that the method of experiment which he has adopted will be found to be of use in the investigation of certain problems of plant physiology.

* Proc. Camb. Phil. Soc., iv. (1883) pp. 331–3.
† Bot. Ztg., xli. (1883) pp. 809–17.
‡ See this Journal, iii. (1883) p. 289.
§ Bull. Torrey Bot. Club, x. (1883) pp. 119–20.
|| Comptes Rendus, xcvii. (1883) pp. 1506–7.

Disease of the Weymouth Pine.*—R. Hartig attributes the disease to which this pine is so liable in Germany to the fact of the thinness of its cork-layer, owing to its native habitat, the boggy lowlands of North America. It is therefore unable to resist the very high transpiration from the heat of the sun in Central Europe, which results in the drying up of the bark and cambium, especially on the southern and western sides, thus rendering the trunk extremely subject to the attacks of fungi, such as *Agaricus melleus*, *Coleosporium Senecionis*, and *Trametes radiciperda*.

Flora of Spitzbergen.†—A. G. Nathorst gives the following as the main results of two visits to Spitzbergen in 1870 and 1882 :—

1. The flora of Spitzbergen is richer than that of any other country of the same latitude, except possibly Grinnell-land; and it is probable that there are still vascular plants remaining to be discovered.

2. The larger part, at all events, of the Arctic flora avoids the coast, and attains its richest development in the most continental regions.

3. During the glacial period, only a very few species, if any, could have maintained themselves in Spitzbergen; most or all of those which now constitute its flora must have migrated there during the post-glacial period.

4. About 75 per cent. of the vascular plants flourish there and produce seeds. These are probably the species which migrated first.

5. The remainder, mostly bog- and shore-plants, are the survivors of a portion of the post-glacial period when the climate was warmer than it is now; these migrated later than the others.

6. The migration of the Spitzbergen flora took place over land, with perhaps a few exceptions.

7. This land formed a now submerged connection between Spitzbergen, Nova Zembla, Arctic Russia, and Scandinavia, from which countries the flora is derived.

8. No interchange with Greenland took place during the quaternary period, except perhaps accidentally.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Fructification of Fossil Ferns.‡—R. Zeiller has examined and described a large number of ferns from the "terrain houiller," where they are very abundant, though the fructification is comparatively rare. From the remains which he has been able to examine, chiefly from the Pas-de-Calais, he gives detailed descriptions of the following genera :—

I. Sporangia grouped into a synangium, and partially united :—Marattiaceæ. Sporangia without annulus. Genera :—*Crossotheca* n. g.—

* Unters. aus d. Forstbot. Inst. München, iii. (1883) pp. 145–9. See Bot. Centralbl., xvi. (1883) p. 304.

† K. Svensk. Vetensk.-Akad. Handl., xx. (1883). See Naturforscher, xvi. (1883) p. 457.

‡ Ann. Sci. Nat. (Bot.), xvi. (1883) pp. 177–209 (4 pls.).

sporangia pendent in the form of a fringe; pinnæ dimorphic. *Calymnatotheca* Stur. *Dactylotheca* n. g.—sporangia exposed, especially on the inferior lobes, almost like the fingers of a hand. *Renaultia* n. g.—sporangia resembling those of *Angiopteris*, but isolated. *Myriotheca* n. g.

II. Sporangia with annulus:—*Senftenbergia* Corda. *Oligocarpia* Göp. (Gleicheniaceæ). *Hymenophyllites* Göp. (Hymenophyllaceæ). *Diplotmema* Stur. *Grand'Eurya* n. g., nearly allied to *Zygopteris*.

The author considers that the family Botryopteridaceæ formed by Renault should be regarded as ranking with Gleicheniaceæ, Cyatheaceæ, and Polypodiaceæ, if not with Marattiaceæ.

Prothallium of Struthiopteris germanica.*—D. H. Campbell has cultivated the spores of this fern, and finds the prothallium to be distinctly dicœcious. The male and female prothallia differ somewhat in form, the former being more distinctly heart-shaped.

Muscineæ.

Mucilage-organs of Marchantiaceæ.†—Organs containing mucilage have been recently described by several observers in different species belonging to the Marchantiaceæ. R. Prescher has examined them in detail, with the following results:—

Organs of this kind occur in a large number of species, usually in the form of isolated mucilage-cells, as in *Marchantia polymorpha*, *cartilaginea*, *chenopoda*, and *paleacea*, *Preissia commutata* and *quadrata*, *Clevea hyalina*, and *Plagiochasma Rousselianum*. *Fegatella conica* contains in addition mucilage-tubes. The mucilage-cells occur in the thallus, and in the male and female receptacles, and especially in the tissue without intercellular spaces; they are found in the greatest numbers immediately beneath the layer which contains the air-chambers; less often they occur also in the epidermis, as in *M. cartilaginea* and *chenopoda*; and in the septa of the air-chamber layer, as in *M. chenopoda*, *Clevea hyalina*, and *Plagiochasma Rousselianum*. The mucilage-tubes of *Fegatella conica* are found exclusively in the tissue of the mid-rib of the thallus, which has no intercellular spaces.

All the organs which contain mucilage are differentiated at a very early period near the growing points. They are distinguished in their youngest state by their thin cell-walls and abundant protoplasm. Several segments usually go to the formation of a mucilage-tube.

The mucilage is formed out of the protoplasm, which never contains starch. It lies in contact with the primary cell-wall, in the form of a thin layer which gradually becomes thicker, and displays from the first its peculiar chemical and physical properties. It is highly refractive, and has great power of swelling; treated with alcohol, it displays stratification, and a brownish colour; its yellow reaction with iodine and sulphuric acid indicates an affinity with vegetable gum. In older parts of the thallus both cells and tubes are completely filled by mucilage; protoplasm is essentially concerned in its formation.

* Bull. Torrey Bot. Club, x. (1883) pp. 118–9.

† SB. Akad. Wiss. Wien, lxxxvi. (1882) pp. 132–58 (2 pls.).

The fact that the cells themselves increase in size during the formation of mucilage, necessitates the hypothesis that intussusception takes an active part in the formation of all those layers which are formed before the completion of the growth of the cells. If growth took place by apposition only, the layers would be formed only after the cells had obtained their full size.

The walls of the mucilage-tubes do not assume a condition capable of swelling during their development, but retain their structure to the end. The death of the thallus causes the tubes to open in succession and discharge their contents. The disorganization of the mucilage-cells in the end of the thallus takes place in the same way.

Nothing can be said with certainty with regard to the physiological function of the mucilage-organs of the Marchantiaceæ, but it is probably connected with their great power of swelling, owing to the capacity of their contents for absorbing water.

Characeæ.

Characeæ of the Argentine Republic.*—C. Spegazzini describes six species of *Nitella*, with four forms, one of *Lamprothamnus*, and three of *Chara*, with two forms. The species of *Lamprothamnus* is new, and is thus described:—*L. Montevidensis* Speg. Maximus, crassus, capitato ramosus, ecorticatus, monoicus. Antheridia globoso-polygona, rufo-fusca v. rufo-rubra (0·20–0·22 mm. diam.); sporangia ad basin antheridiorum enata, infera, globosa (0·30–0·35 mm. diam.), rubescentia, subinconspicue 5–7 gyrata, apice coronula mammiforme, obtusa breviusculaque ornata. Near Montevideo.

American Species of Tolypella.†—The two families into which the Characeæ may be divided are distinguished by the structure of the corona of the sporangium (archegonium), which consists in the Chareæ of five, in the Nitelleæ of ten cells; in some species of the latter family it is evanescent. The Nitelleæ again may be divided into two genera, distinguished chiefly by the position of the antheridium, which in *Nitella* is apical, on the primary ray of the leaf, the archegonia being lateral on the node below the antheridium; and the leaves having but one leaf-bearing node. In *Tolypella* the antheridia are one or several, lateral on the nodes of the leaf and leaflet; the leaves have from one to three nodes bearing leaflets.

T. F. Allen gives a full account of the American species of *Tolypella*, and proposes the following general classification of the twelve known species of the genus, of which four are now described for the first time:—

I. Obtusifolia.—Corona evanescent; sterile leaves undivided.
  A. Ultimate cell of the primary ray of the leaf longer than the other cells. 1 sp.:—*T. longicoma* A. Br.
  B. Ultimate cell not longer. 4 sp.:—*T. nidifica* Leonh.; *T. Normaniana* Ndst.; *T. glomerata* Leonh.; *T. comosa* Allen.

* Ann. Soc. Cientif. Argentina, xv. (1883) pp. 218–31. See Bot. Centralbl., xvi. (1883) p. 257.

† Bull. Torrey Bot. Club, x. (1883) pp. 109–17 (6 pls.).

II. Acutifolia.—Corona persistent.

A. *Indivisa.* Sterile leaves undivided. 2 sp.:—*T. prolifera* Leonh.; *T. fimbriata* Allen.

B. *Divisa.* Sterile leaves divided, usually into four terminal leaflets. 5 sp.:—*T. californica* A. Br.; *T. stipitata* Allen; *T. intricata* Leonh.; *T. intertexta* Allen; *T. apiculata* A. Br.

Fungi.

Rabenhorst's Cryptogamic Flora of Germany (Fungi).*—The publication of this important work has now advanced as far as the issue of the first division of the first volume, which is to comprise the Fungi, under the editorship of Dr. G. Winter. The present division includes the Schizomycetes, Saccharomycetes, and Basidiomycetes, all the species being described which are natives of Germany, Austria, and Switzerland.

Hysterophymes.†—H. Karsten applies this term to elementary organs which have been mistaken for independent living animal or vegetable organisms. In the present paper he explains the process by which he has developed them synthetically by constructing artificial cells of potato digested in a nutrient fluid of about 5 per cent. solution of sodium-ammonium phosphate with some potassium sulphate. In such cells albumen-cells may be seen to develope, and to multiply in a linear direction into the well-known bacterium, bacillus, and vibrio forms. The contents of these bacterioid organisms are coloured blue by iodine in a certain stage of development. On the addition of a solution of cane-sugar, the bacterium-cells formed within the closed potato-cells can be seen to increase and develope into the torula-form.

Cells of the kohl-rabi digested in the same nutrient fluid developed in the same way micrococci and bacteria; and, since they were taken from the bast-tissue, where there are no intercellular spaces, Karsten regarded any entrance of germs from without as impossible. The author considers the experiments to prove that the so-called ferment-cells arise from normally developed cell-sap vesicles, and that torula-cells are only a stage of development of bacterium-cells or micrococci.

Graphiola.‡—This exotic genus of Fungi is chiefly known from *G. Phœnicis* parasitic on *Phœnix dactylifera* and its varieties, as *P. canariensis*, also on *Chamœrops humilis*, and has been variously referred to the Myxomycetes, Uredineæ, and Pyrenomycetes. E. Fischer has undertaken a detailed examination of it, as well as of three other species, *G. congesta*, parasitic on *Chamœrops palmetto*, and *G. disticha* and *compressa*, the hosts of which are not known with certainty, and may belong to quite another genus.

The fructification of *G. Phœnicis* consists of small black elevations on both sides of the leaf of the date-palm, of a diameter about 1·5 mm.

* Rabenhorst, L., 'Kryptogamen-Flora von Deutschland, Oesterreich u. d. Schweiz. 1ter Band, Pilze, von G. Winter, 1te Abtheilung.' Leipzig, 1884.

† Flora, lxvi. (1883) pp. 491–8.

‡ Bot. Ztg., xli. (1883) pp. 745–56, 761–73, 777–88, 793–801 (1 pl.).

and a height of 0·5 mm. From the middle projects a yellow columnar body, about 2 mm. in height, composed of a number of vertical filiform bodies rising from its base, the space between them being completely filled by a mass of yellow spores. The fructification may be regarded as consisting of four parts, an outer peridium, an inner peridium, a spore-forming layer, and a tuft of hyphæ.

The outer peridium consists of a circular wall which spreads over the epidermis of the leaf of the host; it varies greatly in thickness, and consists of a number of branched hyphæ. This is bounded on the inside by a very delicate membrane, the inner peridium.

The hyphæ which are destined to the formation of spores spring from the central part of the peridium; they are vertical to the surface of the leaf, and form a continuous palisade-like layer. The ends of these hyphæ are thicker than those of the hyphæ which compose the sterile weft; they increase gradually in diameter upwards, attaining at the apex a thickness of about 3–4 μ. They are colourless, and filled with protoplasm which is either homogeneous or more refringent in some parts than others; they are septated tranversely into short cells, which at length swell into a spherical or ellipsoidal shape and become readily detached from one another. On the upper of these cells small protuberances now make their appearance, which gradually increase in size till they have attained that of the cells from which they spring; from three to six of them springing from one of the cells of the hyphæ. They are thin-walled and filled with protoplasm of varying refrangibility, which has passed into them from that of the hyphal cell, which eventually perishes. These bodies, which the author calls "spore-initials," produce the spores by one or more bipartitions of their contents. The ripe spores are usually found connected together in pairs; they are spherical or ellipsoidal, and about the same size as the initials, 3–6 μ in diameter; their membrane is usually moderately thick, colourless, and smooth.

The tufts of sterile hyphæ spring, like the fertile ones, from the bottom of the fructification. They are slender, cylindrical, or irregularly prismatic bodies, from 7–18 μ in thickness, and strongly refringent. Each larger bundle consists of from 50 to 100 of such hyphæ; their membrane is much thicker and more refringent than that of the fertile hyphæ, but the refrangibility differs greatly in different parts of the same hyphæ. Their mode of formation is very similar to that of the fertile hyphæ. As they develope they carry up with them the spores, which become attached to them, outside the outer peridium, where they are ready for dissemination.

The spores appear to retain their power of germination for a period of from three to four months. They germinate either directly with the formation of a septated germinating filament, or with the intervention of a single cylindrical sporidium produced from each spore. The germinating filaments grow to a length of 400 μ; their further development was not observed. There is no reason for believing that the genus has any heterœcism or alternation of generations.

As regards the systematic position of *Graphiola*, the author does not agree with any of the views hitherto brought forward, but considers it

as most nearly allied to the Ustilagineæ; differing from them in its highly complex fructification. Until transitional forms have been found, he would erect it into a separate but closely allied family under the name Graphiolaceæ.

Pourridié of the Vine.*—R. Hartig believes that the cause of this disease is not as supposed, the "rhizomorph" of *Agaricus melleus*, but a different fungus, *Dematophora necatrix* n. sp., clearly distinguished from the former by its peculiar apical growth, the formation of sclerotioid agglomerations in the mycelium, and the form of the fructification. The mycelium is parasitic, and rapidly kills not only the vine, but many other trees which it attacks. Under favourable conditions, it forms great numbers of branched conidiophores; but since the perithecial form is at present unknown, the systematic position of the genus must remain at present undecided. *Roesleria hypogœa* he regards as saprophytic, and a secondary cause only of the disease.

E. Prillieux,† on the other hand, while agreeing with Hartig that the disease is not caused by *Agaricus melleus*, looks on *Roesleria hypogœa* as its true source. The coremium-like spores of this fungus he regards as ascospores, formed eight in each ascus.

Oospores of the Grape Mould.‡—E. Prillieux states that he has received from M. Fréchou of Nérac germinating oospores of *Peronospora viticola*. The germinating oospores produce at once a mycelial tube similar to that known in other species of *Peronospora* in which the germination of the oospores has been seen. This is an important step in our knowledge of the grape-mildew, since, inasmuch as the conidia produce zoospores, it had been supposed by some that the oospores would also produce zoospores, as is the case in the related genus *Cystopus*.

Pleospora gummipara.§—The fungus named by Beyerinck *Coryneum gummiparum*, connected with the flow of gum from woody trees, has now been found by C. A. J. A. Oudemans in the perithecial form, and been identified as belonging to the genus *Pleospora*, Sect. *Eupleospora*. As it cannot be identified with any species hitherto known, Oudemans calls it *Pleospora gummipara*, and describes the perithecial, pycnidial, and conidial forms.

Schizomycetes.‖—F. Neelsen gives a very useful epitome of the present state of our knowledge respecting the life-history and classification of this class of organisms, referring chiefly to the labours of Ehrenberg, Cohn, and Zopf. In the mode of investigation adopted by the last-named authority, and the theory of the pleomorphism of

* Hartig, R., 'Der Wurzelpilze des Weinstockes,' 18 pp., Berlin, 1883. Also Unters. aus d. Forstbot. Inst. München, iii. (1883) pp. 95–140; and SB. Bot. Ver. München, Jan. 10, 1883. See Bot. Centralbl., xvi. (1883) p. 208.

† Prillieux, E., 'La pourridié de la vigne, &c.,' 13 pp. (1 pl.), Paris, 1882. See Bot. Centralbl., xvi. (1883) p. 208.

‡ Bull. Soc. Botan. France. Cf. Science, ii. (1883) p. 831.

§ Hedwigia, xxii. (1883) pp. 161–2.

‖ Biol. Centralbl., iii. (1883) pp. 545–58.

the different organisms comprised in the class,* he sees the promise of a fuller and more accurate knowledge in the future of their life-history.

Fæcal Bacteria.†—B. Bienstock has made a detailed examination of the bacteria found in human fæces under a great variety of circumstances. Those obtained from healthy men he found to belong exclusively to the group *Bacillus*, their spores having alone a sufficient power of resistance to the antiseptic action of the gastric fluid. Of this group five distinct forms were observed:—1 and 2. Two large forms, resembling *B. subtilis* in form and appearance, but differing in the mode of germination of the spores, and in not having the power of spontaneous motion. Although always present in the fæces, the author was unable to determine that these bacilli take any part in the fermentative processes of the intestinal canal; and they appeared to have no pathogenous properties. 3. A third form was characterized by its very slow growth and minute size; it acted pathogenetically on mice. 4 and 5. These two forms, invariably present in human fæces beyond the age of suckling, are of the greatest importance in the processes carried on in the digestive canal beyond the stomach. They were of different chemical properties, one bringing about decomposition of albumen, the other of carbohydrates; the second only was present in the fæces of infants fed only on milk. These forms alone have the power of decomposing albumen or carbohydrates; the one producing the well-known products of the decomposition of albuminoids, the other splitting up sugar into alcohol and lactic acid. The first produced no decomposing effect on saccharine solutions; the second none on solutions of albuminoids; though both multiplied freely. The other fæcal bacilli, and those obtained from the air, were also without the least effect. After cultivation for from twenty to forty generations these two forms still retained their power.

The author derives from these experiments the conclusion that the decomposition of albuminoids and carbohydrates in the intestinal canal is due in each case to one specific bacterial form, which brings about the decomposition without the assistance of any others.

Influence of Oxygen at high pressure on Bacillus anthracis.‡—J. Wosnessenski comes to the conclusion that Bert was right in regarding oxygen at very high pressures as being mortal to the protoplasm of *Bacillus anthracis;* but it is not to be supposed that a gradual augmentation in the pressure of the oxygen will gradually lead to the loss of vitality; till the pressure exceeds that of fifteen atmospheres of air the organism resists it better than it does oxygen at a normal pressure. The results obtained with increasing pressure vary considerably, according as the experiments are conducted with thick or thin layers; with the latter the influence of pressure is not marked; so that with them the result is the same as in Chaveau's experiments on *Bacilli* at a normal pressure, if a suitable temperature

* See this Journal, iii. (1883) p. 688.

† Fortschritte der Medicin, i. (1883) p. 609. See Bot. Centralbl., xvi. (1883) p. 305.

‡ Comptes Rendus, xcviii. (1884) pp. 314–7.

is retained—say 35°–38°; for then the virulence of the poison is more pronounced than when the cultivation is undertaken with a thick layer. If, on the other hand, a high temperature, 42°–45°, is brought to bear on thin layers subjected to great pressure, the bacilli in them become almost inoffensive. The author applies the epithet of *eugénésique* to the lower and of *dysgénésique* to the higher temperatures just mentioned.

Bacteria in the Human Amnion.*—Trinchese describes in a brief note *Bacteria* discovered on the internal surface of the amnion of a fœtus extruded after the third month of gestation. The perfect freshness of the membrane made it impossible to explain the presence of these germs as being due to incipient putrefaction; and, on the other hand, it was equally certain that the mother was not suffering from any infectious disease. The epithelial cells of the amnion were quite unaltered, except that the nucleus contained a large cavity filled with liquid, in which were a great number of *Bacteria;* the nuclear substance itself was pressed to one side, and had assumed a crescent-like form. In all other respects the tissues were quite normal.

A fuller account of this interesting phenomenon is promised shortly, and the present note is published to stimulate inquiries into the causes of abortion; it is possible that the presence of microphytes may have a great deal to do with it.

Bacillus of "Rouget."†—Pasteur and Thuillier show that the bacillus of "rouget," as found in pigs, can be attenuated by passing it through rabbits. The inoculated rabbits are all rendered very ill or die, but pigs inoculated with the bacillus after the virus has been passed through a series of rabbits have "rouget" in a mild form, and enjoy immunity from further attacks. A series of inoculations carried through pigeons, on the other hand, increases the virulence of the disease when a pig is inoculated from the last of the pigeons.

Living Bacilli in the Cells of Vallisneria.‡—T. S. Ralph records the presence of these organisms, and states that there is a little difficulty attending the demonstration, but that if the following directions are carried out with other water-plants, he believes they will be seen in those cases also.§

A thin section of the cuticle of the leaf of *Vallisneria* should be sliced off, and placed on a slide, with the cuticular surface next the cover, and then the slide should be placed on a rest, with the cover downwards or towards the table, and remain there for five minutes at least, in order to allow the organisms to fall on to the cuticular walls of the cells, and then examined under a 1/4 in. objective. They must be looked for in the quadrate cells, and will be seen moving about the chlorophyll-grains, even when cyclosis may be going on; and after the lapse of some minutes they will gravitate out of sight,

* Atti R. Accad. Lincei, vii. (1883) p. 237.
† Comptes Rendus, xcvii. (1883) pp. 1163–9.
‡ Journ. of Microscopy, iii. (1884) pp. 17–8.
§ He has since found them in *Anacharis*. See Proc. Roy. Soc. Victoria, 10th May, 1883.

or be found heaped together at the lower end of the cell (or apparent upper end). It is this circumstance which has prevented any recognition of their presence in the plant. They are rarely, if ever, seen in the long, deep-seated cells, which exhibit cyclosis so well in this plant.

Simulation of the Tubercular Bacillus by Crystalline Forms.*—The memoirs of A. Celli and G. Guarnieri give the results of a large number of observations on the bacillus described by Koch in the nodules of tuberculosis, and in the sputa of consumptive patients, and further call attention to certain crystals found not uncommonly in these sputa, which, both by their appearance and by their behaviour towards anilin colours, imitate the tubercular bacilli. The microscopic differences between the two classes of objects are minutely described.

Cultivation of Bacteria.†—Dr. E. Klein has been able to avoid the drying-up which mars Koch's method of growing bacteria on a gelatine fluid film in a moist chamber, by using instead of the latter a cell closed with a cover-glass, to which was sometimes attached a thin glass tube, leading into it, and plugged with cotton wool. The cultivating fluid used is composed of one part of so-called "gold-label gelatine" cut into strips and soaked for a night in cold-water, and then dissolved, just neutralized with carbonate of soda, and filtered while hot, and three parts of pork broth; all the materials are prepared with a view to their perfect sterility by heat and insulation of the air involved by cotton-wool. To the lower side of the cover-glass of the cell is applied a drop of cultivating fluid, which is then allowed to solidify; after this it may be inoculated with the particular bacterium required by dipping a needle which has been heated, or a capillary tube which has been freshly drawn out, into the fluid containing the organism, and then drawing its point once or twice over the charged surface of the cover-glass. The progress of growth may be watched with the Microscope through the cover-glass; thus also the species of the organism thus introduced can be verified, and accidental contamination detected.

Reduction of Nitrates by Ferments.‡—According to A. Springer, the roots of plants are covered with small organisms which reduce nitrates, with evolution of nitric oxide. This ferment closely resembles the butyric ferment, and is probably identical with the *Microzyma cretæ* of Bechamp. It is composed of small cylindrical rods rounded at the extremities, generally isolated, but sometimes joined two by two. They move rapidly with a wriggling motion, and often bend their bodies until they form a perfect circle. Another ferment, or modification, is somewhat smaller, and spins round its smaller diameter as an axis. Phenol has no appreciable action on the new ferment. Similar results have been obtained since the author first announced his results, by Gayon and Dupetit, and Déhérain and Maquenne.

* Atti R. Accad. Lincei—Transunti, vii. (1883) p. 282.

† 11th Ann. Report Local Government Board, 1882, pp. 177–8.

‡ Amer. Chem. Journ., iv. (1883) pp. 452–3. See Journ. Chem. Soc.—Abstr., xlvi. (1884) pp. 350–1.

Algæ.

Rabenhorst's Cryptogamic Flora of Germany (Algæ).*—Parts 6 and 7 of Dr. Hauck's 'Marine Algæ,' in Rabenhorst's 'Cryptogamic Flora of Germany, Austria, and Switzerland,' complete the account of the Florideæ with the Corallinaceæ, and commence the Phæophyceæ, which he divides into three orders, the Fucoideæ, Dictyotaceæ, and Phæozoosporeæ. The small number of species comprised in the first two orders are described, and the Phæozoosporeæ commenced. The families included are the Ectocarpaceæ (including *Sphacelaria*), Mesoglœaceæ, Punctariaceæ, Arthrocladiaceæ (the single genus *Arthrocladia*), and a commencement of the Sporochnaceæ.

Distribution of Seaweeds.†—A. Piccone gives a number of details with respect to the mode of life and distribution of marine algæ. As a rule, they are entirely confined to the coasts; although shells of diatoms are found abundantly at great depths, it is doubtful whether they have lived there, or whether the shells have been carried by currents. The gulf-weed the author thinks does really vegetate in the depths of the "sargasso-sea."

The physical nature of the sea-bottom, whether stony, sandy, or muddy, exercises considerable influence on the distribution of seaweeds, as also on their external form, and especially on their mode of attachment. Of this the author distinguishes three kinds:—attachment-disks, which occur only where the bottom is rocky or stony; a tow-like decomposed base and root-fibres; and a pseudo-parasitism on other algæ. Seeing that algæ derive no nourishment from their substratum, its chemical nature is indifferent.

As regards the purity of the water, a medium quality appears to be most favourable to the growth of seaweeds. A considerable influence is exerted by the varying density at different depths; and, as with land-plants, each species has its optimum temperature. The presence of light is indispensable to their growth; but it entirely ceases only with the absence of the chemical rays. Direct sunlight is more favourable to the growth of green, shade to that of red or brown algæ. Light has also an influence on the production and movement of zoospores, and on the heliophobic tendency shown by many fertilized ova.

Only those algæ which grow in shallow localities follow the movements of waves, and various species establish themselves in protected spots or those exposed to the surf, or according to the nature of the bottom. A great flow and ebb of tide is unfavourable for marine vegetation. The influence of marine currents is very great on the distribution of species.

The dissemination of spores is brought about chiefly by marine currents; but the author believes that their unequal specific gravity is not without importance in this respect. It is probable that they are also transported by fish, attached externally, or even after having been swallowed.

* Rabenhorst, L., 'Kryptogamen-Flora von Deutschland, Oesterreich u. d. Schweiz. 2ter Band, Die Meeresalgen von F. Hauck, Lief. 6-7.'

† Chron. Lic. Christ. Colombo, 1883. See Bot. Centralbl., xvi. (1883) p. 289.

On the retention of the power of germination by the spores of algæ very little is known; but it is probable that they differ greatly in this respect.

The colour of seaweeds is probably of considerable physiological importance. It is possible it may act like the colour of flowers, as an attraction to those marine animals which assist in fertilization, and also as a protection against those which are injurious. The same purpose may also be served by the different taste and smell of different species.

Cystoseiræ of the Gulf of Naples.*—R. Valiante publishes a monograph of this genus. His investigations relate to the histology of the alga and the classification of the species. The points specially described are: The germination of the spores and formation of the embryo; the development of the vegetative organs of the embryo; the rhizoid processes, and radical disk; and the sexual organs of reproduction. In the systematic part eleven species are described, one of them new.

Polysiphonia.†—L. Kolderup-Rosenwinge has investigated the structure of this genus of seaweeds, especially the species *fastigiata*, *nigrescens*, and *violacea*. He confirms the statement of Schmitz that cell-division does not take place either by a transverse septum or by a longitudinal septum which includes the longer axis. The divisions of the common basal cell of "branch" and "leaf" in *P. violacea* were especially followed out and described. A peculiarity of the cell-division in *Polysiphonia* and in some other Florideæ is that the two daughter-cells are of unequal size. It usually gives the impression as if a smaller cell were cut off from a larger one, which remains more or less entirely unchanged. The spiral arrangement of the "leaves" is indicated already in the divisions of the apical cell. The formation of the "branches" takes place in different ways in the different species, pseudo-dichotomous, monopodial, or axillary.

The antheridia and cystocarps are the result of metamorphosis of the "leaves." The following is the mode of formation of the tetraspores in *P. fastigiata*. A large cell is first of all separated from one side of the parent-cell. This divides into three cells by two oblique, vertical, but not radial walls; two of them on the outer side, which behave like pericentral cells, a larger one on the inner side, which is again divided by a horizontal wall into two cells, the upper of which is the mother-cell of the tetraspores.

Pithophora.‡—F. Wolle records the interesting fact of the discovery in several localities in New Jersey, U.S.A., of this singular alga, hitherto known only in the tanks in the hot-houses at Kew, and made, by its discoverer Dr. Wittrock, the type of a new order allied to Confervaceæ.

* Fauna u. Flora des Golfes v. Neapel. vii. Monographie, 1883. Die Cystoseiren, 30 pp. (15 pls.).

† Bot. Gesell. Stockholm, Sept. 16, 1883. See Bot. Centralbl., xvi. (1883) pp. 222–4.

‡ Bull. Torrey Bot. Club, x. (1883) p. 13.

Resting-spores of Algæ.*—N. Wille describes the mode of formation of the non-sexual reproductive cells, commonly known as resting-spores, in a number of filamentous algæ, as *Trentepohlia* (*Gongrosira*) *de Baryana*, *Conferva pachyderma*, *C. stagnorum*, *C. Wittrockii*, *C. bombycina*, *Ulothrix Pringsheimii*, &c. All these cases agree in the reproductive cells thus formed being immotile, not produced by any sexual process, and not resulting from swarm-cells that have come to rest. They may, however, be divided into two classes, those produced without any special cell-formation, as in the cases of *Ulothrix*, *Conferva pachyderma*, and *Trentepohlia*, or after special cell-formation, as in *Conferva stagnorum*, *C. Wittrockii*, *C. bombycina*, and *Pithophora*. The former kind the author proposes to call *Akinetes*, the latter *Aplanospores*. Both kinds vary in this respect, that they may germinate immediately after their formation, or only after a period of rest. In the former case they perform the function of zoospores, i. e. increasing the number of individuals; in the latter case they act like zygotes.

In *Conferva*, *Ulothrix*, and *Œdogonium*, the mode of formation of the resting-cells resembles that in the Conjugatæ. The membranes of the filament become thicker, and incrusted with iron and lime; as soon as the separate cells again begin to grow, the outer dead layer bursts, and the form arises described earlier as a distinct genus under the name *Psichohormium*. In *Conferva pachyderma*, the akinetes are formed by a stronger deposition of cellulose in the inner cell-wall layer, while the outer ones become mucilaginous, and the separate cells are thus set free. The step to the formation of aplanospores in *C. stagnorum* and *Wittrockii* is a very short one. In *Cladophora fracta* single cells at the ends of filaments often swell up in the autumn, and become thicker walled and fuller of protoplasm. These hibernate, filaments with thin-walled cells springing from them in the spring. A similar process takes place in *Conferva bombycina* and in *Pithophora*. In *Trentepohlia de Baryana* two kinds of akinetes are formed.

No exact boundary line can always be drawn between akinetes and ordinary vegetative cells; aplanospores differ more widely from the latter, but pass insensibly into the former. The author's view is that these structures are formed whenever the conditions are unfavourable for the formation of zoospores or for a sexual mode of reproduction. Where they are abundantly produced, it is usual for the formation of zoospores to be rare. This is the case in *Conferva stagnorum* and *Cladophora fracta*, while in *Conferva pachyderma*, *Wittrockii*, and *bombycina*, *Ulothrix Pringsheimii*, and *Pithophora* they are at present unknown; in most species of *Cladophora* they are abundant. In *Trentepohlia umbrina*, quantities of swarm-cells are formed, but they rarely either conjugate or germinate; in *T. de Baryana* they are also formed, but soon perish, reproduction taking place by means of akinetes.

The author regards the resting-cells as affording good characters

* Bot. Gesell. Stockholm, Sept. 26, 1883. See Bot. Centralbl., xvi. (1883) pp. 215–9.

for the determination of species, and even in some cases of genera, but not of the larger groups, since their formation probably depends on external conditions.

Hybridism in the Conjugatæ.*—C. E. Bessey describes an interesting case of hybridism between two species of *Spirogyra*, *S. majuscula* and *protecta*. A perfect zygospore was found, resembling most nearly those of the latter species.

New Genera of Chroococcaceæ and Palmellaceæ.†—In an account of the algæ of Sweden, G. Lagerheim describes as many as sixty species new to that country; and gives also the following diagnosis of new genera:—

Gleochæte (Chroococcaceæ). Cellulæ globosæ vel subovales, binæ vel quaternæ in muco communi homogeneo vel indistinctissime lamelloso inclusæ, utraque seto longissimo instructa. Cytioplasma ærugineo-cærulea, subgranulosa. Divisio cellularum in duas directiones. One species, *G. Wittrockiana*, possibly identical with *Chætococcus hyalinus* Kütz.

Acanthococcus (Palmellaceæ). Cellulæ adultæ globosæ vel subglobosæ, aculeis præditæ. Divisio succedanea, multitudo cellularum filialium globosarum, non aculeatarum, in cellula matricali provenit, quæ, membrana cellulæ matricalis in mucum conversa, liberæ fiunt. Cellulæ perdurantes oleosæ. Two species, one of them the *Palmella hirta* and *Pleurococcus vestitus* of Reinsch.

Dactylothece (Palmellaceæ). Cellulæ cylindricæ vel oblongæ, rectæ vel leviter curvatæ, utroque fine rotundatæ, singulæ-quaternæ in familiis consociatæ, tegumentis vesiculiformibus inclusæ. Familiæ numerosæ hoc modo formatæ stratum viride uliginosum formant. Divisio cellularum in unam directionem fit. Cytioplasma viridis. Zoosporæ ignotæ. Analogous to *Glœothece* among Chroococcaceæ. One species, *D. Braunii*, in greenhouses.

Also the subgenus *Holopedium*:—Merismopedium familiis forma irregulari e cellulis irregulariter dispositis compositis. Divisio cellularum irregularis. Includes the three species of *Merismopedium*, *irregulare*, *sabulicolum*, and *geminatum*.

Chroolepus umbrinum.‡—J. B. Schnetzler finds this alga, associated with a number of others, on the bark of the vine, forming moniliform threads of globular cells about 30 μ in diameter. It also occurs in similar localities imbedded in the thallus of a lichen belonging to the genus *Pyrenula*. In this condition it forms filaments composed of much smaller cells. When the lichen-thallus decays, these cells escape, and, on multiplying, assume again the normal size of those of the free form.

Constant Production of Oxygen by the Action of Sunlight on Protococcus pluvialis.§—In the summer, *Zygnema* and *Conferva* may

* Amer. Natural., xviii. (1884) pp. 67–8.
† Oefvers. af Svenska Vetensk. Akad. Förhandl., 1883, pp. 37–78 (1 pl.).
‡ Bull. Soc. Vaud. Sci. Nat., xix. (1883) pp. 53–4.
§ Chem. News, xlviii. (1883) pp. 205–6.

frequently be seen borne to the surface of pools of stagnant water by innumerable minute bubbles of oxygen gas. Some of the simplest of the unicellular algæ, e. g. *Protococcus pluvialis* and *P. palustris*, exhibit this peculiarity to a remarkable degree. T. L. Phipson has cultivated some of the last-mentioned plants by exposing pump-water to air and light for some weeks, and as soon as good growth was obtained, small dead branches of poplar were put in the water; the *Protococcus* developed rapidly upon them. The branches can then be put in flasks full of water, and the production of oxygen observed; this takes place immediately the flasks are exposed to the sun's rays; the oxygen comes off in the minutest bubbles, but in such great numbers as to form a froth on the surface; in some higher plants, e. g. *Achillea Millefolium*, the gas collects at the end of the leaves, and comes to the surface in large bubbles. If the flask is inverted the evolution of gas continues for about three days; the introduction of a minute quantity of caustic soda stops it on the first day by depriving the plant of carbonic anhydride. On renewing the water after three days, the evolution recommences, and so by keeping up a constant supply of pump-water and the production of oxygen, may be kept up to all appearance indefinitely.

The author has devised a simple apparatus for this purpose. A wide-mouthed bottle with tubulure near the bottom, is fitted with a gas delivery tube, and a tube with tap connected with a water-supply; the water must neither be boiled nor distilled, nor must it be in the slightest degree alkaline. A tap is put in the tubulure and is used to empty the bottle. Some of the poplar branches are placed in the bottle, water is run in, and the bottle exposed to sunlight; the oxygen can be collected in a gas-holder. After three days the old water is run out of the bottle and fresh water run in. The author suggests that by employing graduated vessels, &c., the apparatus might be used as an actinometer. The gas produced contains about 98 per cent. oxygen. The author remarks incidentally that carbonic anhydride in presence of sunlight is not decomposed by plants, but simply absorbed, water and hydrogen dioxide being equally essential for the production of oxygen, and the gas being evolved from the tissue as a consequence of the absorption.

Chromatophores of Marine Diatoms.*—O. Müller describes the peculiar form and structure of the chromatophores in some marine diatoms, hardened and coloured according to Pfitzer's nigrosin-picric-acid method.

In *Pleurosigma angulatum* the chromatophores consist of two very long bands, twice the length of the longitudinal diameter of the cell or more, comparatively narrow, much lobed and indented, but never perforated. They are arranged symmetrically on each side of the cell. For their whole length their surface is applied to the cell-wall, and separated from it by only a thin layer of protoplasm. A middle portion of each band, about one-third of its entire length, runs undivided to the inner surface of the upper shell—i. e. the shell which

* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 478–84.

contains the central portion of the chromatophore. Two pieces, together about equal in length to each of the middle pieces, lie separately on the lower shell, while the ends which enter the apices of the cell turn to the girdle-bands of the cell-wall, where also the pieces which start from the upper and under shells unite. The function of the chromatophore is therefore distributed nearly equally to both sides of the protoplasmic body of the cell. The median line of the chromatophore coincides, as in *Navicula*, with that of the girdle-bands; but the portions which project upon the adjoining cells are not arranged symmetrically in relation to the plane of division. The middle piece of each chromatophore, which lies on the upper shell, on both sides of the raphe, incloses, in the typical arrangement, the central cell-nucleus with a semicircular opening inwards.

Pleurosigma balticum also contains two chromatophores whose median line coincides with that of the girdle-bands, and which project on the shells on both sides; but they are not band-shaped and folded, as in *Pleurosigma angulatum*, but plates of a somewhat complicated structure. *Pleurosigma Hippocampus* has chromatophores of a similar form, but narrower.

Nitzschia Sigma has only a single chromatophore, which is, however, completely divided by the cell-nucleus; not so completely in other species belonging to the same group of the genus. It is plate-shaped, and is applied to that girdle-band which is opposite the two points of the keel. On its median line, in each of the two halves, lie five or more round or oval pyrenoids, bodies which are not unfrequently present in diatoms. They appear here not to be of such simple structure as in other cases. They are coloured more or less dark by nigrosin, and are surrounded by a light border, which, with very high powers, exhibits a differentiation into small bright dots, the structure being therefore similar to that in the Chlorophyceæ.

Division of Synedra Ulna.*—G. Schaarschmidt has found this diatom in an active state of division; he fixed the specimens with picric acid or absolute alcohol, coloured them with hæmatoxylin or eosin, compared them with living specimens, and gives the following as the chief results obtained. When division commences the breadth increases by the girdle-bands becoming separated to a greater distance; but the lamellæ of endochrôme retain their position, and their margins scarcely project in this condition over the girdle-bands; while, in individuals that are not dividing or only preparing to divide, they reach the end of the cells; but in those which have just divided or are dividing repeatedly, they are about 1/6 of the length of the cell shorter than the shell. The strongly refractive colourless nucleus is in the central mass of protoplasm which often lies only on one shell; no nucleoli can be detected in it. In cells which are about to divide it moves into the middle of the cell; its enveloping protoplasm, through which small mucilaginous particles are scattered, then lengthens towards the ends of the cell, where the protoplasm then

* Magy. Növ. Lapok, vii. (1883) pp. 49–58 (1 pl.). See Bot. Centralbl., xvi. (1883) pp. 198–9.

takes the form of an axile band uniting the ends of the cell, and concealing the nucleus in its swollen central part, which no longer touches the shells; the nucleus is now held by delicate threads of protoplasm which spring from the plates of endochrome.

While the axile band is developing thus, the plates of endochrome broaden to such an extent that they almost cover the entire sides of the girdle-bands. At this period, or even earlier, the plates, which were at first constricted, are now bisected.

At this stage of development the division of the nucleus commences. The species under examination exhibits this peculiarity, that the division of the nucleus, which now becomes of a broadly elliptical form, and breaks up immediately into two daughter-cells, proceeds in a direction parallel to the new shells. Only in a few cases are there spindle-fibres stretched between the two daughter-nuclei; these fibres are knotted in the middle, which may be regarded as a tendency towards the formation of nuclear plates. The daughter-nuclei may divide again, so that in the middle of the axile band there are formed at length from four to seven nuclei.

When the division of the nuclei is complete, the substance of the axile band becomes firmer, commencing at the ends, and dark dots are seen in it arranged in longitudinal rows, and later, short transverse striæ corresponding to them, which, however, become gradually indistinguishable towards the centre of the band where the nuclei lie. The daughter-nuclei, which hitherto lay one over the other, now approach one another in a horizontal direction (in the transverse diameter of the cell), and are separated only by the axile band, which is continually becoming denser, and which now divides the cell into two halves as an extremely delicate and flexible septum. The new septum becomes further differentiated, splits, and from it are formed the new shells of the daughter-cells. This process goes on very rapidly, and the transitional steps can be readily followed from the simply punctated or striated lamellæ to the double lamellæ. Cells with split septum are more often met with than with simple septum; but still more often the septum shows the dots only at the ends. These dots or striæ—since the septum is turned with its narrower side towards the observer—probably correspond to the channels of the new shells.

The new septum now acquires firmness, and now the movement commences of the lamellæ of endochrome; of those which lay upon the old shells, those which were opposed diagonally, with their ends pointing towards the middle of the cell, creep slowly through the sides of the girdle-bands, while the other lamella remains upon the old shell, pushing itself beneath it. Delicate threads of protoplasm are not unfrequently found between the upper ends of the lamellæ and the ends of the cell. The lamellæ attain their full size very quickly after their transfer. Frequently they break up into two, three, or more pieces, which become transported in the same way as the larger ones.

The nuclei may break up in the same way by repeated constriction into a large number of daughter-nuclei; four or five nuclei are not unfrequently found in each daughter-cell. The cells of *Synedra Ulni* are therefore multinucleated during and after division.

Arctic Diatoms.*—P. T. Cleve describes the diatoms collected by M. Kjellman during the expedition of the 'Vega' from the following sources:—Arctic diatoms from the ice near Cape Wankarema and near East Cape; from the surface in Behring's Sea; fresh-water diatoms from Japan; diatoms from algæ collected on the island of Labuan, near Borneo; from algæ and coarse bottom-mud collected near Point de Galle, Ceylon; and from bottom-mud between Aden and Bab-el-Mandeb. The Arctic material contained a very large number of species, which varied to an astonishing extent, so that in many cases it was scarcely possible to trace out the limits of the species. On the other hand, samples from the bottom of the North Siberian Sea were quite free from diatoms. The descriptions, &c., are in English, and several new species are described.

A few new species are also described by the same authority,† collected during the Arctic expedition of Sir George Nares.

Pelagic Diatoms of the Baltic.‡—A. Engler describes the pelagic diatoms gathered in the Baltic, chiefly in scum on the surface of the water in the bay and harbour of Kiel. Different times of the year are distinguished by the appearance of different genera and species. Among the more interesting forms observed was the remarkable genus *Chætoceros*, provided with horns or bristles from 5 to 20 times the length of the cylindrical part of the cell, the cell-contents being in communication throughout. Of this genus many species are known in the Arctic and Pacific Oceans; six are now described from Kiel Bay, one of them, *C. Grunowii*, new, was found with spores.

Diatoms of Lake Bracciano.§—M. Lanzì has examined for diatoms the water from the middle of this lake, and finds that, like the pelagic species, they differ from those found in shallow water. The swimming deep-water species found were *Fragilaria crotonensis* Edw. (*Nitzschia Pecten* Brun.), *Cyclotella comta* var. *oligactis* Grun., *C. comensis* Grun., and *Asterionella formosa* Hass. Those found near the shore, living on plants, stones, &c., belonged to the genera *Navicula*, *Stauroneis*, *Mastogloia*, *Cymbella*, *Amphora*, *Cocconeis*, *Achnanthes*, *Gomphonema*, *Staurosira*, *Synedra*, *Epithemia*, *Surirella*, *Cymatopleura*, &c.

* Cleve, P. T., 'Diatoms collected during the expedition of the *Vega*,' 60 pp. (4 pls.), Stockholm, 1883.

† Journ. Linn. Soc. (Bot.), xx. (1883) pp. 313–7.

‡ Ber. Deutsch. Bot. Gesell., i. (1883); Gen.-Versamml. in Freiburg, pp. x.–xiii.

§ Atti Accad. Pont. Nuovi Lincei, xxxv. (1883) May 21. See Bot. Centralbl., xvi. (1883) p. 257.

MICROSCOPY.

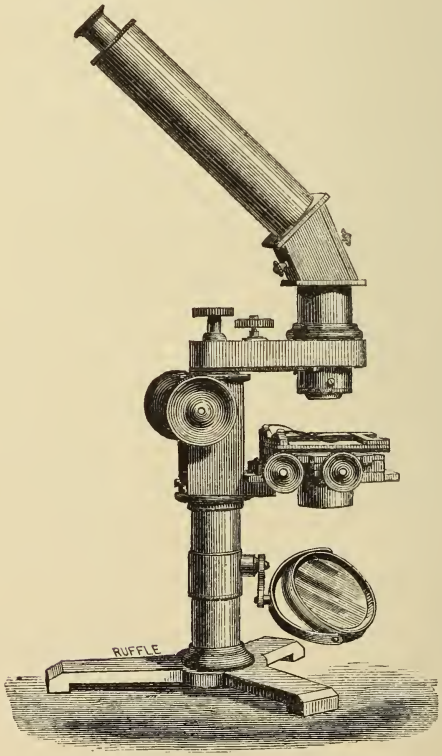
a. Instruments, Accessories, &c.

Ahrens's Erecting Microscope.—In this instrument (fig. 28), by Mr. C. D. Ahrens, the erecting prism is inserted below the body-tube, and the latter is inclined at an angle of about 45°.

The prism is similar to Nachet's erecting prism.

When the Microscope has a fine adjustment, the prism is mounted on a piece of tube, as shown in the woodcut; but when the fine

Fig. 28.



adjustment is omitted, as in the smaller forms, the prism is fixed directly on the arm.

For convenience of packing, the inclined body-tube slides off, and a cap is fitted over the top of the prism-box.

The advantages claimed by Mr. Ahrens for the instrument are

the erection of the image by a prism at the lower end of the body-tube immediately over the objective instead of over the eye-piece, "so that any objective and any eye-piece can be used without any trouble," and the convenient inclination of the tube.

Bulloch's Improved "Biological" Microscope.*—Mr. Bulloch has made further improvements in his "Biological Microscope," principally in the substage.

The substage and mirror-bars move independently, with the object as a centre, as heretofore; but immediately beneath the stage, just above where the rackwork ends, the substage-bar is cut transversely and the two parts joined together by a pinion and screw passing vertically through lateral projections cast for the purpose. About this pin the lower part, carrying the substage with its rack and centering screws, swings laterally, entirely out from beneath the stage. The space between stage and mirror is thus unobstructed by the substage, and the substage itself is practically clear of the Microscope, where it can be seen, and apparatus removed from or added to it with even more facility than if it were held in the hand.

Mr. Hitchcock regards it "as the greatest improvement in substage fitting that has been made for years, and one that is sure to be appreciated as its value becomes known."

The substage-ring is also made in two parts, and the lower part swings to one side independently. This part may carry a tinted glass to modify the light, or the diaphragms of a condenser, which could be conveniently changed. It would be better to place the condenser and its diaphragms in the upper substage-ring, while the polarizer with its plates of mica and selenite are fitted in the lower ring. Such an arrangement would give the microscopist every facility for work that could be desired. Without removing a single accessory, he would be prepared to use the light directly from the mirror by turning the substage aside. Then the condenser could be brought into use by a single motion, and the different effects of oblique light and dark-ground illumination obtained by the simplest possible operation of changing diaphragms. By bringing in the polarizer, which is always ready for use, all the effects of polarized light can be obtained.

Cox's Microscope with Concentric Movements.†—The Hon. J. D. Cox describes the new features of this stand (fig. 29) to consist in "the construction of the arm of the instrument in the form of the segment of a circle in which is a circular groove or slot; the pillars of the base have on their inner faces tongues which fit the slot in the arm. The inclination of the instrument is made by the sliding of the whole body along the fixed tongues in the pillars of the base; the centre of motion of the whole body is also the optical centre of the instrument, around which the stage, the substage bar, and the mirror bar all revolve. The body is clamped up in any position by the set-screw, with large milled head, in the base. The result is a shifting

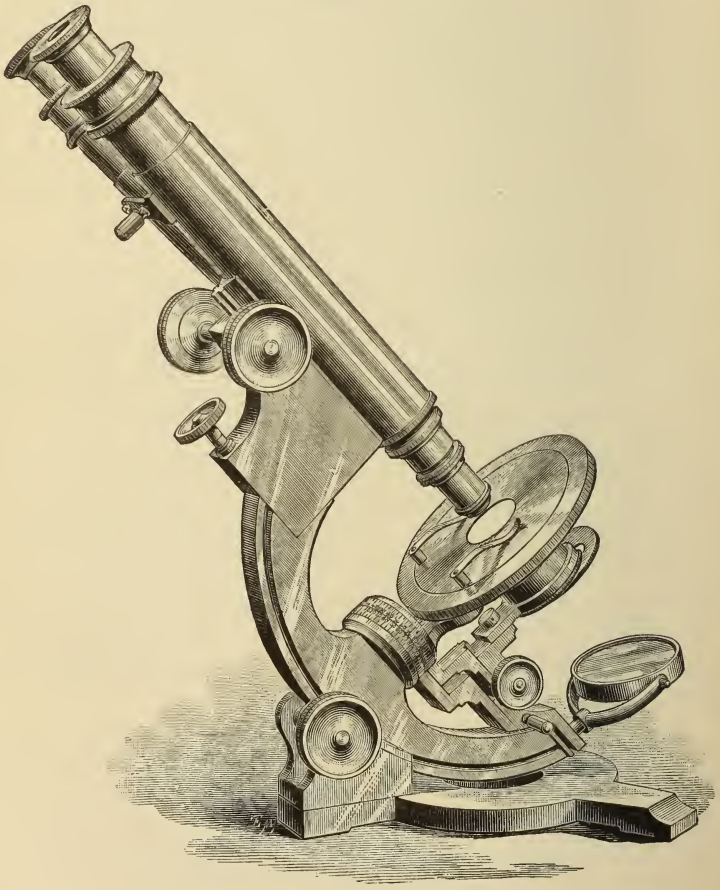
* Amer. Mon. Micr. Journ., v. (1884) pp. 9-10.

† Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 147-8 (1 fig.).

of the centre of gravity in changing the inclination of the instrument, so that great stability in all positions is secured, and the optical centre is thus made the centre of all the circular motions of the parts of the instrument.

The first application of the sliding motion of the body was made by Geo. Wale in his 'Working Model,' but he did not make the

Fig. 29.

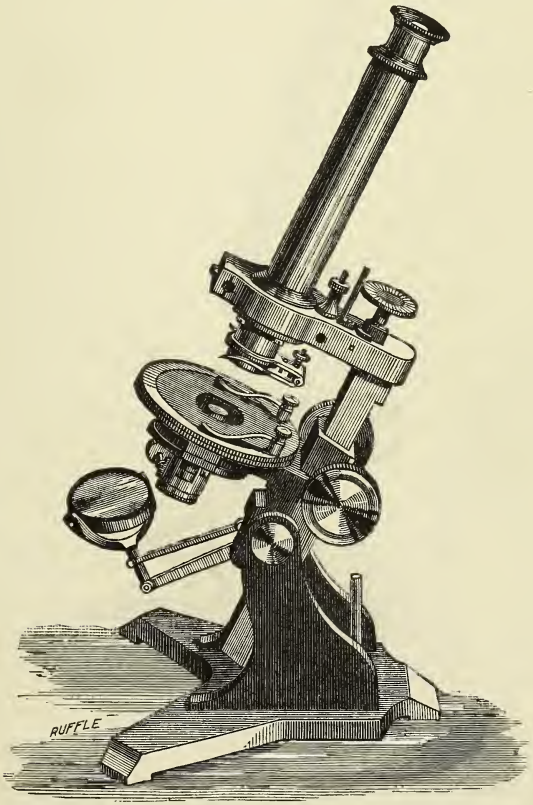


centre of motion the optical centre of the instrument. Mr. Wenham in his elaborate concentric Microscope uses a separate rocker arm with the whole body of the ordinary instrument pivoted above it. My design, which has been constructed by the Bausch and Lomb Optical Company, greatly simplifies the Wenham instrument, and extends the principle contained in Wale's, and makes a very compact,

stable, and satisfactory stand. The radius of the circular motion is 4½ in., the stage is 4½ in. in diameter, the concave mirror has 4½ in. focal length, and the diameter of the mirror may be from 2½ to 3 in."

Geneva Company's Microscope.—This instrument (fig. 30), made by the "Société Genevoise pour la Construction d'Instruments de

Fig. 30.



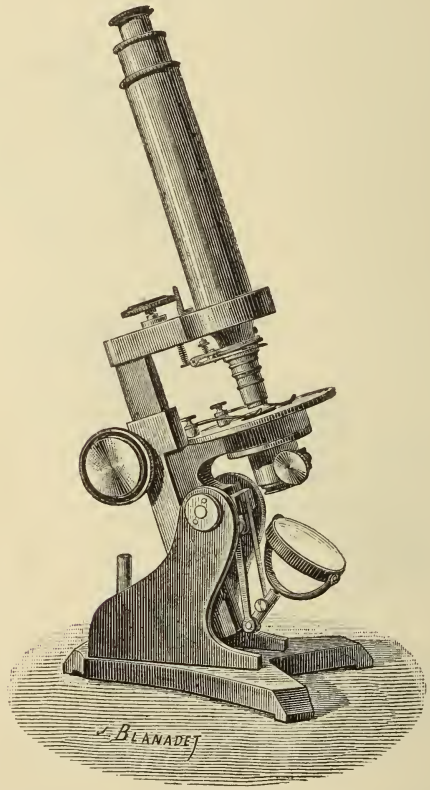
Physique," has two specialities; one being the spring pincers for rapidly inserting the objective, described *infra* p. 284, and the other the mounting of the mirror.

The mirror is attached, as shown in the woodcut, to three arms articulated in such a way that "the centre of the mirror is made to describe a curved line very nearly an arc of a circle, the centre of which is on the object under examination. The most suitable illumination is thus obtained very rapidly, the observer not having to

regulate at the same time the focal distance of the mirror and its lateral distance from the axis of the Microscope."

The condenser fits into a double cylindrical tube beneath the stage, the inner tube being moved up or down in the outer by rack and pinion. The diaphragms are also inserted in the inner tube.

Fig. 31.



The whole arrangement can be readily turned away from the axis on an excentric pivot.

The stand, in its general form, size (16 in. high), and workmanship, is one of the best that we have received from the Continent.

[Since fig. 30 was cut, the Geneva Company have supplied us with fig. 31, which shows more of the mode of attachment of the arms of the mirror.]

"Giant Electric Microscope."—This Microscope (*ante*, p. 109) has continued to be the subject of somewhat ludicrous comments on the part of the newspaper press.

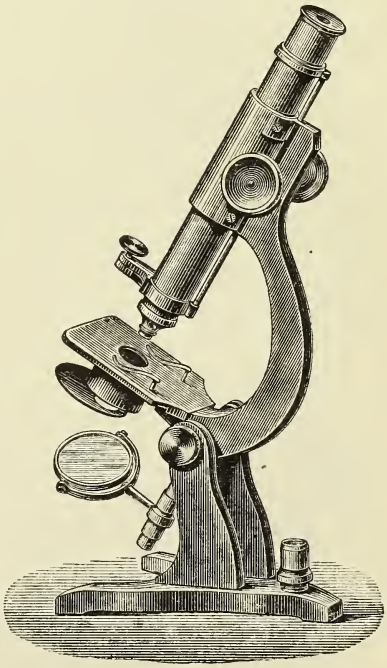
The one point of remark is the extent of the magnification

(4,000,000 times), even the *Times* (28th January) signalling specially the fact that the "eye of the smallest sewing needle made appears to be about 6 feet long by 4 feet wide, the needle itself appearing to be about 20 feet thick. *From this it will be judged how well the minutest details in the minutest specimens are brought out*" (!)

Most of the writers are not content to limit the value of such an instrument to the display of objects to large audiences, where the inferiority of the display is to some extent compensated for by the increased number of spectators who can see the objects at the same time, but evidently suppose that the increase of the magnification represents a proportionate increase in the scientific value and capacity of the instrument, and that by the use of "Giant Electric" Microscopes we are brought many degrees nearer to the vision of the ultimate molecules of matter than we are when sitting at home with a student's Microscope only.

The *Standard* of 28th January says, "But although this great Microscope can make the eye of the smallest sewing needle apparently a huge orifice some seven feet by five in dimensions, yet the component particles of the tissues of either animal or vegetable organisms cannot be *even yet* made visible, and the minute divisions of matter would remain unknown, so far as the sight is concerned, and would be an inscrutable mystery, except for the deep reasonings of the educated human mind;" while the *Norwood Review* asks "What assistance, for instance, may not surgeons derive from it in the study of nosology? It is safe to predict that Science in her onward march will find a valuable accessory in the "Giant Electric Microscope"!

Fig. 32.



Tolles's Student's Microscope.—Fig. 32 is given by Dr. L. Dippel in the latest edition of his 'Das Mikroskop' (p. 541) but without the explanation that it represents not a modern arrangement, but one of the earliest forms of Microscope devised by the late R. B. Tolles, the peculiarity of which was that the rack of the coarse adjustment was cut on a rod attached at both ends to the body-tube and passed through the straight part of the limb where the pinion acted upon it. We believe this plan was adopted for economy of manufacture, as the body-tube sliding in a socket required very

little outlay in the matter of accurate bearings. It was, however, abandoned in favour of the usual Jackson slides and rack.

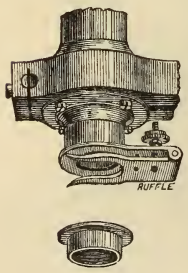
Another feature in the design of the stand, which we have found convenient in practice, was the greater bend of the limb than usual, by which the space above the stage was left free for manipulations with either hand. This latter feature has been maintained in all the later models of Microscopes issued by Mr. Tolles.

Winter's, Harris's, or Rubergall's Revolver Microscopes.—Mr. Harris of Great Russell Street, W.C., informs us that Thomas Winter was the "first and true inventor" of these instruments (described *ante*, pp 114–5) more than 56 years ago, when Mr. Harris inherited the business.

The one described as a simple Microscope bears the name of "T. Winter, No. 9, New Bond Street, London," while that figured at page 115 has, it appears, engraved on the cross arm carrying the body-tube, "Thomas Rubergall, Optician to H.R.H. the Duke of Clarence, 24, Coventry Street, London." Winter worked for Mr. Harris, and sold the first model to him (the simple form mentioned *ante*, pp. 114–5). Later Winter made some for Rubergall, probably the compound one (fig. 11). He also made some much smaller ones, which were sold for a few shillings.

Geneva Co's. Nose-piece Adapters.—This (fig. 33) consists of two pieces of brass hinged together at the back. The upper is immovably attached to the nose-piece of the Microscope; the lower terminates in a fork, which lies just under the nose-piece. The two plates are kept together by a set-screw, acting on a spiral spring, which can be tightened or loosened as required. The objectives are screwed to the collar shown in the fig., which slides in the fork. When the objective is centered with the optic axis, a slight projecting rim on the upper plate drops into the aperture of the adapter; the objective is then held fast, but is readily removed on applying a moderate downward pressure, which depresses the forked plate and enables the collar to be slipped out. By the set-screw the amount of pressure required to be applied can be varied.

Fig. 33.



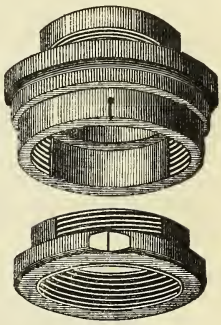
The above form is a fixture on the Microscope, but the Company make another which is removable. It does not appear, however, to differ in principle from the nose-pieces of Nachet and Vérick (see this Journal, i. (1881) pp. 661–2).

The advantages of such arrangements are explained by the Geneva Company to be (1) economy of time, (2) "a mechanical centering of the objective much more perfect than can be obtained with a screw, the defects of the centering being immediately recognized can be partly corrected, and (3) we can readily choose the side of the objective which gives the best images, when oblique illumination is used."

Zentmayer's Nose-piece.*—This (fig. 34) is yet another of the nose-pieces for rapidly changing objectives, so many of which have been brought out during the last few months.

Mr. Zentmayer's plan consists simply in the adoption of Mr. Nelson's form of adapter (see vol. ii. (1882) p. 858) with the inner screw-thread filed smooth in two opposite segments, but in place of altering the thread of the objective itself, he puts on it a separate collar, the inner thread of which is entire, but the outer thread filed smooth in two places in a similar way to that of the adapter.

Fig. 34.



Mr. Zentmayer thought it useless to adopt the original plan, "unless all the prominent manufacturers would agree to cut the screw-threads of objectives and nut in the same relation," which would be difficult to establish; but "by means of the collar he can manufacture a nose-piece and collar for any objective without having either at hand."

Törnebohm's Universal Stage Indicator.†—A. E. Törnebohm describes his arrangement as follows:—"Every petrological Microscope is now, as a rule, provided with a scale, or other arrangement on the stage, whereby we can readily find again any particular point in a preparation which it is desired to mark. According to the methods hitherto used, however, the contrivance which gives the position of a point in the preparation, is only available for a given Microscope, or at most for the Microscopes of a given maker. It would naturally be better if it were available for all petrological Microscopes, so that in sending away a preparation for inspection we could easily indicate the point to be observed without an ugly ring of ink. This advantage can be easily attained by the following simple contrivance, which I have adapted to my Microscope for years past and which I have found very effective.

The stage is divided by lines crossing at right angles, like a chess-board, the distance between the lines being exactly 2 mm. Every fifth line should be somewhat thicker so as to facilitate the counting. It is superfluous to mark the lines with figures. Two of the lines must cross each other *exactly* in the centre of the stage, and the counting starts from these. When I wish to mark a point in a preparation, I first adjust it in such a manner that the edges of the slide are parallel with the lines. I then determine the position of one corner (preferably the lower left corner) by counting from the two middle lines, and write the result, in the form of a fraction, upon the label of the preparation, as for example $\frac{113}{78}$ if the distance along the vertical edge (the writing on the preparation being horizontal) is found to be 11·3,

* Amer. Mon. Micr. Journ., v. (1884) pp. 42–3 (1 fig.).

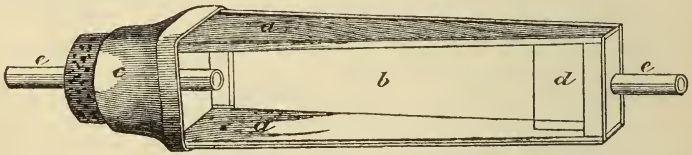
† Neues Jahrb. f. Mineral. Geol. u. Paläont., 1883, i. pp. 195–6.

and that along the horizontal edge 7·8. An estimate can be very well made within a tenth (that is to 0·2 mm.) which is sufficiently near. It may sometimes happen with large preparations and slides of ordinary size that the corner to be marked lies outside the divisions. I therefore mark the position of the opposite diagonal, and put an angle round the fraction thus : $\overline{\frac{106}{47}}$ * * *

I have been able to convince myself by trials that divisions which are good for one Microscope are equally good for others similarly arranged, and that therefore the contrivance is a practical one."

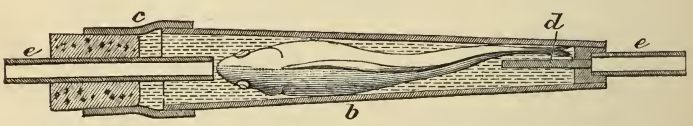
Stokes's Fish-trough.*—A. W. Stokes describes a simple apparatus for aërating living fish whilst under observation. It is shown in perspective at fig. 35, and in longitudinal section at fig. 36,

Fig. 35.



a, *a* being two wedge-shaped slips of wood well soaked in paraffin wax to render them waterproof, *b*, *b*, two 3 × 1 glass slips, so arranged as to form, with the wood slips, a wedge-shaped glass box. The larger end of this box is inclosed in a short piece of indiarubber tube *c*, and this tube is closed by a cork. A short piece of glass *d* is fixed inside about midway between the glass sides of the box, so that it will form a shelf upon which the fish's tail may be during examina-

Fig. 36.



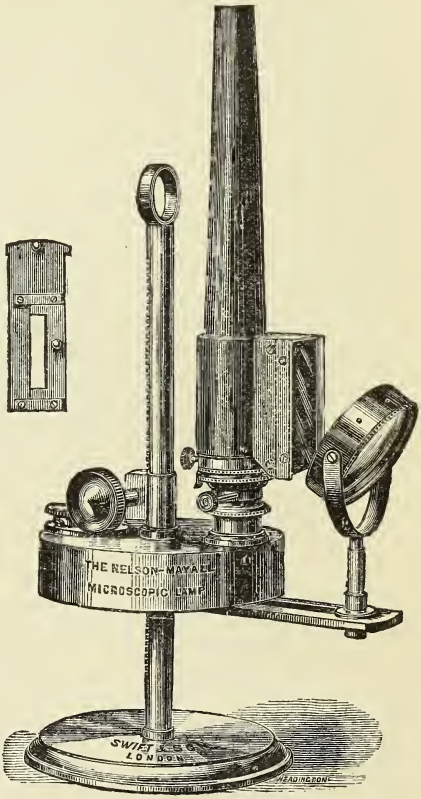
tion, as shown in fig. 36. At either end of the box are fitted two short glass tubes *e e*, which when the instrument is in use are respectively connected by indiarubber pipes with bottles at different levels, to obtain a circulation of water.

Nelson-Mayall Lamp.—At the Society's meeting in January, Mr. J. Mayall, jun., exhibited the modified form of Nelson's lamp,† shown in fig. 37. The modifications consist (1) in making the oil-well circular instead of square, so that the standard passes conveniently through the centre, and the well carrying the lamp can

* Journ. Quek. Micr. Club, i. (1884) pp. 322–3 (2 figs.).
† See this Journal, *ante*, p. 125.

be rotated for purposes of centering, &c.; (2) a rackwork is applied to the standard by which the height of the lamp can be adjusted rapidly; (3) the base is made thinner and the fittings beneath the well altered so that the burner can be put 3/4 of an inch lower than formerly; (4) the oblong frame carrying the lamp-glass (an ordinary 3 × 1 slip) is provided with two extra grooves, in which may be slid 3 × 1 slips of tinted or ground glass, or a brass plate (shown in the fig.), to which an adjustable diaphragm is fitted, can be used in combination with white or tinted light; (5) the cylindrical part of the chimney is arranged so that an opal glass reflector may be inserted if desired. Whilst adding but little to the cost of the lamp as devised by Mr. Nelson, the new form combines several points of novelty suggested by practical experience.

Fig. 37.



Standard Micrometer Scale.* — It will be remembered that the American Society of Microscopists ultimately abandoned their original micrometric unit of 1/100 mm. and adopted 1/1000 mm. or 1 μ. The United States Bureau of Weights and Measures undertook to prepare and authenticate a standard scale, and in August 1882, such a scale, ruled on a platin-iridium bar, and verified with great care by Professor C. S. Pierce, was placed at the disposal of the National Committee on Micrometry representing the various Microscopical Societies. A sub-committee for testing this micrometer was appointed, on whose behalf Professor W. A. Rogers subjected the plate to a prolonged and elaborate study which was not completed until August 1883.

This scale is divided into ten millimetres, each division being marked by three lines distant from one another ten microns, and the measurement is to be made from the mean position of one triplet of lines to that of another. The first millimetre is again divided in the same manner into tenths of millimetres. The first tenth of a milli-

* Proc. Amer. Soc. Micr., 6th Annual Meet., 1883, pp. 178-200.

metre is subdivided into ten spaces of ten microns each. There are thirteen of these lines at the beginning of the centimetre, the first tenth of a millimetre being measured from the mean of the first three to the mean of the eleventh, twelfth, and thirteenth. The scale is engraved on a piece of platin-iridium made by Matthey, and containing 20 per cent. of iridium.

Professor W. A. Rogers gives the results of a very elaborate "study" of the scale, which is now in the custody of the American Society of Microscopists, and available, under regulations, to "parties of eminent ability" for the comparison and verification of their standards. Three copies are to be made on glass, which will be lent out.

Microscopic Test-Objects.*—The correspondence on this subject between "Monachus" and Mr. E. M. Nelson has been further continued, the former finally accepting (as "that which was to be demonstrated") Mr. Nelson's admission that when he wrote that he had by particular means made the discovery of the "true structure" of *Surirella gemma* he did not mean the "ultimate true structure."

There is one point however in the correspondence left untouched, which we refer to because the misapprehension which Mr. Nelson was under on the subject has at one time or another been widely shared and we have no doubt is so still.

If we have a grating (fig. 38) it will, as we know, give rise to

Fig. 38.

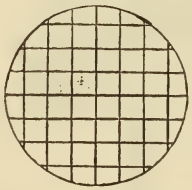
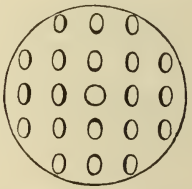


Fig. 39.



diffraction spectra as in fig. 39. But if we stop off all the spectra except two nearest the central dioptric beam (say at the top and side) we shall still see the grating. Hence it has been supposed that only those spectra were really necessary for the image, or as Mr. Nelson puts it, "the true structure can be seen without taking up all the diffraction spectra."

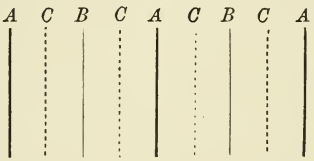
It cannot be too clearly borne in mind that this is an erroneous notion and that it is a fundamental point of the diffraction theory that if we are to see a true image of the object, *all* the diffraction spectra into which the original pencils were separated must be again gathered up and brought to the eye, so that wherever any of the diffraction spectra (up to the limit of vanishing intensity) are wanting, the image is incomplete. The absence of the spectra shut off may produce very considerable variations in the image, not only in the breadth of the lines and spaces, but otherwise.

* See Bibliography, *infra*.

Aperture and Resolution.*—L. Wright, while agreeing in the utter impossibility of ever knowing by absolute observation the "true structure" of minute objects, yet thinks there is something in the objections to overmuch dependence upon the results of very oblique light.

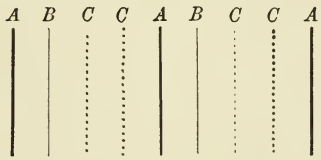
Let us suppose we have an object whose true structure is something like fig. 40, explained or described as follows:—

Fig. 40.



Let the black lines A A A denote strong ribs, or striations, or ridges 20,000 to the inch; B B lesser ridges midway between them, and C C C either valleys or fainter markings midway between these. A low-angled lens would show the black lines only; a good glass would bring out B B as well; a good immersion the faint dotted lines C C C. But even in this simple case these latter would certainly appear as lines; for the distances represented by the dots are far too minute for their spectra (transverse to the others) being included in any lens yet made. Let us, however, now suppose the real structure to be modified as in fig. 41, the second strongest markings B B being next

Fig. 41.



A A A, but C C C altogether absent, and not as here shown. The second lens would, in this case, show only a slight thickening or blurring of the coarser striation A A A; but the immersion objective might show nearly the same image as that given by the previous structure, since the narrow intervals A B, A B, A B, would give the same spectra as if the gaps C C C were filled up. It is true the wider distances B A, B A, B A would, by their own spectra, strengthen the B B lines; but the dotted lines C C C would be created, and appear to show structure which did not exist.

But no microscopic structure really consists of absolute *lines*, and hence this is a very small part of the complicated problem. If, as we have supposed, AAA are ridges, they will have some absolute breadth,

* Engl. Mech., xxxviii. (1884) pp. 470–1 (2 figs.).

and these dimensions really constitute a still more minute set of lines, whose spectra are far beyond the collecting power of our lenses. Hence the reason why real lines, like Nobert's test-bands, can be truly "resolved" or photographed, though microscopic objects cannot. Supposing the objective can resolve lines of 100,000 to the inch, all it is capable of showing in an *object* is, that something—*some* variation of structure—occurs at regular intervals of 100,000 to the inch. If this is so, it will be shown as lines; but it is perfectly obvious that very rarely can it *really be* mere lines. It will have form of some kind; and every minute variation in light and shade due to that form, constitutes an infinitely minute *set of distances*, which will all cause their own spectra, too distant, if not too faint, to be gathered in.

Error may arise in yet another way. Lord Rayleigh has shown mathematically, and partially proved experimentally (by gratings eaten out in gelatine) that if an optical grating be composed (instead of white and black lines) of equally transparent narrow stripes, whereof each alternate one retards light half a wave-length more than its neighbours, the spectra are *fourfold in brightness*. Now these also would image lines, though falsely. The application to transparent microscopic objects need not be pointed out.

Yet the more we understand the true relations of these spectra, and their optical effects, the truer will our interpretations become, within, at least, the limits of microscopic vision, and the more certainly shall we be directed to methods of manipulation which may truly interpret the phenomena. Taking merely the theory of the matter, let us consider the case of fig. 41 where only the lines A A and B B really exist, but C C are apparent by the illusory spectra of the narrow spaces between A B, A B. It is plain we have means, if our suspicion as to the existence of C C C is awakened, of clearing it up. For we can stop off not only the central pencil, but those inner spectra which give us the coarsest intervals A A A. This will bring into stronger relief the spectra representing the next widest spaces, B A, B A, and thus we may correct the former result. Also it is obvious that any skilful manipulator with a knowledge of physical optics, by stopping off central pencils, and, when necessary, inner spectra, might bring into stronger relief the much fainter spectra caused by fainter and finer striations, which were before "drowned," as it were, in the coarser phenomena. Mr. Stephenson proved this in the case of *P. angulatum*, bringing out minute patterns, when the central pencil was stopped off, which had never before been seen.

It is also evident why so much is learnt from various incidence of the light; but it will also appear that this should be studied more gradually than most mirror arrangements permit. As a rule, microscopists adjust for one obliquity, and make their observation; then try another. It would rather appear that continuous observation under a steadily increased obliquity must be necessary to good interpretation; and that even then a competent knowledge of the physical phenomena of optical gratings is necessary, as well as a careful collation and comparison of the appearances with those presented

under similar treatment by coarser objects, of which true dioptric images can be obtained. But even then it will be only a matter of interpretation more or less correct. All we know of *A. pellucida* is, that there are striæ, or ridges, or something occurring at intervals of so many to the inch. It is obvious they cannot be mere lines, as they appear to us; but as any "form" must involve another set of lines of at least double the minuteness, and probably far more, what is there can never be known, except from analogy and comparison with larger diatoms. As a rule, we must get lines only in minute structures, and as a rule, that appearance is certainly false. Nevertheless, the variations in distance between the spectra under gradually increased obliquity, and their consequent image-results, appears the most likely general method of ascertaining the true *proportions* of distances between striæ not all equidistant, while the successive stopping out of the inmost and brightest spectra appears the most promising general method of revealing those fainter spectra which may lie hidden behind, and which reveal some periodic variation in structure at the distances of the apparent lines.

The Future of the Microscope. — Amongst the reports on the South Kensington Loan Collection of Scientific Apparatus is one by Prof. Abbe on the "Optical Aids to Microscopy," * the earlier part of which (pp. 383–91) is occupied with a general description of the stands, objectives, and other apparatus exhibited, with critical comments. The succeeding thirty pages are devoted to a consideration of "the facts which throw a light on the conditions of optical performance, and furnish hints in regard to further progress."†

The author commences with expressing the opinion that no *epoch-making* advance in the way of an extension of the domain of microscopical perception is now possible, although there is still great room for improvement in other, and in a relative sense minor, respects. The curve of progress, after having risen abruptly for several decades,

* Hoffmann, A. W., 'Bericht über die wissenschaftlichen Apparate auf der Londoner Internationalen Ausstellung im Jahre 1876.' 8vo, Braunschweig, 1878. Cf. pp. 383–420, Abbe, E., 'Die optischen Hülfsmittel der Mikroskopie.'

† It appeared to us, on a perusal of Professor Abbe's paper, that he had not given sufficient weight to the increase in aperture and resolving power obtained by the use of homogeneous immersion, but to our objections on that point he writes as follows :—"Your objection leaves out of sight the general point of view from which the question of further perfection of the Microscope is discussed here. When the article was written, the opinion was generally spread, still—even among microscopists—*that it was only a question of time that the Microscope should display the molecules themselves.* This opinion I had always in view during the whole discussion. Hence results the large standard applied by me in estimating and measuring progress. The increase of delineating power from 1·1 to 1·4 or 1·5 is an exceedingly *small* increase compared with the *supposed* increase from 1·1 to ∞. That half the wave-length in air 'is the approximate limit,' and that this will not be overcome in a 'considerable' extent is true, notwithstanding homogeneous immersion, having regard to the said standard of estimation. The *important* point is that the *wave-length* does constitute a limit; that the *value* of the wave-length may be reduced in some degree by media of higher refraction is the *subordinate* feature under the point of view of the paper."

appears to have a tendency towards an asymptote parallel to the base line.

A condensed and summarized statement is given of the theoretical principles on which the compound Microscope is based, including the author's now well-known views on the formation of the images of minute objects in microscopical vision, together with observations on the important function of aperture in the Microscope, and the increase of aperture obtained by immersion lenses as compared with dry.

The remainder of the paper is devoted to a consideration of the possible ways and means by which, in the future, new successes may be hoped for, "the most important practical advantage of a rational theory of the Microscope being that, destroying mere vague hopes, it enables a proper direction to be given to the aims of the inventor."

With regard to a still further extension of aperture beyond 1·5 (the refractive index of crown glass), the author suggests that it may be thought that in process of time transparent substances, available for the construction of objectives, will be discovered, whose refractive index will far exceed that of our existing kinds of glass, together with immersion fluids of similarly high refractive power, so as to give new scope to the immersion principle. What, however, he asks, will be gained by all this? We shall perhaps, with certain objects, such as diatoms, discover further indications of structure where we now see bare surfaces; in other objects, which now show only the typical striations, we shall see something more of the details of the actual structure by means of more strongly diffracted rays; but we should get on the whole little deeper insight into the real nature and composition of the minuter natural forms, even should the resolving power of the Microscope be increased to twice its present amount; for, whatever part of the structure cannot at present be correctly represented on account of its small size, will then also give an imperfect image, although presenting a somewhat higher degree of similarity than before. If, therefore, we are not to rest upon conjectures which surpass the horizon of our present knowledge (as, for instance, would be the expectation of the discovery of substances of considerably higher refractive power than has hitherto been found in any transparent substance), our progress in *this* direction in the future will be small, and the domain of microscopy will only be very slightly enlarged, the more so because every such advance, however great, will be but of limited utility to science, on account of very inconvenient conditions. For a given extension of the aperture can only render possible a correspondingly enhanced performance of the Microscope when the object is surrounded by a medium whose refractive index at least equals that aperture. If the Microscopes of the future should utilize the high refractive power of the diamond, all the objects would have to be imbedded in diamond, without any intervening substance. The result of this consideration is, therefore, that as long as aperture serves that specific function, which experiment and theory compel us to ascribe to it at present, there is a *limit* to the further improvement of the Microscope, which, according to the present condition of our knowledge, must be considered as insurmountable. The optics of the day have already so

nearly approached this limit, that any very important improvement in the way of a further development is no longer to be anticipated. This limit to all optical observation, in the direction of minuteness, can be approximately defined by half the wave-length (in air); at least microscopical observation cannot be applied to objects which are smaller to a *considerable* extent than half the wave-lengths, although the latter can be somewhat exceeded with immersion lenses.

The measure of the details accessible to our vision is not an absolute one, but is related to the wave-length of the light by which in any particular case the image is formed. There is, therefore, a certain latitude which can be utilized to some extent in favour of optical perception. In observations with white light those rays predominate, in the formation of the image visible to our eye, which show the greatest intensity in the visible spectrum. The mean wave-length will therefore correspond with the bright green, and may be taken as $0{\cdot}55\ \mu$. Somewhat smaller wave-lengths, those of the blue rays, allow of effective observations with so-called monochromatic illumination, the advantages of which for the recognition of the finest details have long been known to the microscopist.

Still more favourable are the conditions of image-formation with photography, since in this case the wave-length of the violet rays, which are the active ones, is $0{\cdot}40\ \mu$ only. The performance of objectives under otherwise similar circumstances extends, therefore, perceptibly further with photography than with direct observation. Not only does the photograph show finer details at the limit of the resolving power than would be directly visible to the eye, but even when the object is not at the extreme limits of resolution, but the correctness of the image is yet more or less problematical, it gives a greater guarantee of the truth of the representation than does the ordinary image. Hence photo-micrography, in difficult examinations, has a value not to be underrated.

A further step may be taken in this direction by utilizing rays which probably lie far beyond the limits of the visible spectrum in the ultra-violet. If these images are not directly visible, it is possible to imagine them made visible by means of fluorescent substances. But for this the optician must have materials for the construction of the objective which possess at least the transparency of quartz for the ultra-violet rays, without those properties which now preclude its application for such a purpose, and substances of similar transparency must also be found for imbedding the object and for the immersion fluid.

This consideration shows to what extent we must quit the sure ground of experience if from our present standpoint we reckon on a *fundamental* improvement of microscopy. The result of such attempts leaves no prospect in the main of the realization in the future of hopes and wishes which rest on the notion of an ever-extending and unlimited improvement in our optical instruments. Judging from what lies within the horizon of our present knowledge, a limit is put to the range of our eyes by the action of light itself, a limit which is not to be overstepped with the tools given us by our present know-

ledge of nature. "There remains, of course," says the author, "the consolation that there is much between heaven and earth that is not dreamt of in our philosophy. Perhaps in the future human genius may succeed in making forces and processes serviceable which may enable the boundaries to be overstepped which now seem impassable. Such is, indeed, my idea. I believe, however, that those instruments which may perhaps in the future more effectively aid our senses in the investigation of the ultimate elements of the material world than the Microscope of the present, will have little else than the name in common with it."

There is, therefore, but small scope left for the advance of optical art, in regard to the most important point in the efficiency of the Microscope—aperture—the possible direction of which has been indicated in the foregoing observations. The further perfecting of the instrument must chiefly relate to the two other factors of its optical performance, viz. the magnifying power and the dioptrical exactitude with which the image is formed. In these is to be found the most important task left for the optician in reference to the Microscope.

With regard to the first—the amplification of the image—the author proceeds to explain in outline the point since dealt with more in detail in his papers on the relation of aperture to power,* and the uselessness of a magnifying power that is out of proportion to the aperture—increased size without visible detail, so that we have "mere emptiness." There is room for improvement of the eye-piece in reference to many points—the size of the field, the uniformity of the magnifying power, &c.; but they are points of subordinate importance, because they do not touch the performance of the Microscope in its most essential respects. The practical optician has, it appears, adopted this view. At least the fruitless efforts to increase the actual capacity of the Microscope by special eye-pieces have ceased.

It is an essentially different matter with the remaining factor. The conditions on which depend the more or less perfect union of the rays in an optical system are so manifold and so complex, and the ways and means of satisfying certain requirements are so numerous that a wide field will remain open to optical science for all time. The imperfection of the optical image at the focal point springs from two causes very similar in their effects. The one arises from the residual spherical and chromatic aberration which even the best devised combinations of refracting media still leave; the other lies in the want of homogeneity, precise form, and exact centering of the lenses which even the most perfect art can never wholly remove. The result is that every objective unites the cones of rays proceeding from the points of the object, not in mathematically exact image points, but in light surfaces of greater or less extent—circles of dissipation—and thereby limits the distinct representation when the details are of a certain minuteness.

Of course every part of the optical system, the objective as well as the eye-piece, contributes to this imperfection of the image. In its practical importance, however, the part played by each of the elements

* See this Journal, ii. (1882) pp. 300 and 460, and iii. (1883) p. 790.

of the compound Microscope is extraordinarily different. If we disregard the faults of the image towards the margin of the field, and consider only the maximum sharpness of the image in the region of the axis, the eye-piece is, as a matter of fact, quite without influence. In the simplest eye-pieces with unachromatic lenses, their action in the centre of the field is practically free from error, when we estimate the conditions under which they act. It is undoubtedly accurate, as is often urged, that the eye-piece, even in the axis, exercises *an* influence on the spherical and chromatic aberration of the pencils, but at the same time as accurate as it is to say that the sun rises earlier for a tall man than it does for a short one.

For the proper performance of the Microscope, those faults in the image are alone important which originate in the action of the *objective*, and are only enlarged in the objective-image by the eye-piece. From whatever cause these may spring, whether from external imperfection of the lenses, or from aberrations, their common influence consists in their imposing a certain limit to the useful magnifying power in the case of every objective. The more perfectly an objective of given focal length acts in both respects, the higher the magnifying power it admits of by means of tube and eye-piece; the more imperfect the union of the rays, the lower the magnifying power at which the dispersion circles from each point of the image destroy its sharpness and clearness. Moreover it is entirely unimportant in itself by what means a given magnifying power is to be produced, whether by longer tube and weaker eye-piece, or by shorter tube and stronger eye-piece; the amount of the *united* magnifying power is alone to be considered, and must be compared to the magnifying power which the objective, used as a magnifying glass, would give by itself. The ratio in which tube and eye-piece may increase the available magnifying power over that of the objective alone, without deterioration of the image, forms the exact standard of the perfection of an objective. On the one hand, this points out the reason why the attainment of a higher magnifying power always necessitates objectives of shorter focal length. This would not be the case if the objective could be arranged so as to unite the rays perfectly, for nothing would then hinder the production of any desired amplification of the image, by means of tube-length and eye-piece, however great the focal length of the objective might be. On the other hand, it is shown that every advance in perfecting the objective, with regard to its dioptrical functions, must enable amplifications, hitherto attained with sufficient clearness by lenses of short focal length only, to be equally well attained by lower power objectives.

A comparison of the Microscope of the present day with those which twenty, thirty, and forty years ago gave the best performance, shows the steady progress which optics have made in this respect. Without doubt it is of the greatest interest to examine what prospects there are for the further perfecting of optical instruments in this direction. If the opinion previously expressed on the importance of aperture and on the extreme limit of microscopical perception is right, no improvement of the objectives in their dioptrical action can substan-

tially enhance the performance of the Microscope in the whole; for, with the present constitution of the objective, magnifying powers are attainable with which the smallest detail that can be represented is distinctly visible; *the progress will merely consist in obtaining in equal perfection the same amplifications that we now have at command by means of relatively lower power objectives.* But even this would be a matter of great practical importance if we should succeed in materially surpassing the present performance, so that, for instance, the strongest magnifying power, for which we now use lenses of 1 mm. and less focal length, would be at least as perfectly obtained with objectives of from 3 to 4 mm. Not only would the great difficulties be removed, which are now attendant upon work with high magnifying powers, in consequence of their too short working distance, but it would be no less an advantage that every objective would offer a greater latitude for useful magnifying power. Even with regard to purely optical perfection, the production of higher magnifying powers by stronger eye-pieces, instead of stronger objectives, would be a decided gain, by lessening certain faults in the image which impair its clearness outside the axis. The aberrations outside the axis (erroneously attributed to the convexity of the field) which in objectives of large aperture are always but very imperfectly corrected, vary for the most part with the *square* of the distance from the axis, for which reason their obnoxious influence will, with the employment of stronger eye-pieces, diminish more quickly than the magnifying power increases. Possible apprehensions of other drawbacks which might attend the use of stronger eye-pieces are groundless, for, if it should become necessary, combinations of lenses could be constructed, by which any high magnifying power that may be desired could be as conveniently obtained as with the present eye-pieces.

In judging of the ways and means which are open, according to this view, for the perfecting of the Microscope, we must consider the various sources of error which spring from its deficiencies.—At the present day an extraordinary perfection is attainable in the technical accomplishment of objectives. With technical aptitude and a rational method of work we can correctly produce given curves, even in very small lenses, up to a few thousandths of the radius. The irregular deviations of the surface from a strictly spherical form, however, can be restricted, when necessary, in their absolute quantity to small fractions of the wave-lengths and the centering of the separate surfaces can be exactly executed with exceedingly small deviations. With the exception, perhaps, of the strongest objectives, which, in consequence of their very small dimensions, allow of only uncertain means of measuring and proving, we can see the unavoidable errors diminishing almost to the vanishing point. The actual imperfections which are seen in the dioptrical working of the Microscope of the present time must chiefly be referred, therefore, to the imperfect correction of the aberrations.

The study of the conditions which must be fulfilled for the perfect correction of the chromatic and spherical aberrations in an objective shows two drawbacks not to be overcome by the practical optics of the day.

One arises from the unequal course of the dispersion in crown-glass and flint-glass, in consequence of which it is impossible with the present kinds of glass, to unite perfectly all the coloured rays in the image. In the best combinations of lenses which can be made, there is always therefore a considerable secondary chromatic aberration in the image which impairs its clearness.

The second still greater hindrance is the inequality of the spherical aberration of an objective for light of different colours, and the impossibility of compensating this inequality with our present resources. It is not difficult even with a large aperture (using light of one particular degree of refrangibility) to remove perfectly, practically speaking, the spherical aberration, at least in the axis, so that the objective, with monochromatic light of this fixed colour, will give an almost perfect union of the rays; the system is however under-corrected for the less refrangible rays, and over-corrected for the stronger. The larger the aperture of an objective, the greater of course will be the residual aberration which originates in this difference of the spherical correction for the various colours. Their effect appears in the form of a characteristic diversity which the chromatic correction of the objective shows for the different zones of the free aperture, an objective which possesses the most perfect possible chromatic correction for the central rays, and gives the most favourable images with direct illumination, being more or less strongly over-corrected chromatically for the peripheral rays, and with oblique illumination shows the outline of the object with distinct chromatic fringes, and conversely. In objectives of moderate aperture, perhaps up to 40° or 50°, we may restrict the detrimental effect of this chromatic difference of the spherical aberration, by dividing the refractions over a greater number of separate lenses than would be otherwise required by the aperture. English and American opticians have in this way constructed weak objectives of from 30 to 20 mm. focal length, which give a more perfect union of the rays than the corresponding more simply constructed lenses in use on the Continent, and which allow of a much higher magnifying power by means of draw-tube and eye-piece. The above-mentioned class of aberrations offer, however, an insurmountable difficulty in the case of the large apertures of dry and immersion objectives. The impossibility of removing them entirely with the present resources must be unquestionably considered the greatest difficulty which has hitherto hindered a more perfect action of the objective, with regard to its dioptrical working.

It is not difficult to define the cause from which this defect springs. The impossibility of removing the chromatic difference of spherical aberration, originates in the fact that with the existing kinds of glass (crown-glass and flint-glass), the dispersion increases with the mean refractive index in such a manner that greater dispersion always accompanies the higher index (with very slight deviations) and conversely. The aberrations could be compensated for, or at least nearly so, if there were materials applicable to optical purposes, by which a relatively smaller refractive index could be united with

higher dispersive power, or a higher refractive index with a relatively lower dispersive power. It would then be possible by proper combination of such materials with the usual crown and flint glass, to partly remove the chromatic and spherical aberrations, independently of each other, and thus fulfil the essential conditions on which the removal of the chromatic difference depends.

As the defects of the present objectives, in regard to the chromatic as well as the spherical aberration, originate in the optical properties of the substances on which the optical art of the day is based, the further perfecting of the Microscope in its dioptrical working, is therefore chiefly dependent on the progress of the art of glass-making, and will in particular require, *that new kinds of glass should be produced, which admit of a better correction of the so-called secondary spectrum and which show a different relation of the refractive to the dispersive power than at present has been obtained.*

The hope that such claims can be satisfied, in the more or less distant future, and the way opened for a substantial perfecting of the Microscope, as well as of the other optical instruments, rests on thoroughly established facts. The mode in which, in the kinds of glass now used, the indications of refraction and of chromatic dispersion appear, need not be considered as a natural necessity. For a sufficient number of different transparent substances may be chosen from amongst natural minerals and out of the many artificially formed chemical compounds, which offer essentially different properties as regards their refraction and chromatic dispersion, only that in other respects they are not adapted for optical use. Experiments for the manufacture of glass with less secondary dispersion, which were undertaken several years ago in England, with the co-operation of Prof. Stokes, although they were without practical result, gave noteworthy suggestions on the specific effect of certain bases and acids on the refractive properties. The uniformity which the present kinds of glass show in their optical properties, is to be attributed to the fact that the glass factories have hitherto used only a small number of materials, scarcely any other than aluminium and thallium, besides silica, alkali, lime, and lead, and we might reckon with some confidence on a greater variety of production, if only the glass manufacturers, led by methodical study of the optical properties of various chemical elements in their combinations, would leave that very limited field.

Unfortunately there seems little hope under present circumstances of any important advance in this direction in the immediate future. The present prospect, on the contrary, indicates a state of affairs which endangers many scientific interests. The manufacture of optical glass has been for a long time not far removed from a kind of monopoly; at least the art is in the hands of so few, that competition is out of the question. Since Daguet's glass-works were closed, there are now only two such institutions, which supply the general demand, while the third, founded by Utzschneider and Fraunhofer—the only one in Germany—has remained exclusively in the service of one optical workshop. It must, it is true, be admitted that this art has made very important progress in many respects during the last

thirty years. Not only are the present kinds of crown and flint glass produced in formerly unattained perfection, as regards purity, homogeneity, and freedom from colour, but the whole series of optical glass has been widely extended in one direction by the manufacture of flint glass which considerably surpasses the previous kinds in high refractive power and dispersion. This progress, however, is all in the direction of inherited tradition. The art of glass-making has not apparently started on a fresh path, to enrich practical optics with new materials, and from the lack of earnest competition, the business interests of the proprietors of this manufacture do not offer any special incentive to the pursuit of ends which do not promise them assured advantages. Further, let us reflect how dangerous it is, that a branch of industry so important and so indispensable to many sciences should be in the hands of the few, so to speak, for under these circumstances unfortunate coincidences might threaten its continuance, and occasion a serious calamity. It is therefore a vital question for optical and other sciences interested therein, that in the future more forces should be gathered into the field, and that a keener competition should call forth stronger incentives to progress.

We can scarcely suppose that private initiative will suffice to supply this need without a strong external impulse. Undertakings of this kind are attended with so much difficulty and necessitate so large an outlay for results, which even under favourable circumstances, are so remote, that they can have little attraction even for enterprising people. A great rise in the industry in question can scarcely be expected unless funds are freely granted for its furtherance by Corporations or the State. The field is open here for learned societies which are in a position to offer material help towards the needs of science, to perform a most beneficial and worthy task. For great and various interests are dependent on the increasing efficaciousness and progress of the glass-manufacture. It is not, by any means, the Microscope alone which is here considered, but all arts and sciences dependent on the use of optical resources.

A retrospect of the last portion of this discussion on the ways and means of perfecting the Microscope in the future, shows a more favourable prospect than the earlier considerations. As regards that part of the performance of the Microscope which touches the dioptrical functions of the objectives, an increasing improvement of the instrument in important points may be expected in the future. The difficulties which at present oppose further progress in this respect, and will perhaps long continue to do so, need not in any way be considered as insurmountable. This is the proper field in which optical art may hope to attain further results. The question of the best adapted and most advantageous means of solving the difficulty under consideration is certainly not exhausted either as regards theoretical optics, or those practical arts which co-operate in the work of opticians. Theory may, in time, by a deeper insight into optical problems, point out new methods of removing, more effectually than at present, the chromatic dispersion and spherical aberration in objectives; practical optics may, by the perfecting and refining of the method of

work, render possible a still greater exactness of the mathematical forms which theory seeks to realize, and the art of glass-making may in the future produce new materials instead of those now used, which, in their optical properties, may offer more favourable conditions for the construction of perfect objectives than our present crown and flint-glass. Doubtless united efforts in this direction will result in a continual progress towards perfection of construction, which will bring great benefits to the scientific application of the Microscope, if even it does not increase the absolute capacity of performance of the instrument.

In this direction lie the ends attainable. Efforts grounded on a fundamentally different aspect of the question will be thwarted in the future, as in the past, by the barriers which nature opposes to human illusions.

Webb's 'Optics without Mathematics.' *—The author of this work makes the astonishing statement that "the magnifying power of the Microscope is more frequently given in superficial measure!" though he considers that "it is better for our purpose to reckon it in the linear form."

Benecke, B.—Die Anwendung der Photographie zur Abbildung mikroskopischer Objecte. (The use of photography for representing microscopic objects.)
[Summary of recent papers on the subject by T. C. White, W. H. Walmsley, G. J. Johnson, R. Hitchcock, C. Kiär, &c.]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 109–13.

Botterill, C.—Protoplasm. (Presidential Address to the Liverpool Microscopical Society.)
Micr. News, IV. (1884) pp. 57–68.

Bradbury, W.—The Achromatic Object-glass, XXX.
Engl. Mech., XXXVIII. (1884) pp. 485–7.
" " " " XXXI. Littrow's Formulæ.
Engl. Mech., XXXIX. (1884) pp. 6–7.

"Brass and Glass," A night with.
[Report of Meeting of Western Microscopical Club.]
Engl. Mech., XXXVIII. (1884) pp. 513–4.

Bulloch, W. H.—The Congress Nose-piece.
[Reply to A. McCalla *infra*, agreeing that he suggested the idea, "but it is one thing to suggest an idea and another to put it into practical shape."]
Amer. Mon. Micr. Journ., V. (1884) pp. 58–9.

C., J. D.—New Eye-piece Micrometer. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) p. 52.

D., E. T.—Graphic Microscopy.
II. Eyes of *Epeira conica.*
III. Palate of Limpet.
Sci.-Gossip, 1884, pp. 25–6 (1 pl.); pp. 49–50 (1 pl.).

Dallinger's (Rev. W. H.) Nomination to the Chair of the Society.
Journ. of Science, VI. (1884) p. 118.

Dippel, L.—Mikrographische Mittheilungen. (Microscopical Notes.)
[(1) The formula for *a* on p. 312 of his 'Handbook of General Microscopy.' (2) Remarks on some test-objects of the genus *Grammatophora*, (3) Correction-adjustment with homogeneous-immersion objectives.] [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 23–33 (1 fig.).

Edison Electric Lamp, Homologous sections and molecules.
Micr. Bull., I. (1884) p. 14.

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* See Bibliography, *infra*, p. 303.

ENGELMANN, T. W.—Das Mikrospectral-photometer, ein Apparat zur quantitativen Mikrospectralanalyse. (The microspectral photometer, an apparatus for quantitative microspectral analysis.) [*Post.*] *Bot. Ztg.*, XLII. (1884) pp. 81–8.

FAWCETT, J. E.—Photomicrography.
[An ordinary camera can be used.] *Micr. News*, IV. (1884) pp. 52–3.

FEUSSNER, K.—Ueber die Prismen zur Polarisation des Lichtes. (On prisms for the polarization of light.) [*Post.*]
Zeitschr. f. Instrumentenk., IV. (1884) pp. 41–50 (8 figs).
Nature, XXIX. (1884) pp. 514–7 (8 figs.).

FLESCH, M.—Ueber einen heizbaren, zu schnellem Wechsel der Temperatur geeigneten Objecttisch. (On a hot stage for a rapid change of temperature.) [*Post.*] *Zeitsch. f. Wiss. Mikr.*, I. (1884) pp. 33–8 (1 fig.).

FRANCOTTE, P.—Description d'une Chambre-claire. (Description of a camera lucida.) [*Post.*]
Bull. Soc. Belg. Micr., X. (1884) pp. 77–9.

Gauss on the Object-glass. See Mellor, T. K.

GILTAY, E.—Theorie der Wirkung und des Gebrauches der Camera Lucida. (Theory of the action and use of the camera lucida.) [*Post.*]
Zeitschr. f. Wiss. Mikr. (1884) pp. 1–23 (10 figs.).

GRUNOW, J.—The Abbe Illuminator.
[Instructions for using this illuminator as constructed by him.]
Amer. Mon. Micr. Journ., V. (1884) pp. 22–3.

HERRICK, S. B.—The Wonders of Plant Life under the Microscope. 248 pp. and 85 figs. 16mo, New York, 1883.

HITCHCOCK, R.—The Standard Micrometer of the American Society of Microscopists. [Cf. *supra*, p. 287.] *Amer. Mon. Micr. Journ.*, V. (1884) pp. 34–5.
„ „ "Our Advertisers."
[Brief notices of various American opticians.]
Amer. Mon. Micr. Journ., V. (1884) pp. 56–7.
„ „ Giant Electric Microscope.
[Notes as to the absence of novelty and the unsteadiness of the light.]
Amer. Mon. Micr. Journ., V. (1884) p. 57.

HURD (F.) Portable Microscope.
[Statement only of "a design which he believes will prove satisfactory," packing $5 \times 2\frac{7}{8} \times 1\frac{3}{8}$ in.]
Amer. Mon. Micr. Journ., V. (1884) pp. 37–8.

Journal of the Royal Microscopical Society, Vol. III.
[Review.] *Journ. of Science*, VI. (1884) pp. 106–7.

JULIEN, A.—Immersion Apparatus.
[Title only of paper read at meeting of Society of Naturalists of the Eastern United States.]
Amer. Nat., XVIII. (1884) p. 224.

KAROP, G. C.—Table for Microscopical Purposes.
[Soft white wood, 2 ft. 9 in. long, 1 ft. 6 in. wide, and 2 ft. 3 in. high. No cross-bar to the legs in front. Top 1 in. thick, "so that at any time it may be planed afresh if discoloured or eroded by acids." On each side in front is a sliding board to serve as an arm-rest, 6 in. wide and 15 in. apart. A piece of plate glass 7 in. × 6 in. let in the top over a piece of white paper or card. Half the glass blackened behind, and on the card opposite the other half is marked a 3 × 1 space, with centering lines, microscopical measurements, magnifying powers, &c.]
Journ. Quek. Micr. Club, I. (1884) pp. 312–3 (1 fig.).

KITTON, F.—Drawing with the Microscope.
[Objects to E. Holmes' suggestion of placing the slide cover downwards (*ante*, p. 146) that "the upper and under surfaces of an object are not as a rule alike; a further objection is that all powers exceeding 4/10 could not work through an ordinary slide." Gives the Wollaston camera the preference over all others tried.]
Sci.-Gossip, 1884, pp. 41.

KNAUER, F.—Das Mikroskop und seine Anwendung. (The Microscope and its use. *Naturhistoriker*, V. (1883) pp. 525–7 (*concl.*).

MAINLAND.—Substitute for a Revolving Table.
[Highly lacquered Japanese tray, 20 in. × 12 in.]
Journ. Quek. Micr. Club, I. (1884) p. 323.

MATTHEWS, J.—Revolving Table.
[*Ante*, p. 147.] *Journ. Quek. Micr. Club*, I. (1884) p. 319.

McCALLA, A.—The "Congress" Nose-piece.
[Claims to be the original inventor and not W. H. Bulloch.]
Amer. Mon. Micr. Journ., V. (1884) pp. 38–9.

" " "Give credit to whom credit is due." [Same subject.]
The Microscope, IV. (1884) pp. 30–3.

MELLOR, T. K.— Gauss on the Object-glass.
Engl. Mech., XXXIX. (1884) pp. 56–7.

MICHAEL, A. D.—Polarization of light by a concave mirror of opal glass, or a piece of white china. *Journ. Quek. Micr. Club*, I. (1884) pp. 323–4.

"Microscopists" and the position of the Microscope.
["The statement is often made that the Microscope owes its present approximation to perfection, and microscopical methods their extensive development, to "microscopists," that term being applied to those who consider the Microscope as an end, not a means, and whose whole use of the instrument is confined to the resolution of test-objects and the study of the marking of diatoms. Nothing is more erroneous. The Microscope is far more in debt to the biologist who uses it as a means to solve some problem. To him we owe all our methods for staining, all our facilities for section-cutting, and every discovery in the use of microchemical reagents."]
Science Record, II. (1884) p. 87.

"Monachus."—Microscopic Test-Objects.
[Reply to L. Wright and E. M. Nelson, *infra*.]
Engl. Mech., XXXVIII. (1884) pp. 517 and 560.

MOORE, A. Y.—Slide of *Amphipleura pellucida* mounted in a medium of refractive index 2·3. [*Infra*, p. 319.] *Amer. Mon. Micr. Journ.*, V. (1884) p. 37.

" " The Parabola as an Illuminator for Homogeneous immersion Objectives. [*Post.*] *The Microscope*, IV. (1884) pp. 27–30 (1 fig.).

NELSON, E. M.—Microscopic Test-Objects.
[Reply to (1) "Monachus," *ante*, p. 141—*supra*, p. 288; (2) T. T., *ante*, p. 148; and (3) L. Wright *infra*.]
Engl. Mech., XXXVIII. (1884) pp. 516–7 (4 figs.).

" " Möller's Probe-Platte.
[Remarks on plates mounted in phosphorus, monobromide, balsam, and dry.]
Engl. Mech., XXXVIII. (1884) p. 540.

" " Microscopic Test-Objects.
[Further in reply to "Monachus."]
Engl. Mech., XXXVIII. (1884) p. 560 (4 figs.).

" " On the Selection and Use of Microscopical Apparatus.
[*Résumé* of "demonstration" at the Quekett Microscopical Club.]
Engl. Mech., XXXIX. (1884) p. 48.

OLLARD, J. A.—Simple form of Revolving Table made out of two mincing boards.
[Exhibition only.]
Journ. Quek. Micr. Club, I. (1884) p. 323.

PELLETAN, J.—Le Microscope "Continental."
[Warning against imitations!] *Journ. de Microgr.*, VIII. (1884) p. 121.

PENDLEBURY, C.—Lenses and Systems of Lenses, treated after the manner of Gauss. 95 pp. and 24 figs. 8vo, Cambridge, 1884.

PENNY, W. G.—Theory of the Eye-piece. IV. Distortion of Curvature.
Engl. Mech., XXXVIII. (1884) p. 497 (1 fig.).

" " " " V. Summary of Formulæ—On Further Approximations for the Distortion, and General Remarks—Proposed Eye-piece.
["The first lens plano-concave, the second plano-convex, with focal length *numerically* equal to that of the first, and placed at a distance from it equal to twice the focal length of the eye-lens, the curved side of each of

them being turned towards the eye." Proposed to be called "an undistorted eye-piece, not because the distortion is absolutely 0, but because it would seem to be much smaller than that of those in use."

Engl. Mech., XXXVIII. (1884) p. 541.

Physicians, Microscopes for.

[Recommendation of Beck's 'Economic.']

Cinc. Med. News, XVI. (1883) pp. 833–4.

"Prismatique."—Object-glass working, XI.

Engl. Mech., XXXIX. (1884) p. 24.

Prize, Questions for Examination in Competition for Bulloch and Grunow's.

4to, 1 p. (11th February, 1884).

[Seventeen questions on optics, lenses, objectives, camera lucida, magnifying powers, diffraction, and mounting. Open to any student in the senior class for five years of the Chicago Medical College.]

Queen's (J. W. & Co.) New Spot-lens Mounting. [*Post.*]

Micr. Bull., I. (1884) p. 11 (3 figs.).

Rogers, W. A.—Corrections to paper on the "Conditions of success in the construction and the comparison of standards of length."

Proc. Amer. Soc. Micr., 6th Ann. Meeting (1883) pp. 240–1.

Rohrbach, C.—A new fluid of great specific gravity, of large index of refraction, and of great dispersion.

[100 parts of iodide of barium are mixed with 130 parts of scarlet biniodide of mercury. About 200 cc. of distilled water are added to the powders, and they are then stirred up with a glass rod while heated in a test-tube plunged into an oil bath previously warmed to 150° or 200° C. A fluid double iodide of mercury and barium is formed, which is then poured into a shallow porcelain dish and evaporated down until it acquires a density so great that a crystal of epidote no longer sinks in it. When cold even topaz will float in it. It is then filtered through glass-wool. The fluid so prepared has a density of 3·575–3·588, boils at about 145°, and is of a yellow colour. Its refractive index is 1·7755 for the C line, and 1·8265 for the E line of the spectrum. For the two D lines of sodium the refractive indices are 1·7931 and 1·7933 respectively. So great is the dispersion that, using a single hollow prism with a refracting power of 60°, the dispersion between the two D lines is almost exactly 2′ of angle.]

Amer. Journ. Sci., XXVI. (1883) p. 406.

from *Ann. Physik u. Chem.*, No. 9, pp. 169–74.

Seip, A.—Address to the Lehigh Valley Microscopical Society.

(On the value of the Microscope.]

Amer. Mon. Micr. Journ., V. (1884) pp. 39–40.

Slack, H. J.—Pleasant Hours with the Microscope.

[Horizontal position of Microscope. *Post.*]

Knowledge, V., (1884) pp. 109–10.

Stodder, C., Death of.

Micr. Bull., I. (1884) p. 9.

Amer. Mon. Micr. Journ., V. (1884) pp. 55–6.

Stokes, A. W.—Simple apparatus for aërating living fish whilst under microscopical observation. [*Supra*, p. 286.]

Journ. Quek. Micr. Club, I. (1884) pp. 322–3 (2 figs.).

Stowell, C. H.—Gleanings from the Journ. R.M.S. for December.

[Claims for Mr. E. H. Griffith the invention of a Revolver Microscope similar to Mirand's, III. (1883) p. 897, and of a nose-piece adapter similar to Matthews's, ibid., p. 903.]

The Microscope, IV. (1884) pp. 35–7.

Stowell, C. H. and L. R.—Proceedings of the American Society.

[Urging earlier publication.]

The Microscope, IV. (1884) p. 39.

Washington Microscopical Society, formation of.

Amer. Mon. Micr. Journ., V. (1884) p. 58.

Wassell, H. A.—Plate Glass for Optical work.

Engl. Mech., XXXIX. (1884) p. 57.

Webb, T. W.—Optics without Mathematics. 8vo, London, n.d., 124 pp. and 58 figs. [Microscope, pp. 61–6, 107–8. *Supra*, p. 300.]

Wicksteed, R. J.—The Microscope; its history, construction, utility and improvement.
[Title only of communication to the Ottawa Microscopical Society.]
Science, III. (1884) p. v.
Wright, L.—Microscopic Test-Objects—Aperture and Resolution.
[Criticism of "Monachus" and E. M. Nelson.]
Engl. Mech., XXXVIII. (1884) pp. 470-1 (2 figs.).
„ „ Microscopic Tests.
[Reply to "Monachus" and E. M. Nelson.]
Engl. Mech., XXXIX. (1884) p. 34.
Zentmayer's Nose-piece. [*Supra*, p. 285.]
Amer. Mon. Micr. Journ., V. (1884) pp. 42-3 (1 fig.).

β. Collecting, Mounting and Examining Objects, &c.

Preparing and Mounting Sections of Teeth and Bone.* — J. E. Ady explains as follows what he terms the "laccic" method of occlusion.

1st. Saw a piece off the tooth or bone, rub it flat on an engineer's file, polish the flat surface on a fine hone, Water-of-Ayr stone being preferable.

2nd. Fasten the section on to a piece of plate-glass, 1 in. square, with a cement made by melting six parts of "button" lac with one part Venice turpentine.

3rd. File the section down moderately thin, and then reduce further on the Water-of-Ayr stone, examining from time to time with the Microscope.

4th. Soak the section off with strong methylated spirit, wash thoroughly in clean spirit, and dry between tissue paper.

5th. Make a thin solution of white shellac in methylated spirit, filter, and keep in a stoppered bottle.

The section is to be dipped in this solution, drained, and laid on a cold plate under a bell-glass. In about half an hour it will be dry.

6th. Mount in cold balsam and benzol in preference, in order to avoid heating the section, as that would give it a tendency to curl; but as the melting point of the shellac is higher than that of the balsam, the latter may be used if thought desirable, as it may even be caused to boil without affecting the shellac.

Expanding the Blow-fly's Tongue.†—C. M. Vorce writes:—

If the head of a living fly be cut off, the tongue will usually retract; pressure on the head will expand the tongue, but unless it be secured by some means before the pressure on the head is released, it is apt to wholly or partly retract again. If only the tip is wanted, it is easily secured by placing the severed head on a clean slip and pressing it with a needle till the tongue is fully expanded, when a drop of turpentine is applied, a cover laid on the tongue, and a clip applied before the pressure is removed from the tongue. To secure the whole tongue, split one end of a small stick for an inch or so,

* Journ. Quek. Micr. Club, i. (1884) p. 332.
† Amer. Mon. Micr. Journ., v. (1884) p. 12.

and holding the split open by a knife-blade, place the severed head in the cleft with the top downward, and, withdrawing the knife-blade, allow the stick to close upon the head, when it will fully distend the tongue. Now dip the head and tongue in turpentine and leave it immersed for a few days, when it will be found well cleaned, still perfectly distended, and can be released from the stick or cut from the head without danger of its collapsing. Mounted in a cell in balsam, it is a truly beautiful object.

Perchloride of Iron as a reagent for Preserving Delicate Marine Animals.—We have already referred (vol. iii. (1883) p. 729) to Dr. H. Fol's objection that the reagents in common use for instantaneous killing, such as picro-sulphuric acid, osmic acid alone or in combination with chromic and acetic acid, and corrosive sublimate, fail to give successful preparations, and noted his success with perchloride of iron. He now adds some further remarks on the subject.*

An alcoholic solution diluted to about 2 per cent. will answer ordinary purposes, but a stronger solution should be used in case it is desired to kill a large number of animals in a large vessel. It will not do, however, to turn a saturated solution directly into sea water, as precipitates would be copiously formed which would utterly ruin the preparations. After the animals have sunk to the bottom of the vessel, most of the water may be turned off, and 70 per cent. alcohol added. In order to remove from the tissues the ferric salts adhering to them, it is necessary to replace this alcohol with alcohol containing a few drops of hydrochloric acid.

The "fixation" of the animals in an expanded life-like form is perfect, and the action of the dilute acid is of so short a duration that it causes no injury to the tissues. Not only infusoria and Rhizopods, but also large pelagic animals, such as Medusæ, Ctenophora, Salpæ, Heteropods, *Doliolum*, &c., may be thus killed and transferred to alcohol, with their form, histological structure, and cilia perfectly preserved. After complete removal of the yellowish colour due to the presence of ferric salts by washing in acidulated alcohol, the tissues of transparent animals remain almost free from cloudiness.

The best method of staining such objects is to add a few drops of gallic acid (1 per cent. solution) to the alcohol. After twenty-four hours the alcohol is turned off, and pure alcohol added. Thus treated, the protoplasm will take a light-brown colour, the nuclei a much deeper brown. Carmine stains too deeply and diffusely, and cannot be successfully removed.

Action of Tannin on Infusoria.†—H. Gilliatt, struck with the remarkable appearance shown in Mr. Waddington's illustrations (vol. iii. (1883) p. 185), made a number of experiments with glycerole of tannin, as described by him. On exposing *Paramecium aurelia* to the action of the tannin, he found the effect quite as startling as described; the animalcules, as the acid began to affect them, darted

* Zeitschr. f. Wiss. Zool., xxxviii. (1883) pp. 491–2. See Amer. Natural., xviii. (1884) pp. 218–9.

† Proc. Linn. Soc. N. S. Wales, viii. (1883) pp. 383–6.

about with great rapidity, endeavouring to conceal themselves beneath any vegetable matter on the slip, their motions gradually growing slower; then they revolved slowly two or three times. A sudden contraction of the body followed, and in a few seconds the appearance shown in Mr. Waddington's illustrations.

The regularity of the fine transparent acicular fringe that now surrounded the animalcule, or whether it was completely thrown off, appeared to depend, as described by Mr. Waddington, on the strength of the solution. In those cases where the appendages were separated from the body, it was not unusual to find a few spiral shaped, although after careful comparison the majority were rod-like.

After examination of numerous specimens treated with the acid, it seemed difficult to reconcile cilia of such length—in some cases exceeding the width of the body—with the action apparent in the ciliary movements of the living animalcule. But while observing an example under oblique illumination, Mr. Gilliatt was struck with the appearance of fine lines across it, and was thus reminded of the rod-like bodies or trichocysts so fully developed beneath the cuticle of *P. aurelia*; and after referring to the views of W. S. Kent, Stein, Allman, and Ellis, on the effects produced "on the trichocysts by the use of acetic acid, or a small stalk of *Geranium zonale* (Horseshoe Geranium), he considers that it may be "fairly concluded that the effects observed by Mr. Waddington in his experiments must be attributed to the action of tannic acid on the trichocysts of *Paramecium aurelia*, and not, as he considers, to its action on the cilia."

Professor D. S. Kellicott * has also satisfied himself that the bodies are trichocysts. Glycerole of tannin acts even more energetically than acetic acid, and is, he considers, sure to become a valuable reagent in the study of infusoria. By applying in proper dilution, the infusorian is not at once killed, and the cilia may be seen yet in motion, with the trichocysts extending far beyond them.

Another writer † refers to "the hirsute covering of *Paramecium* and other infusoria shown when a solution of quinine is added to the water in which they live, although the cilia are quite invisible when the animals are swimming about. Quinine may prove to be a valuable reagent for killing the infusoria and rendering their cilia visible."

Preparing Fresh-water Rhizopoda.‡—In fixing the living animal, K. J. Taránek uses small (8–10 cm. long) pieces of soft red blotting-paper of triangular shape, and, in order to draw off the water under the cover-glass, lays a piece of this paper upon the slide in such wise that the point of it reaches the edge of the cover-glass, and comes in contact with the water beneath. The blotting-paper immediately causes a current, which, however, is very weak, as only the corner of the paper is active. If the current is strong, so that the animal begins to move with the water, the paper must be removed; but if

* Bull. Buffalo Nat. Field Club, i. (1883) p. 110.

† Engl. Mech., xxxviii. (1883).

‡ Abh. math.-naturwiss. Cl. K. Böhm. Gesell. Wiss., xi. (1882) Art. No. 8, iv. and 56 pp. (5 pls.). See also *supra*, p. 247.

the current is weak, which can be well regulated by the shape of the blotting-paper, the animal keeps its position unaltered; and as by the absorption of the water the cover-glass exercises greater pressure upon the slide, there is less danger of losing the animal from the field. Then add to the opposite edge of the cover-glass by means of a glass rod a drop of 1/2 per cent. osmic acid, which immediately penetrates to and kills the animal without altering its shape. In the same way are added to the preparation the different alcohols, 15, 45, 90, up to 100 per cent., whereby the animal obtains the required hardness. Then follows the staining with picro-carmine or methyl green (which have proved to be the best for Protozoa). In the same manner, after 5–7 minutes the stream of colour is replaced by weak alcohol (50–30 per cent.), when the whole preparation is complete.

This method is very simple and very quick, the whole manipulation lasting 7–12 minutes, so that the preparation is finished in a quarter of an hour. Care must be taken to have the object always in sight, and not to keep up too strong a current.

The stained object can be well examined in the weak alcohol, and, if the blotting paper is removed, can be kept whole hours in it. The manipulation is well adapted for drawing with the camera; but to make a permanent preparation, it must be treated with a clearing fluid, glycerine, oil of cloves, &c., and finally with Canada balsam, which, dissolved in benzine, is quite thin and liquid. The application of the clearing fluids is the chief difficulty in the preparation, because the absolute alcohol flows through quicker than the liquids which follow, which gives rise to small air-bubbles between the two liquids. "It is, of course, obvious that the preparations often do not come up to the requirements of our day, especially as regards beauty. For, beside the objects prepared, there are a number of algæ, infusoria, mud, &c., in the preparations, by which they are made more or less dirty."

Arranging Diatoms.*—E. H. Griffith thinks that those who wish to arrange diatoms will find the following of great assistance:—

With a pipette place the diatoms on a film of mica, as the mica is very thin, and when mounted can instantly be heated to an intense heat over an alcohol lamp. With a pair of scissors cut small strips from the best part of the diatom field of mica, moisten the mica on the other side and lay it on the prepared slide near the centre of the slip to be used, or if the diatoms are to be mounted on a cover-glass, place the strip near it, and with a pen make a delicate dot of ink on the under side of the slide to mark the place for placing the diatom. From the mica the diatoms can be very easily picked, while from the glass sometimes it is almost impossible to pick them. Several strips of mica may be placed side by side with different kinds of diatoms if desired.

Instead of putting the diatoms on a cover-glass and the cover-glass on a metal strip, in order that organic matter may be burned away over a spirit-lamp, put them with a pipette on the end of a thin

* The Microscope, iii. (1883) pp. 205–6.

strip of mica and then burn them, avoiding the great annoyance of having a cover-glass, diatoms and all, slide or fly off. The mica being thin and a poor conductor of heat, the end may be brought to a red heat almost instantly. Now place a glass slip on the turntable, and make a dot or a small circle in the centre as a guide for placing the diatoms. Turn the marked side down, and with gelatine or other material size the spot over the dot or circle; then with scissors cut from the film of mica a small piece from the best part of the diatom field, moisten the other side and lay it on the glass slide near the marked centre. A crescent-shaped piece may be cut, if desired, that may extend partially around the marked spot. The mica being thin, the focus of low powers need not be changed while transferring the diatoms from the mica to the slide, and one trial will demonstrate that it is much easier to pick from mica than from glass; also that there is less danger of having the mica fall from the slide while at work. Those who desire to make the arrangement on a cover-glass can do so by placing a cover over the marked centre, sizing it, and then transferring to the cover instead of to the slide.

Mounting Diatoms in Series.*—P. Francotte uses Threlfall's method † for arranging diatoms in series. The solution of caoutchouc being poured upon the slide, the benzine evaporates, and the diatoms are arranged; it is then slightly heated, and the diatoms sink into the layer of caoutchouc, where they remain definitively fixed, and can be covered with a thin glass coated with balsam.

Synoptical Preparation of Pulverulent Objects (Diatoms from Guano, Fossil Earths, &c.).‡—P. Barré describes as follows his process of making these preparations, which enable specimens of different pulverulent objects to be compared.

After covering one of the surfaces of a cover-glass with balsam in the manner described for arranging diatoms, § and heating it until the hardened balsam no longer contains any trace of chloroform, the cover-glass is placed in the instrument fig. 42, A. *a* is a plate of brass, ·75 mm. in thickness. *b* is a strip of steel, fixed at *e* to the plate *a*, and to which is riveted another brass plate *c*. To the latter are soldered nine copper tubes, made as thin as possible (1/5 or 1/6 mm.) These tubes pass through the plate *c*, and project about 1 mm. from its under surface. The tubes are of exactly the same length, so that the cover-glass, covered with hardened balsam, meets all the nine tubes at once.

The plate *a* has a rectangular aperture *d* (indicated by dotted lines), and exactly opposite to the orifices of the nine tubes in the plate *c*.

The cover-glass is placed between *a* and the tubes, the surface covered with balsam being *in contact with the nine tubes.*

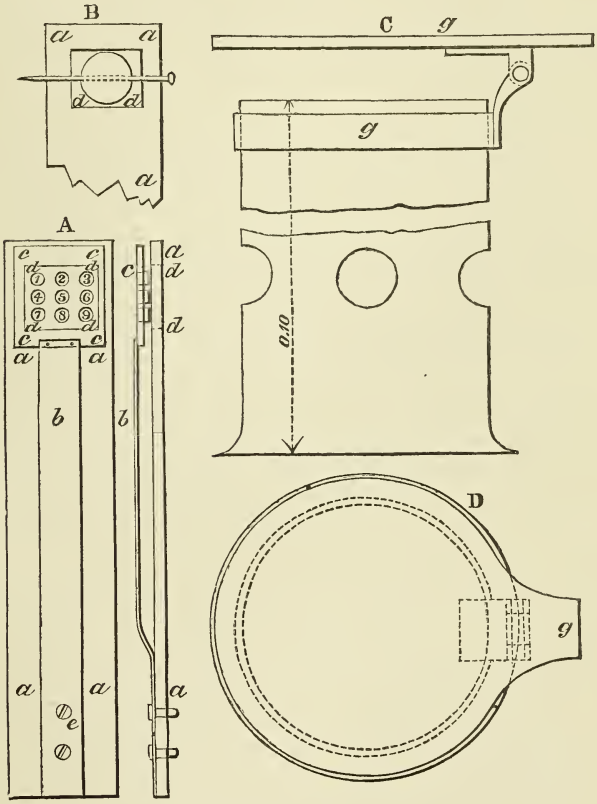
This operation complete, a copper or steel wire, or even simply an

* Bull. Soc. Belg. Micr., x. (1884) p. 65.
† See this Journal, iii. (1883) p. 600.
‡ Bull. Soc. Belg. Micr., x. (1883) pp.16-18 (1 pl.).
§ See this Journal, iii.(1883) p. 453 (1 pl.).

ordinary pin, is introduced transversely between the lower surface of the cover-glass and the square opening (fig. 42, B). This causes the cover-glass to rest with equal pressure on all the nine tubes at once.

Thus prepared, the glass, fixed in the instrument, is exposed to

FIG. 42.



the heat of a spirit-lamp. The balsam is again liquefied, the extremity of the tubes in contact with it become attached, and it is then allowed to cool.

The varieties of powder containing diatoms are then introduced into the tubes by means of a quill, and spread by a fine and very soft brush on the inner surface of each tube. The operation should be performed very carefully, so as not to allow particles of powder to fall into the adjoining tubes. The glass is again heated, and the diatoms adhere to the softened balsam in all the tubes at once—after which it is again allowed to cool. Then, by raising the spring *b*, the cover-glass is carefully loosened, and can then be

detached with a slight pressure. The surface of the glass having the diatoms is then blown and brushed, and the preparation is completed by the process described for arranging diatoms.

The essential point of the operation is in sufficiently hardening the balsam on the cover-glass. The heating must be carried as far as is possible without altering the colour. To succeed, it is advisable to cover the spirit-lamp with a metal chimney to avoid the flickering of the flame. This chimney has a cap (*g*, fig. 42, C and D), movable vertically, so that it can be raised or lowered. It is also convenient to joint it in such a manner that the hot plate can be placed perpendicularly, if desired.

It is, of course, permissible to increase at pleasure the number of tubes. The author makes preparations containing sixteen and even twenty-five varieties of earths; and expects to greatly exceed this number. Indeed, the only limit is the size of the cover-glass.

Logwood Staining.*—A. C. Cole says that "up to the present time, no stain has been found to equal logwood for certainty and permanency of results, and beauty of colour, which, besides being beautiful, is also not too tiring for the eye. We go further, and say that the more a histologist departs from a use of logwood and adopts other stains, the more unsatisfactory will be his total results. If ten men were each to make for himself a histological cabinet, the work of each being equal in other ways, the one who would produce the best cabinet would be found to have used logwood and picro-carminate of ammonia for the great majority of his slides, using other stains which have been found to suit special cases, such as aniline-blue-black for nerve-centres, methyl-aniline for amyloid or waxy degenerations in pathological histology in a few cases only. He would further have been found to have used benzole balsam as his mounting medium in the case of his logwood stains, and glycerine jelly for mounting his picro-carmine slides. Such a cabinet would last a thousand years, and be as perfect the last day as on the first. On the other hand, the worst cabinet, especially after, say about ten years, would be found to have been composed of a few logwood slides, mounted in dammar varnish, and the great majority stained with all sorts of aniline and other fancy dyes, and mounted in glycerine. The dammar preparations would be found to be little better than fine grey dust, and the fancy dyes to be conspicuous by their absence. So far as can be judged by our present data, a preparation stained with logwood and mounted in balsam is unchangeable; so is a preparation stained with picro-carminate of ammonia and mounted in good glycerine jelly.

With these preliminary remarks, we now proceed to give formulæ for those stains, and those only, which have been found really good in every way. As staining is yet in its infancy, we daily read of a fresh stain, and a new method of staining. We need scarcely draw the attention of our readers to the present mania for 'rushing into print,' and the numerous worthless, not to say senseless, communications to

* 'The Methods of Microscopical Research,' Part VII. (1884) p. xli.

our various journals on the subject of dyes for histological work. We advise the histologist to ask himself this question:—Is it my object to make for myself a complete educative histological cabinet, or to investigate the subject of stains, and therefore to experiment with the various stains? The operator should settle this question once for all, and *before* he commences his work."

Staining with Hæmatoxylon.*—Dr. C. L. Mitchell describes a new and simple method of preparing a logwood staining fluid, by which a permanent, reliable, and satisfactory preparation can, he claims, be easily made, and which places within the reach of every microscopist, a staining fluid "stable in composition, comparatively easy of preparation, and unequalled in the delicacy and clearness of differentiation of its colouring."

In staining fluids prepared from extract of logwood, the partially oxydized tannin in the liquid gradually absorbs more oxygen from the air and changes to other complex organic compounds; the colouring matter is also affected by the decomposition, and gradually becomes converted into other substances, and the liquid finally becomes of a dirty muddy colour, and is half filled with a lumpy sediment. This change will be found to take place in all ordinary logwood staining fluids, whether prepared from the extract or from the drug itself, although from the nature of the case those made from the extract would be most quickly affected. The idea therefore occurred to the author, that if the tannin could be removed, and the lake of logwood isolated in a state of comparative purity, a staining fluid could be prepared which might possibly be both permanent and satisfactory, and the following formula is the result of his investigation:—

Mitchell's Hematin Staining Fluid.

℞	Finely ground logwood	ʒ ij.
	Sulph. alumin. and potash (potash alum) ..	ix.
	Glycerine	f. ʒ iv.
	Distilled water	a sufficient quantity.

Moisten the ground logwood with sufficient cold water to slightly dampen it, place it in a funnel or percolator, packing it loosely and then percolate sufficient water through the drug until the liquid coming from the percolator is but slightly coloured. Allow the drug to drain thoroughly, and then remove it from the percolator and spread out on a paper or board to dry. Dissolve the alum in eight fluid ounces of water, moisten the dry drug with a sufficient quantity of the fluid and again pack in the percolator, this time rather tightly, and pour on the remainder of the alum solution. As soon as the liquid percolates through and commences to drop from the end of the percolator, close the aperture with a tightly fitting cork and allow the drug to macerate for forty-eight hours. Remove the cork at the expiration of that time, allow the liquid to drain off, and then pour sufficient water upon the drug to percolate through twelve fluid ounces

* Proc. Acad. Nat. Sci. Philad., 1883, pp. 297–300.

altogether. Mix this with the glycerine, filter and place in a close-stopped bottle.

In this process nearly all the tannin is removed by percolating the drug with cold water, a menstruum in which the colouring principle is not very soluble, and the subsequent maceration and percolation with the alum solution removes the logwood lake in a state of comparative purity. The glycerine is added simply for its preservative qualities, and this may still be increased by the addition of a few drachms of alcohol to the solution.

The hematin staining fluid thus prepared is a clear heavy fluid of a deep purplish red colour. It will keep its colour for a length of time and deposits no sediment. A sample exhibited by the author had been made for nearly a year, frequently exposed to a strong light and open to the air, but was unchanged. Permanent and beautiful in its colour, which is of a delicate violet hue, clear and sharp in its definition of the different tissues under examination, it will bear use with the very highest powers and it is hoped enables observers to distinguish minute differences of tissue which have hitherto escaped notice.

As to the method of using the fluid, it yields good results when used undiluted, as a quick stain; but the best results are obtained by placing the tissues in a weak solution (ten drops to two fluid drachms) with warm distilled water for about twelve hours. This produces results of surpassing delicacy and beauty.

Dry Injection-masses *—The variously coloured gelatine emulsions in common use as injections keep for only a short time, and have, therefore, to be prepared as occasion arises for their use. The dry emulsions recommended by Dr. H. Fol are very easily prepared and convenient in use. As they will keep for any length of time they can be prepared in quantities, and will thus be ready for use at any moment.

Carmine Emulsion.—One kilogramme gelatine (softer kind used in photography), soaked in water for a few hours until thoroughly softened; after turning off the water, heat the gelatine over a water bath until liquefied, and then add to it, little by little, one litre of a strong solution of carmine in ammonia. The mixture, stiffened by cooling, is cut up, and the pieces packed in a fine piece of netting, Vigorous pressure with the hand under water forces the emulsion through the net in the form of fine strings or vermicelli. These strings are placed in a sieve and washed until they are free from acid or excess of ammonia; then collected and re-dissolved by heating. The liquid is poured upon large sheets of parchment which have been saturated with paraffin, and these sheets are then hung up to dry in an airy place. The dried layers of the emulsion, which are easily separated from the parchment, may be cut into strips and placed where they are protected from dust and dampness.

The carmine solution used in this emulsion is prepared as

* Zeitschr. f. Wiss. Zool., xxxviii. (1883) pp. 492–5. Cf. Amer. Natural., xviii. (1884) pp. 219–20.

follows:—A strong solution of ammonia is diluted with 3–4 volumes of water, and carmine added in excess. After filtering, the solution is mixed with the gelatine, and then enough acetic acid added to change the dark purple-red into blood-red. It is not necessary to completely neutralize the ammonia. The dry emulsion requires only to be placed in water for a few minutes and melted over the water-bath to be ready for use.

Blue Emulsion.—A slightly modified form of Thiersch's formula:—

1. To 300 ccm. of melted gelatine add 120 ccm. of a cold saturated solution of green vitriol (ferro-sulphate).

2. To 600 ccm. of melted gelatine add first 240 ccm. of a saturated solution of oxalic acid, then 240 ccm. of a cold saturated solution of red prussiate of potash (potassic ferricyanide).

3. No. 1 poured slowly into No. 2 while stirring vigorously; the mixture heated for 15 minutes.

4. After cooling, the emulsion is pressed through netting, the vermicelli washed and spread on waxed paper for drying. In this case the vermicelli must be dried directly, as they do not melt well without the addition of oxalic acid.

The dry vermicelli are prepared for use by first soaking in cold water, and then heating with the addition of oxalic acid enough to reduce them to a liquid.

Black Emulsion.—1. Soak 500 g. gelatine in two litres of water in which 140 g. of common salt have previously been dissolved, and melt the mass on the water-bath.

2. Dissolve 300 g. nitrate of silver in one litre distilled water.

3. No. 2 poured very slowly into No. 1 while stirring. An extremely fine-grained emulsion may be obtained by using 3–4 times as much water in Nos. 1 and 2.

4. No. 3 pressed into vermicelli as above, and then mixed with No. 5. by clear daylight.

5. Mix 1½ litre cold-saturated potassic oxalate with 500 ccm. of a cold-saturated solution of ferro-sulphate.

6. No. 4 mixed with No. 5 gives a thoroughly black emulsion, which should be washed several hours, again melted, and finally poured in a thin layer on waxed paper.

A grey-black emulsion may be obtained by using 240 g. potassic bromide in the place of common salt in No. 1, the remaining operations being the same.

Schering's Celloidin for Imbedding.*—Mr. G. C. Karop finds that a form of pyroxylin, known as Schering's patent celloidin, used by photographers for making a uniform quality of collodion, is an excellent material for imbedding. It is in the form of flat cakes of extremely tough, horny consistence, and "said to be non-explosive," burning like paper, and simply carbonizing if heated in a test-tube.

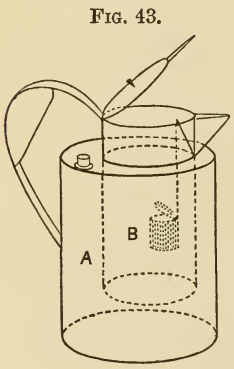
"A sufficient quantity is cut up and dissolved in equal parts of absolute alcohol and absolute methylated ether 0·717, until the solution is thin enough to pour. This takes some time, and the

* Journ. Quek. Micr. Club, i. (1884) pp. 327–8.

mixture should be well stirred daily, and kept in a warm room. The mass to be cut is hardened in any desired manner, and fastened by needles in the requisite position for cutting in a paper case the same size as the well of the microtome. The celloidin solution is poured in as free from bubbles as possible, and allowed to set slightly. The paper case and its contents is then placed in a quantity of methylated alcohol of 80°, not less, as otherwise the colloidin becomes tough, and not more, or it will dissolve it. It is left in this until of the proper consistence to cut, about as firm as boiled egg albumen. If possible, the sections should be cut under the surface of methylated spirit. Katsch's machine is made for, and is simply perfect for this purpose, but sections can be cut very well if the whole surface of the microtome in use is kept flooded with spirit. The sections can be stained by any of the ordinary fluids; the celloidin takes a slight stain, but as it is perfectly amorphous it does not in any way interfere, and can, of course, if the species of section admit it, be dissolved away by the mixture of ether and alcohol. On the whole, it seemed about the best thing for the purpose that he had met with, and members might judge of its fitness by the fact that it enabled one to cut sections of the whole eye, every structure remaining *in situ*, a feat he supposed impossible with any other material."

Gage's Imbedding-mass Cup.*—S. H. Gage describes the imbedding-mass cup, shown in fig. 43, about 1/5 natural size. A is a water-bath, into the top of which is firmly soldered the cup B for the imbedding-mass, having a fine wire gauze basket, suspended by a stiff wire, for holding the tissue. The cup is placed on one side of the water-bath to facilitate the pouring out of the imbedding-mass. The apparatus may be heated on a stove or by a gas or alcohol flame.

Fig. 43.



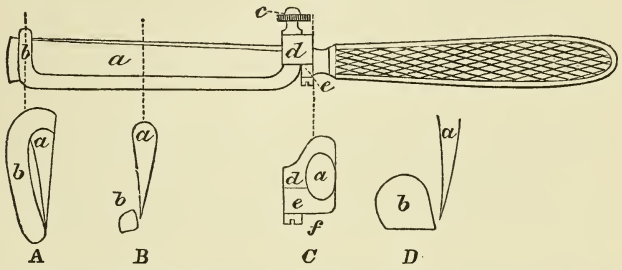
Gage and Smith's Section-flattener.†—S. H. Gage and T. Smith have devised a section-flattener somewhat similar to that of Andres, Giesbrecht, and Mayer,‡ but, as they consider, simpler and applicable to every form of section knife.

The section-flattener (fig. 44) consists of a rod *b* of spring brass about 5 mm. in diameter, flattened on two sides *b* and *d*, extending parallel with the edge of the knife, and projecting about 2 mm. beyond it. Opposite the cutting edge the space between the rod and knife is about 1 mm., while nearer the back of the knife the distance is greater (D, *a*, *b*). At each end the rod is bent at right angles. Next the handle it passes through a hollow cylinder *d*, into which it is secured by a milled nut *c*. At the free end of the knife the rod is

* Medical Student (N.Y.) i. (1883) pp. 14–16 (2 figs.).
† 'The Microscope,' iv. (1884) pp. 25–7 (1 fig.).
‡ See this Journal, iii. (1883) p. 916.

hooked over the back of the blade A, the spring of the wire securing it firmly. At the two angles of the rod it rests on the blade, so that in cutting sections any amount of pressure may be applied at these points. The rod is attached to the knife by means of a clamp, which

Fig. 44.



The section-flattener attached to a section knife:—*a*. Blade of the section knife; *b*. section-flattener; *c*. milled nut; *d*. the part of the clamp bearing the hollow cylinder; *e*. part of the clamp; *f*. screw holding the two parts of the clamp together.

A. Section showing the manner of hooking the section-flattener over the back of the blade.

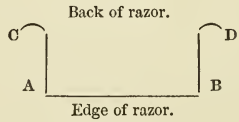
B and D. Sections showing the form of the section-flattener and its relation to the cutting edge, except at the ends.

C. Section of the tang of the knife, showing the manner of attaching the clamp.

consists of two pieces clasping the tang, and held together by a screw *c*. To clean the knife and rod, or to remove sections, the rod may be raised as it swings freely in the hollow cylinder attached to *d*. The rod may be entirely removed, as is necessary in sharpening the knife, by removing the milled nut *c*; the entire apparatus may be removed from the knife by loosening the screw *f*.

Francotte's Section-flattener.*—P. Francotte also describes a simple apparatus made by bending an iron wire or knitting needle 1 mm. in diameter into two right angles, the points A and B being 7 to 8 cm. apart.

Fig. 45.



The arms A C and B D are bent into hooks, so as to attach the apparatus to the back of the razor. A C and B D should be of such a length that A B is 0·1 or 0·2 mm. behind the edge.

In cutting, the sections are partially rolled round A B. It is then easy to transfer them to a glass slide and to make them flat, which is generally done without difficulty.

* Bull. Soc. Belg. Micr., x. (1884) pp. 58–60 (1 fig.).

Employment of the Freezing Method in Histology.*—Dr. Axel Key and Professor Gustav Retzius reproduce in German an account of the freezing method which had been previously published by them in Swedish. The method is in many cases of great advantage, but it often causes certain abnormal appearances which, without due care, might be taken for actual features in the tissue examined; for example, in fine sections of tendon cut when frozen and fixed afterwards by means of perosmic acid, a series of longitudinal canals were seen; and in sections of brain a regular system of lacunæ communicating with each other appeared to exist which it was quite impossible to demonstrate by means of an injection. All these appearances, in fact, are produced by the freezing method itself; the water contained in the tissues is driven out at the moment of freezing, and collects into lacunæ where there is the least resistance. It is evident, therefore, that the greatest care must be exercised by histologists who make use of this method.

Improved Method of Using the Freezing Microtome.†—Prof. W. J. Sollas considers that the process of obtaining thin slices of soft structures by means of imbedding in paraffin has now been brought to a state of almost ideal perfection; on the other hand the method of "freezing" still remains almost in its infancy. At present it is only with great trouble that a continuous series of slices can be obtained with it, and if these are cut from a loose disconnected tissue, they break up immediately on being introduced into water to free them from the gum in which they are always imbedded. Moreover the waste of time involved in transferring from water to a glass slide is simply appalling.

Yet the freezing process has special advantages of its own.

In the case of many tissues it affords a clearer insight into structure; perfect staining is not so indispensable (provided, as is usually the case, glycerine be used as a medium for mounting): and when hard parts occur in a preparation along with soft, both may be evenly cut through with equal ease. It is not likely, therefore, to fall wholly out of use, particularly for certain refined histological work, and improvements may be confidently expected.

The following may perhaps be regarded as a first step to others. Instead of freezing in gum, as is usual, one uses gelatine jelly. This is prepared and clarified in the ordinary manner. It should set into a stiff mass when cold, how stiff will best be learned by experience.

The tissue to be cut is transferred from water to the melted jelly, and should remain in it until well permeated.

It is then placed on the piston of a Rutherford's microtome; the "well" should not be filled, for adherence it is sufficient to roughen the surface of the piston with a file. No more jelly should be used than is sufficient to surround the specimen; if too much has been added, it may be removed when frozen by careful paring.

When well frozen, slices may be cut in the ordinary way; while

* Retzius's Biol. Untersuchungen, ii. (1882) pp. 150–3.

† Quart. Journ. Micr. Sci., xxiv. (1884) pp. 163–4.

frozen they should be quickly transferred to the glass slide on which they are to be mounted. On touching the glass, the slice of jelly almost immediately thaws and adheres as a consistent fibre to the surface. When enough slices have been placed on the slide, they should each be covered with a drop of glycerine (the sooner this is added the better); a cover-glass is then superposed, zinc white or some similar cement is run round it, and the preparation is complete. In process of time the glycerine will permeate the gelatine and convert it into glycerine jelly; if this does not take place soon enough, it may be hastened by placing it in an oven kept at a temperature of about 20° to 30° C.

In this way a series of entire slices of great thinness may be obtained from the most disconnected structures; even when they contain hard silicious spicules, as in the case of sponges.

Diatoms may be cut without difficulty by this method, and the author says he has now beside him some slices of *Pleurosigma* which reveal the internal anatomy of these in an admirable fashion. It need not be added that the process effects a considerable saving in labour and time.

Mayer's method of Fixing Sections.*—P. Mayer proposes an improvement on the methods of Frenzel, Threlfall, and Schällibaum.

A mixture of equal volumes of filtered white of egg and glycerine is made, and spread with a fine brush in a very thin and uniform layer on a cold slide. The sections are then laid on it, and the whole warmed for some minutes on a water-bath; they can now be treated with oil of turpentine, alcohol, water, and colouring reagents, without any danger of their moving. The glycerine only serves as a means of keeping the surface of attachment moist; if the paraffin in the sections melts, it immediately carries away the albumen, so that the neighbourhood of the section is almost or altogether freed from it, and this is an additional advantage of the method. The mixture of albumen can be kept clear by the use of antiseptics (carbolic acid).

Alum-carmine and strong alcoholized solution of carmine are very useful staining reagents. The latter is slightly modified from the well-known preparation of Grenacher in that 4 gr. of carmine are dissolved in 100 ccm. of 80 per cent. alcohol, with the addition of 30 drops of concentrated pure hydrochloric acid, heated for about half an hour in the water-bath; this solution is filtered, while still hot, and the superfluous acid is carefully removed by the addition of caustic ammonia, added till the carmine begins to be deposited. When quite cold this solution stains very rapidly (for example, embryos of lobsters are stained in about a minute) and intensely, though diffusely; washing in alcohol acidulated with hydrochloric acid is therefore necessary if the nuclei alone are to be stained. The moment of satisfactory cleansing may be judged by the appearance presented by the albumen, which will completely give up the carmine to the alcohol, or will, at most, be only faintly coloured.

* MT. Zool. Stat. Neapel, iv. (1883) pp. 521–2.

Gum and Syrup Preserving Fluid.*—The very great objection to the use of freezing microtomes was the impossibility of taking spirit-hardened material and cutting it without an eighteen or twenty-four hours' preparation. Up to a few months ago, any one wishing to cut by freezing had to take his specimens out of spirit, cut them of convenient size, and soak them in water for twelve or more hours to get rid of the spirit, then place them in gum solution some hours further. This was a great drawback, and rendered it a necessity that the operator must think over what he wished to cut, and prepare it through twenty-four hours previously !

All this is changed. Specimens are now kept the year round, if the operator chooses, in gum and syrup, having a little carbolic acid in it, and he freezes and cuts any tissue so placed at any moment he likes.

To make the gum and syrup medium, take of gum mucilage † (B.P.) five parts; syrup, ‡ three parts. Add five grains of pure carbolic acid to each ounce of the above medium.

Tissue may remain in this any length of time. For brain, spinal cord, retina, and all tissues liable to come in pieces, put four parts of syrup to five of gum.

The operator will do well to make the gum mucilage and syrup separately, and to keep them so till wanted.

Cutting Tissues Soaked in Gum and Syrup Medium.§—Take a piece of tissue not more than an eighth of an inch thick, and press it gently between a soft cloth to remove all the gum and syrup from the *outside* of the tissue. Set the spray going, and paint on the freezing-plate a little gum mucilage : then put the tissue upon this and surround it with gum mucilage with a camel-hair brush. The tissue is thus saturated with gum and syrup, but surrounded when being frozen with gum mucilage only. This combination prevents the sections curling up, on the one hand, or splintering from being too hard frozen on the other. Should freezing have been carried too far, the operator must wait a few seconds. It ought to cut like cheese.

Gum Styrax as a Medium for Mounting Diatoms. ‖—Referring to Dr. Van Heurck's recommendation of "styrax," ¶ Mr. F. Kitton writes that the resin which is the product of *Liquidambar orientale* is prescribed in the British Pharmacopœia under the name of gum styrax, and in the drug trade is known as "strained gum styrax." It has the colour of the old-fashioned black treacle, but is of greater consistency; a temperature of 212° renders it fluid. In its commercial state it is unfit for microscopic purposes, first from its

* Cole's 'Methods of Microscopical Research,' 1884, p. xxxix.

† Gum mucilage B.P. is made by placing 4 oz. of picked gum acacia in 6 oz. of distilled water and stirring occasionally until the gum is dissolved. This is to be strained through muslin.

‡ Syrup is made by dissolving 1 pound of loaf sugar in 1 pint of distilled water and boiling.

§ Cole's 'Methods of Microscopical Research,' 1884, pp. xxxix.–xl.

‖ Sci.-Gossip, 1884, p. 66.

¶ See this Journal, iii. (1883) p. 741.

impurities, probably owing to the rough method employed in obtaining it—the stems are cut in small pieces and boiled, when the gum rises to the surface, and is skimmed off; and second, from its thickness. It is therefore necessary that it should be dissolved in one of the following menstrua: chloroform, benzol, ether, a mixture of benzol and absolute alcohol. When the resin is dissolved it must be filtered, and it is then ready for use. The solution should be of the colour of brown sherry, and the consistency of limpid olive oil. Its consistency can of course be increased by evaporating a portion of the benzol, and the whole of the latter should be eliminated before placing the cover-glass on the slip. Its refractive index is then 1·63, very nearly that of monobromide of naphthaline. The American liquid-amber is prescribed in the American Pharmacopœia, but seems to be unknown in Europe. It would, if obtainable, be preferable to gum styrax, as its colour is a pale yellow. The colour of the styrax is practically of little consequence, as the film between the cover and slip is very thin, and does not show any appreciable amount of colour when placed under the Microscope.

During the past four or five months Mr. Kitton has used this medium for various Diatomaceæ. The transverse striæ on *Pleurosigma littorale* and the longitudinal on *Navicula cuspidata* are much more sharply defined, and the striæ on all of them are more easily resolved than when mounted in Canada balsam. The most striking difference between gum styrax and Canada balsam is displayed by *Polymyxus coronalis*. In balsam, the valves are perfectly hyaline, and the rays and puncta almost invisible; in gum styrax the valves are light brown, and the markings easily resolved. *Heliopelta*, as might be expected, does not exhibit more structural detail, but every line and dot is more distinct than when it is balsam-mounted. Several of the *Aulisci* are also much improved when mounted in this medium. Mr. Kitton cannot say much of its merits as a medium for mounting other microscopic objects. He has tried it for thin wood sections, hairs, chalk foraminifera, and a few butterfly scales, all of which show better than they do in balsam. The colour of styrax becomes objectionable when a thick layer is necessary. Dr. Van Heurck directs that the commercial gum styrax should be exposed in thin layers to the light and air for several weeks, to eliminate the moisture contained in it previous to dissolving it, but Mr. Kitton has not found this necessary with his sample.

Mounting Medium of High Refractive Index.*—Professor Hamilton Smith is reported to have mounted *Amphipleura pellucida* and *Navicula rhomboides* in "something having a refractive index of 2·4," the result being "past all expectation, beating everything yet seen," "making a new era in diatom mounting," and "far surpassing all that has been done in phosphorus."

Dr. A. Y. Moore has also † mounted *A. pellucida* in a medium of index 2·3. The appearance of the frustule is said to be "quite

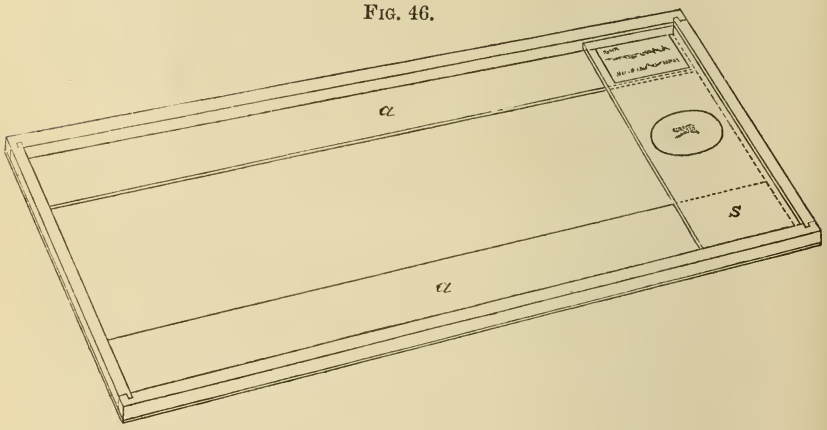
* Journ. Quek. Micr. Club, i. (1884) pp. 333–4.
† Amer. Mon. Micr. Journ., v. (1884) p. 37.

remarkable. It can be distinctly seen under a low-power objective under circumstances that a specimen in balsam would be quite invisible." He "has had no difficulty in seeing the dots on the valves with a Spencer 1/10 in. N.A. 1·35, with Beck's vertical illuminator, using lamplight."

Kingsley's Cabinet for Slides.*—J. S. Kingsley has had in use for some time a cabinet for holding his preparations, which, while not entirely new, possesses (it is claimed) some original features. It is based upon the model of Dr. Hailes,† but is more compact.

Rectangular frames of light wood are made, measuring inside $3\frac{1}{8}$ by $6\frac{1}{4}$ in., and just the depth of the thickness of a slide (fig. 46).

Fig. 46.



On one side of this strips are glued of four-ply Bristol board *a*, in the manner shown in the figure. These skeleton trays are kept in a box, piled one upon another. By this plan the slides are kept flat, and each one is held in place by the strips of Bristol board, which form the bottom of the tray above it. The preparation and its cover project between these strips; but, as will readily be seen, are prevented from touching the under surface of the slides in the tray above.

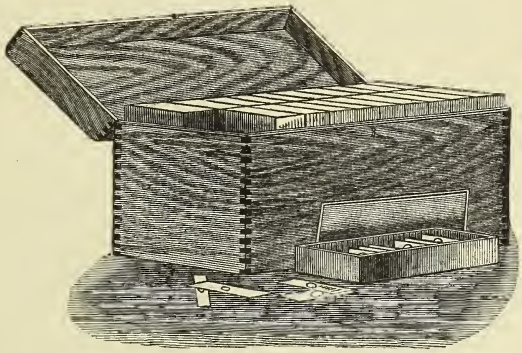
The especial advantage claimed for this plan is its compactness, safety, and portability; features of no small importance when one is returning from the sea-shore after the summer's work.

Pillsbury's Slide Cabinet.‡—J. H. Pillsbury has devised a cabinet (fig. 47) to allow of a set of slides being taken out and carried to the class-room or the society-room in safety, without being transferred to trays for that purpose and afterwards replaced in the cabinet.

* Science Record, ii. (1884) p. 67 (1 fig.).
† See this Journal, iii. (1883) p. 456.
‡ Science Record, ii. (1883) pp. 25-6 (2 figs.).

Neat, light, and yet firm "trays," each with sawn slots for holding twenty-five slides, are fitted to a polished cherry cabinet in such a way that they stand on end in two rows with sufficient space between the rows to make it convenient to get hold of the trays to take them out. The slides thus lie flat. The upper end of each tray

Fig. 47.



has a printed label with numbered lines for the name of the objects contained in the tray. There is a series of corresponding numbers on the bottom of the box to facilitate the replacing of the slides. This arrangement gives a complete list of the slides in the collection, spread out when the lid of the cabinet is opened, without any handling of the specimens.

The slides should be arranged by series, those likely to be wanted for use together being put in the same tray.

Examining the Heads of Insects, Spiders, &c., alive.*—Mr. E. T. Draper recommends a cone of pasted paper to be made rather larger than the specimen, with the apex cut off. A vigorous spider will soon project its head through the aperture. When in this position it should be blocked behind with cotton wool slightly wetted. The cone can then be gummed to a slip, apex upwards.

Many insects can be arranged in the same way for the observation of facial movements, and such front views admit of interesting and extended study, the action of the antennæ, palpi, and various organs of the mouth may be watched, and curious effects produced by the excitation of saccharine or nitrogenous juices, administered from the top of a sable pencil.

Examining Meat for Trichinæ.†—C. Renson describes the following new process for discovering *Trichinæ*:—Slices from 2-3 mm. thick are taken from several different portions of the piece of meat to be examined—by preference from the surface of the flesh. From each is cut a series of thin sections, which are placed together in

* Sci.-Gossip, 1884, p. 26.

† Bull. Soc. Belg. de Micr., x. (1883) pp. 24-5.

the following solution:—Methyl-green, 1 gramme; distilled water, 30 grammes. After about ten minutes' maceration, the sections are withdrawn and placed to decolour in a large test-tube filled with distilled water for half an hour, the water being shaken and changed two or three times.

When the water is very clear, it should be stirred with a glass rod, and on holding the test-tube against the light it is very easy to distinguish with the naked eye the sections containing *Trichinæ*. These present themselves under the form of small, dark-blue, elongated spots, methyl-green staining much more deeply the cysts of the *Trichinæ* than the rest of the tissue.

It is sufficient to examine the sections with a power of 50, and if "no *Trichinæ* are found, one may be absolutely certain that the meat does not contain any."

Bolton's Living Organisms.—Mr. T. Bolton continues his praiseworthy efforts to supply microscopists with a variety of living organisms, animal and vegetable. Several which he has sent out were entirely new to science, while others were new to England. His portfolio of drawings has now reached its tenth number. Microscopists subscribing to Mr. Bolton's "bottles," may certainly feel that apart from the practical return which they receive for their subscription, they are doing a real service to microscopy.

Cole's Studies in Microscopical Science.—Here, also, great credit is due to the editor, Mr. A. C. Cole, for the exertions which he has made to meet a want that has been felt by microscopists for the last half century. During that time the cry has constantly been that, though slides could be bought in profusion, no guide to their intelligent examination was forthcoming. Mr. Cole supplies weekly, not only a slide with a full description of the object, but also a coloured plate. It will be a matter of very great regret if these "Studies" are allowed to lapse for want of proper support from microscopists.

In addition to the "Studies," Mr. Cole is also publishing in parts, "Popular Microscopical Studies," and "Methods of Microscopical Research."

Alcohol, Absolute, preparing.

["The microscopist can prepare an alcohol which is so nearly devoid of water as to fulfil all ordinary requirements by a very simple process. Ordinary blue vitriol (cupric sulphate) is burnt or calcined until all water of crystallization is expelled and the resulting powder is put into (95 per cent.) alcohol, from which it extracts a large proportion of the water. By repeating the operation several times, an almost absolute alcohol may be obtained."]

Science Record, II. (1884) p. 65.

Baumgarten, P.—Beiträge zur Darstellungsmethode der Tuberkelbacillen. (Contributions to the method of demonstrating the bacillus of tubercle.)

Zeitschr. f. Wiss. Mikr., I. (1884) pp. 51–60.

Bergonzini.—Sull' uso del collodio e del fenolo nella technica microscopica. (On the use of collodion and fennel oil in microscopical technics.)

Spallanzani Modena, XII. (1883) Fasc. 4.

Blackham, G. E.—Boxes for Objects. [*Post.*]

Proc. Amer. Soc. Micr., 6th Ann. Meeting (1883) pp. 236–7.

Bradley's Mailing Cases. See Pillsbury, J. H.

Brass, A.—Die Methoden bei der Untersuchung thierischen Zellen. (The methods for the investigation of animal cells.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 39–51.

Breckenfeld, A. H.—A new method of mounting *Hydra*. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) pp. 49–50.

Browne's (R., jun.) Case for Objects.
["Each box holds thirty slides in a case that will easily slip into the pocket, and can be set up on the shelf of a bookcase. It has a movable flap-cover over the slides, on which there is a list of numbers so that the slides can be catalogued."]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, p. 236.

Calliano.—Il regolatore del preparato al microscopio. (Guide for microscopical preparation.)
Giorn. R. Accad. Med. Torino, XLVI. (1883) Nos. 4, 5.

Casse. See Renard, A.

Cattaneo, G.—Fissazione, colorazione e conservazione degli Infusorii. (Fixing, colouring, and preserving Infusoria.)
Bollett. Scientif., V. (1883) pp. 89–95.

Certes, A.—Analyse micrographique des Eaux. (Microscopical analysis of water.) 8vo, Paris, 1883, 28 pp. and 2 pls. [*Post.*]

Cleaning Slides and Covers.—Letters by F. Dienelt, A. L. W., E. W. Owen, S. Wells, and D. S. W. *Amer. Mon. Micr. Journ.*, V. (1884) pp. 59–60.

Cole, A. C.—Studies in Microscopical Science.
Vol. II. No. 11. Sec. I. No. 6. Fibrous Connective Tissue. Plate 6. Areolar Tissue × 40, pp. 21–4.
No. 12. Sec. II. No. 6. Chap. III. The Morphology of Tissues (*continued*), pp. 21–4. Plate 5. Types of Simple Tissues. Plate 6. Prothallus of Fern × 250.
No. 13. Sec. I. No. 7. Fibrous Connective Tissue (*continued*). Tendon, pp. 25–7. Plate 7. Tendon of Lamb T. S. × 70.
No. 14. Sec. II. No. 7. Primary Tissue, pp. 25–8. Plate 7. L. S. through apex of root of Maize (Sachs).
" " Methods of Microscopical Research.
Part VII. Stains and Staining. pp. xli.–iv. [*Supra*, p. 310.]
Part VIII. pp. xlv.–viii. Mounting. (Slides. Covers. Cleaning Covers and Slips. Labels. Transference of Sections. 1. The floating method. 2. Transferring with brushes. 3. By section-lifters.)
" " Popular Microscopical Studies. No. 6. A Grain of Wheat (*continued*). pp. 25–8. Plate 6. Germination of Wheat.

Day, F. M.—The microscopical examination of Timber with regard to its strength.
[Title only of paper read before American Philosophical Society, 21st Dec. 1883.]
Amer. Nat., XVIII. (1884) p. 333.

Dienelt, F.—See Cleaning.

Dimmock, G.—Pure carminic acid for colouring microscopical preparations. [*Post.*] *Amer. Nat.*, XVIII. (1884) pp. 324–7.

" " See Minot, C. S.

Errera, L.—See Renard, A.

Fastening Insects and other small forms for dissection.
[In such dissections one occasionally experiences considerable difficulty in fastening the object in the dissecting pan. Pins are inconvenient as they are in the way, and besides they frequently injure portions of the specimen. These difficulties may, however, be avoided by partially imbedding the object in wax or paraffin, which, however, should not extend above the middle line of the body. The paraffin and the imbedded object may then be readily fastened in the dissecting tank, or, when it is necessary to stop operations, the paraffin and object may be placed in alcohol.]
Science Record, II. (1884) p. 86.

Fearnley, W.—On a new and simple method of applying air-pressure to Wolff's bottles. [*Post.*] *Brit. Med. Journ.*, 1883, pp. 859–60 (2 figs.)

Fennessy, E. B.—Microscopic.

[A very pretty slide, and one very easily made, is the raphides in the sap of the daffodil. It is only necessary to squeeze out a drop of sap from the flowering stem on to a slide, and on its drying, which may occur spontaneously, or be done over a spirit-lamp, we find hundreds of crystals strewn over the field of view. With the polariscope they are exceedingly interesting and brilliant. If we drop over the warmed glass a little Canada balsam, we can press on a cover-glass.]

Engl. Mech., XXXIX. (1884) p. 34.

Francotte, P.—Nouveaux réactifs colorants. (New staining reagents.) [*Post.*]

Bull. Soc. Belg. Micr., X. (1884) pp. 75–7.

Gage, S. H., and T. Smith.—Section-flattener for dry section-cutting. [*Supra*, p. 314.] *The Microscope*, IV. (1884) pp. 25–7 (1 fig.).

Gierke, H.—Färberei zu mikroskopischen Zwecken. (Stains for microscopical purposes.) *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 62–100.

Giltay, E.—Ueber die Art der Veröffentlichung neuer Reactions- und Tinctionsmethoden. (On the mode of publication of new reactions and stains.)

Zeitschr. f Wiss. Mikr., I. (1884) pp. 101–2.

Grant, J.—Microscopic Mounting. VIII. Hardening and Wet Mounting.

[1. Hardening agents; alcohol and chrome solutions; water. 2. The process of hardening.]

Engl. Mech., XXXVIII. (1884) pp. 517–9.

Hall, J.—Preparation of Rock-sections.

[Title only of paper read at meeting of Society of Naturalists of the Eastern United States.]

Amer. Nat., XVIII. (1884) p. 224.

Hamlin, F. M.—[" Advises the use of crimson lake as a colour for the ground of opaque mounts. When the object is white he considers this better than a black ground, but for objects of different colours he selects a ground which seems to show them best."]

Amer. Mon. Micr. Journ., V. (1884) p. 37.

Haushofer, K.—Beiträge zur Mikroskopischen Analyse. (Contributions to Microscopical Analysis.) [*Post.*]

SB. K. Bayerisch. Akad. Wiss., XIII. (1883) pp. 436–48 (1 pl.).

Hitchcock, R.—Microscopical Technic. I. Apparatus and Material. II. Mounting in general.

Amer. Mon. Micr. Journ., V. (1884) pp. 27–31, 51–2.

„ „ Imbedding Diatoms for making sections. [*Post.*]

Amer. Mon. Micr. Journ., V. (1884) pp. 54–5.

Ingpen, J. E.—Remarks on Mounting in Phosphorus.

[An attempt is being made to mount diatoms in absolutely solid phosphorus.]

Journ. Quek. Micr. Club, I. (1884) p. 334.

Insley, H.—Preparation of Coal.

[Has tried section-making of every kind of fire coal he could get, grinding as thin as possible,—could get no light to pass through the section on account of the presence of so much colouring matter.]

Midl. Nat., VII. (1884) p. 51.

Kain, C. H.—Some thoughts about Mounting.

[Discussion of various media.—" Some experiments by Mr. E. E. Read, of the Camden Microscopical Society, would seem to indicate that cosmoline may prove a valuable medium in which to mount the starches. The starch-grains are certainly remarkably well displayed in it. How permanent the mounts may prove is a question of time. It is not improbable that several of the petroleum products—even the plebeian kerosene itself—may be found not unworthy of the microscopist's attention."—" Dr. W. W. Munson some time ago called attention to the preservative properties of a solution of hydrate of chloral, and the medium is

evidently deserving of more attention than it has had. A slide of algæ put up in this solution over four years ago still remains as bright and pure as when first mounted, and, what is quite important, the cell contents of the algæ appear to be less contracted than is usually the case."—Cells and Cements.]

Micr. Bull., I. (1884) pp. 9–11.

KAROP, G. C.—Schering's patent Celloidin for Imbedding. [*Supra*, p. 313.]
Journ. Quek. Micr. Club, I. (1884) pp. 327–8.

KINGSLEY, J. S.— A new Cabinet for Slides. [*Supra*, p. 320.]
Science Record, II. (1884) p. 67 (1 fig.).

KITTON, F.—Glass Cells.
[Directions for perforating thin glass and thick glass slips.]
Sci.-Gossip, 1884, p. 41.

„ „ On Gum Styrax as a medium for Mounting Diatoms.
[*Supra*, p. 318.] *Sci.-Gossip*, 1884, p. 66.

MARPMANN, G.—Die Spaltpilze. (The Schizomycetes.) 193 pp. and 25 figs. 8vo, Halle, 1884.
[Contains a chapter on "Methods of Research," pp. 107–13.]

MILES, J. L. W.—Mounting in Canada Balsam.
[Report of meeting of Mounting Section of the Manchester Microscopical Society. Mentions that a "new cell having alternate elevations and depressions has been devised by a member of the section, in the use of which, by leaving an excess of balsam round the cell and cover-glass, air-bubbles ultimately escape through the spaces and loss by evaporation of essential oil in the balsam is provided for."]
Micr. News, IV. (1884) pp. 55–6.

MINOT, C. S.—Classification of Microscopic Slides.
[Also includes a note on Dr. Dimmock's plan. [*Post.*]
Science Record, II. (1884) p. 65.

MITCHELL, C. L.—Staining with Hæmatoxylon. [*Supra*, p. 311.]
Proc. Acad. Nat. Sci. Philad. (1883) pp. 297–300.

OSBORN, H. F.—Method for Double Injections.
[The veins are first injected through the arteries with coloured gelatine and then a differently coloured plaster of Paris is injected in the same way, forcing the gelatine before it, but as this stops at the capillaries, the arteries and veins can readily be distinguished.]
Science Record, II. (1884) p. 84.

OWEN, E. W.—See Cleaning.

PILLSBURY'S (J. H.) New case for Mailing Slides. [*Post.*]
Science Record, II. (1884) p. 86 (2 figs.).
Micr. Bull., I. (1884) p. 12 (2 figs.).
The Microscope, IV. (1884) p. 41 and Advt. i. (2 figs.).

PRINZ, W.—See Renard, A.

QUEEN'S (J. W. & Co.) Slides of Animal Hairs and Fibres (textile). Vegetable Esculents and Adulterations. *Micr. Bull.*, I. (1884) p. 13.

RASMUSSEN, A. F.—Om Dyrkning af Mikroorganismer fra Spyt af sunde Mennesker. (On the culture of Micro-organisms from the sputum of healthy men.) 136 pp. and 2 pls. 8vo, Copenhagen, 1883.

RENARD, A., L. ERRERA, CASSE, and W. PRINZ.—Discussion on the present condition of Physiological Chemistry and the advantage of the employment of Microchemical methods.
Bull. Soc. Belg. Micr., X. (1884) pp. 67–9.

SCHAARSCHMIDT, J.—Ueber die Mikrochemische Reaction des Solanin. (On the Microchemical Reaction of Solanin.)
Zeitschr. f. Wiss. Mikr., I. (1884) p. 61–2.

SHARPE, B.—Various methods of Carmine Staining.
[Title only of paper read at meeting of Society of Naturalists of the Eastern United States.]
Amer. Nat., XVIII. (1884) p. 224.

Slack, H. J.—Pleasant Hours with the Microscope.
[Commensalists—Symbiosis—Lichens and the Schwendenerian Theory. [Trachelomonads and *Amœbæ*] [*Astasia trichophora*] [Flower and Pollen of Hazel, Gymnosperms, &c.]
Knowledge, V. (1884) pp. 82–3 (1 fig.), pp. 109–10 (2 figs), pp. 141–2 (6 figs), pp. 182–3 (2 figs.).

Smith, T.—See Gage, S. H.

Smith, W. D.—New modification of a Turntable.
[An attempt to unite in one piece of apparatus the most valuable points in Kinné's and Dunning's instruments. It consists of a circular brass plate, on the under side of which is a lever having its fulcrum on the axle of the table. This lever moves two arms which work in slots cut in the plate so that they always approach or recede from the centre in an exactly equal degree. The arms carry on the upper side of the plate two flat pieces of brass 2 in. in length, which grasp the slide, one of these being fixed at right angles to the slot, and the other pivoted so as to be able to adjust itself to the slide, as in Dunning's instrument.]
Journ. Quek. Mikr. Club, I. (1884) p. 31.

Smith's (H.) new Mounting Medium. [*Supra*, p. 319.]
Journ. Quek. Mikr. Club, I. (1884) pp. 333–4.

Sollas, W. J.—An improvement in the method of using the Freezing Microtome. [*Supra*, p. 316.] *Quart. Journ. Micr. Sci.*, XXIV. (1884) pp. 163–4.

Stillson, J. O.—Cabinet for Objects. [*Post.*]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, p. 237.

Streng, A.—A new Microchemical Test for Sodium.
Jahrb. f. Mineral., 1883, II., Ref. p. 365.
See *Journ. Chem. Soc.*—Abstr., XLVI. (1884) pp. 366–7.

Up de Graff, T. S.—Measuring Blood-corpuscles.
[Remarks on C. M. Vorce's article and R. Hitchcock's comments, *ante*, p. 159.]
Amer. Mon. Micr. Journ., V. (1884) pp. 26–7.

W., A. L.—See Cleaning.

W., D. S.—See Cleaning.

Wells, S.—See Cleaning.

White, T. C.—Method of preparing Sections of Hard Tissues.
[First "Demonstration" of the second series, with remarks by J. E. Ady on preparing and mounting sections of teeth and bone, *supra*, p. 304.]
Journ. Quek. Micr. Club, I. (1884) p. 330–2.

Wilson, E. B.—Methods of Section-cutting.
[Title only of paper read at meeting of Society of Naturalists of the Eastern United States.]
Amer. Nat., XVIII. (1884) p. 224.

Wright, L.—Mounted Insect Preparations.
[Commendation of A. Topping's preparations.]
Engl. Mech., XXXIX. (1884) p. 34.

Zentmayer's (J.) new Centering Turntable. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) p. 23 (1 fig.).

PROCEEDINGS OF THE SOCIETY.

Annual Meeting of 13th February, 1884, at King's College, Strand, W.C., the President (Prof. P. Martin Duncan, F.R.S.) in the Chair.

The Minutes of the meeting of 9th January last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting, was submitted, and the thanks of the Society given to the donors.

	From
Owen, R.—On Parthenogenesis. 76 pp. and 1 pl. 8vo, London, 1849.	
Siebold, C. T. E. v.—On a True Parthenogenesis in Moths and Bees. (Translated by W. S. Dallas.) viii. and 110 pp. and 1 pl. 8vo, London, 1857.	*Mr. Crisp.*
6 Slides of Crystals of Uric Acid, from Lepidoptera	*Mr. C. M. Vorce.*

The Report of the Council was read by Mr. Crisp (see p. 329).

The adoption of the Report was moved by Mr Glaisher, who congratulated the Society upon its extremely satisfactory nature, and having been seconded by Mr. Michael, was put to the meeting and carried unanimously.

The Treasurer (Dr. Beale, F.R.S.) read his Statement of the Income and Expenditure of the Society for the past year, which showed that more than 750*l.* had been received from Fellows.

The adoption of the Treasurer's Statement was moved by Mr. Glaisher, who said that he regarded it as one of the most pleasing facts connected with the Society that they were progressing in the manner shown by these reports, and he urged upon every Fellow of the Society to do all that could be done to still further advance their position so as to place them in the first rank amongst Societies.

Dr. Millar seconded the motion, which was put and carried unanimously.

The List of Fellows proposed as Officers and Council for the ensuing year was read as follows :—

President—*Rev. W. H. Dallinger, F.R.S.

Vice-Presidents—*John Anthony, Esq., M.D., F.R.C.P.L.; *Prof. P. Martin Duncan, M.B., F.R.S.; James Glaisher, Esq., F.R.S., F.R.A.S.; Charles Stewart, Esq., M.R.C.S., F.L.S.

Treasurer.—Lionel S. Beale, Esq., M.B., F.R.C.P., F.R.S.

* Have not held during the preceding year the office for which they are nominated.

Secretaries—Frank Crisp, Esq., LL.B., B.A., V.P. & Treas. L.S.; Prof. F. Jeffrey Bell, M.A., F.Z.S.

Twelve other Members of Council—A. W. Bennett, Esq., M.A., B.Sc., F.L.S.; *Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.; *G. F. Dowdeswell, Esq., M.A.; J. William Groves, Esq.; John E. Ingpen, Esq.; John Matthews, Esq., M.D.; John Mayall, Esq., jun.; Albert D. Michael, Esq., F.L.S.; John Millar, Esq., L.R.C.P., F.L.S.; *William Millar Ord, Esq., M.D., F.R.C.P.; *Urban Pritchard, Esq., M.D.; William Thomas Suffolk, Esq.

Mr. Curties and Mr. Crouch having been appointed Scrutineers by the President, the ballot was proceeded with, and the Scrutineers having handed in their report of the result, the President declared the Fellows who had been nominated to be duly elected as Officers and Council for the ensuing year.

The President then read his Address (see p. 173), in which he dealt principally with low-power objectives, congratulating the Society upon the great progress which had taken place since his first address in the comprehension of the subject of aperture and in the use of the numerical aperture notation.

Dr. Anthony said that the pleasing duty devolved upon him of returning thanks to the President for his address. He would also add to this the thanks of the Society for his three years' services as their President. He did not have the pleasure of personally hearing the previous addresses, but he read them with charm in the Journal (as he hoped to read the one they had just heard); indeed, the first one he had not only read once but three times, and thought he might say he had not done with it yet. He had that evening had the pleasure of hearing some things which he knew before but which had been placed in a new light; but in addition to these there was much which he did not know, and he might refer especially to the interest of the remarks as to the Bacteria. He would venture also to recognize warmly the admirable manner in which the President had met all with whom he had come in contact, and his able conduct in the Chair. If he might be allowed to use a simile, he might say that the versatility of the President's qualifications reminded of the mighty power of a Nasmyth's hammer, which while it was able to shape a ton of glowing metal could nevertheless be made to crack a single nut. He had great pleasure in proposing a vote of thanks to the President for the address and for the able manner in which he had fulfilled the duties of his office during the last three years.

Mr. Crisp, in seconding the motion, said that in his experience they never had a President who had given more attention to his duties or who had been more ready to advance the Society's interests, whilst at their meetings he was always ready to deal with whatever subject might be before them, and to throw light upon it.

* Have not held during the preceding year the office for which they are nominated.

Dr. Anthony having put the proposition to the meeting, it was carried by acclamation.

Prof. Duncan, in thanking the Fellows for the very warm manner in which the vote of thanks had been received, said they could perhaps hardly realize what a feeling of satisfaction arose in his mind when he found that they were parting from each other under such very gratifying circumstances. Throughout his triple term of office nothing disagreeable had ever happened, and as to their general prosperity, the state of their finances would afford conclusive proof as to that, apart from the fact that no less than 143 Fellows had been elected during the three years. With regard to his successor he could only say that he believed that they would find the Rev. Mr. Dallinger a most admirable President, and one well qualified in every way to fill the position to which he had been elected.

The following Instruments, Objects, &c., were exhibited:—

Mr. T. Bolton:—*Bacillaria paradoxa*.

Mr. F. R. Cheshire:—Inosculating Muscular Fibres from the dorsal vessel of *Apis mellifica* (third segment).

Mr. Crisp:—

(1) Hirschwald's Goniometer Microscope.

(2) Nelson's Student's Microscope.

(3) Pringsheim's Photo-chemical Microscope.

(4) Schieck's Corneal Microscope.

Mr. Rosseter:—*Stephanoceros Eichhornii*.

Mr. C. M. Vorce:—Crystals of Uric Acid from Lepidoptera.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. William H. Bates, M.D., John Bennett, William E. Damon, Richard L. Mestayer, A.S.C.E., John Morley, and William Wales.

REPORT OF THE COUNCIL FOR 1883.

Fellows.—The number of new Ordinary Fellows elected during 1883 was 53, as against 40 in 1882. After deducting 28 Fellows (2 of whom were compounders) who have died or resigned, this leaves a net increase of 25 for the year, and an addition to revenue of 44*l.* 2*s.* per annum.

Of the Honorary Fellows, Dr. F. Pacini died during 1883, and in his place was elected Dr. H. van Heurck, of the Botanical Gardens, Antwerp, well known as a microscopist and for his excellent synopsis of Belgian diatoms.

The list now includes 551 Ordinary, 50 Honorary, and 83 Ex-officio Fellows, or 684 in all.

The Council are of opinion that, under existing circumstances, the subscription of Foreign Fellows is too low. For a payment of 21*s.* per annum Fellows residing abroad, within the limits of the Postal

THE TREASURER'S ACCOUNT FOR 1883.

Dr.

1883.	£	s.	d.
To Balance brought from 31st December, 1882	208	18	0
„ Interest on Investments	89	12	5
„ Admission Fees .. .. } „ Annual Subscriptions .. .. }	712	5	0
„ Compositions	56	14	0
„ Journals and Reprints sold by Assistant-Secretary	4	6	6
„ Screw tools sold	2	17	4
„ Difference in rate of Exchange (Foreign Remittance)	0	4	0
	£1074	17	3

Cr.

1883.	£	s.	d.
By Rent, Gas, and Attendance	96	13	0
„ Salaries, Reporting, and Commission	141	2	6
„ Books and Binding	27	5	0
„ Expenses of Journal, 1882	80	0	0
„ „ „ 1883	400	0	0
„ Stationery and Miscellaneous Printing	9	1	9
„ Coffee at Evening Meetings	17	7	0
„ Fire Insurance	1	4	0
„ Cheque Book and Commission	0	5	6
„ Petty Cash and Postage of Journal	88	14	4
„ Subscription to Mr. Bolton's Bottles	2	2	0
„ „ Mr. Cole's Slides	4	4	0
„ Balance remaining 31st December, 1883	206	18	2
	£1074	17	3

L. S. Beale, *Treasurer.*

Investments, 31st December, 1883.

1200*l.* Freehold Mortgages. 1057*l.* 13*s.* 3*d.* Three per cent. Consols (including 100*l.* Quekett Memorial Fund).

The foregoing Annual Account examined and found correct, February 1st, 1884.

Philip J. Butler, Robert Kemp } *Auditors.*

Union, receive the Journal post-free, or an equivalent of 32*s*. The Council recommend that after the present year (1884) the annual subscription for Foreign Fellows should not be less than 31*s*. 6*d*.

Revenue.—With the additions to the number of Ordinary Fellows, the income of the Society has continued to increase, and the report of the Treasurer, showing a total receipt of 866*l*., is the most satisfactory report which the Society have ever had placed before them.

Library.—Mr. Reeves having tendered his resignation as Librarian and Assistant-Secretary, the Council took into consideration the question of recognizing his long services to the Society, and resolved to recommend to the Annual Meeting a grant to him of 100*l*. out of the capital funds of the Society.

The Council selected, as Mr. Reeves' successor, Mr. James West, previously assistant in the library of the Linnean Society, and have arranged that in future the Library, in place of being open from 11 to 4 as formerly, shall be open from 10 to 5.

Journal.—The Journal for 1883 contained 1000 pages, the exact limit fixed by the Council. The index has been further improved by including in it the names of all authors whose names appear in the Bibliographical lists, so that a reference to the index will alone be necessary to find any paper noted during the year. In other respects the Journal has been continued on the same basis as before, and every care has been taken to insure that no paper or article of any importance in Microscopy shall escape notice in the pages of the Journal.

The sales of the Journal have steadily increased notwithstanding the augmentation in price, and of the second or current series only 17 sets remain. This places no little difficulty in the way of a satisfactory adjustment of the Exchange List, which must necessarily be still further curtailed so as to insure at least 25 sets being in future left in the Society's hands. The Council have been reluctant at present to increase the number printed, as they have felt it desirable to limit as much as possible the expense of the Journal in view of the probability of having to engage a paid editor on Mr. Crisp relinquishing the honorary editorship.

Papers.—The papers read during the year have been of considerable interest, and have embraced a variety of subjects, including Dr. Hudson's on "New *Floscularicæ*" and a "New *Asplanchna*," Mr. Matthews' on the "Red Mould of Barley," Prof. Abbe's on "The Relation of Aperture to Power," Mr. Lovett's on "Preparing Embryological and other Delicate Organisms," Mr. Michael's on "The Anatomy of the Oribatidæ," Mr. Stearn's on "The Use of Incandescence Electric Lamps," Mr. Waddington's on "The Action of Tannin on the Cilia of Infusoria," Messrs. Morris and Henderson's on "The Ringworm Fungus," Mr. Beck's on "Cladocera of the English Lakes," Mr. Squire's on a "Method for Preserving the Freshwater Medusæ," and others by Prof. Bell, Mr. Crisp, Mr. Dowdeswell, Dr. Maddox, and Dr. Schröder.

MEETING OF 12TH MARCH, 1884, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (THE REV. W. H. DALLINGER, F.R.S.) IN THE CHAIR.

Mr. Glaisher said he had great pleasure that evening in introducing to the Fellows their new President, the Rev. W. H. Dallinger, F.R.S., whose name was so familiar to most of them, and whose work in a difficult branch of microscopical research was so well known. He begged therefore, on behalf of the Fellows of the Society, to offer a most hearty welcome to Mr. Dallinger, on the occasion of his taking his seat in the Presidential chair for the first time.

The Rev. W. H. Dallinger (who on rising was received with cheers) said that it was with very considerable pleasure that he occupied that evening the honourable position to which they had elected him, and he thanked them sincerely for the kind manner in which they had received the remarks of Mr. Glaisher. In coming amongst them as their President, he confessed to feeling a certain amount of trepidation, which arose in part from the newness of the position to which he had been elected, partly from the fact of his but slight personal acquaintance with so many of the Fellows of the Society (although he was well acquainted with many by name), but chiefly from the consciousness that he was succeeding a President who was in so many ways better qualified to fill the position, and whose admirable conduct as their President during the past three years was so well known and so cordially acknowledged by all. As they were no doubt aware, his own work with the Microscope had been special rather than general; he might say that he had taken a small corner of a very large field and had endeavoured to work it thoroughly. Whilst, however, endeavouring to become more or less master of the special point which he had made his study, he had not allowed anything of importance which concerned microscopy to escape notice, though doubtless there were many points to which he had not devoted particular attention. Although, therefore, it was possible that he might not be very pronounced on some points, his interest in the Microscope was of the deepest kind, and his strong desire was that the instrument, whether used by the youngest student or by the advanced observer, should be scientifically employed, and that every effort should be made to render it more than ever a means of promoting true research.

The Minutes of the meeting of 13th February last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
7 vols. of the publications of the Palæontographical Society	*Mr. Crisp.*
2 Slides of Sticklebacks	*Mr. J. Norman, jun.*

Mr. John Mayall, jun., exhibited Mr. Nelson's microscope lamp, embodying several modifications and improvements which he had suggested should be made in it since its original introduction. The body of the lamp was now fitted with a rack and pinion movement by which it could be easily raised or lowered, and a slight alteration enabled the burner to be brought down 3/4 in. nearer to the table than before. An adjustable slot diaphragm plate had been made to fit in front of the glass of the lamp, and an extra groove had been provided in which tinted glass might be placed. The cylindrical part of the metal chimney was now made so that an opal glass reflector could be inserted if desired.

The President said he was struck with the description of the lamp in its original form which had appeared in the Journal of the Society, and he was very desirous of examining it further. The ability to lower the lamp so much was a most useful feature, the fault of most lamps being that they could not be brought low enough for many purposes.

Mr. E. Ward's new cells, devised by Mr. Wilks for mounting without pressure in Canada Balsam, were exhibited (see p. 325).

Herr E. Böcker's improved form of freezing microtome was exhibited by Mr. J. Mayall, jun.

Mr. J. W. Groves said that the diagonal motion given to the knife was very ingenious. There was also an ingenious automatic arrangement by which the specimen was raised after making each cut so as to be in position for the next section. A screw adjustment enabled the thickness of the sections to be controlled, and when once set, any number of consecutive sections could be cut of the same thickness by simply repeating the movement of the razor.

Mr. Crisp, in reply to a question from Mr. Michael, referred to the description given in the Journal of the instrument in its original form, and read extracts therefrom.

Mr. Beck said that he thought the object in introducing a new piece of apparatus should be increased simplicity of construction, and he should like to know if it was claimed that the new microtome could cut a section very much better than any other, because if not he hardly saw what utility there was in introducing it. Any one who was in the habit of cutting thin sections would be aware how very inconvenient it was to have to wipe up and clean a complicated instrument, as compared with a more simple one. Those who had much practical experience of section cutting knew that the difficulty lay more with the substance to be cut, as to its condition, freshness, hardness, &c., than with the instrument with which they cut it.

Mr. Crisp mentioned with regret that since their last meeting they had received an intimation of the death of Mr. Charles Stodder, of Boston, who had always been very kind and courteous in his relations with the officers of the Society.

Mr. E. H. Griffith's note on a multiple eye-piece was read by Mr. Crisp, and his diagram in illustration enlarged upon the board. Mr. Griffith proposes to set the different eye-lenses in a revolving disk with projecting milled edge, the diaphragm with different sized apertures being arranged in the same way. A draw-tube is provided to vary the length of the eye-piece.

Mr. Crisp read the following letter which had been received on behalf of a Microscopical Society of Ladies at San Francisco :—

San Francisco, Cal., Jan. 14, 1884.

Dear Sir,—I have the honour to announce to you that at the instance of Prof. Henry G. Hanks, our State Mineralogist, we in the summer of 1882 moved in the matter of the organization of a Microscopical Society, whose membership should consist entirely of women. August 10th, 1882, a few ladies joined me in my class-room (I am a teacher in the Girls' High School of this city), and together we organized a Society to be known as the California Microscopical Society. We elected Mrs. Mary W. Kincaid our President. Aug. 20th, 1883, we incorporated our Society under the laws of California, and re-elected Mrs. Kincaid as President. Now, in 1884, at the suggestion of Mr. Hanks, we formally announce ourselves to you.

We have twenty-five members, the use of several fine instruments, are interested in our work, and hope to increase both our numbers and usefulness.

Mr. Hanks says that so far as he is aware, the California Microscopical Society is the only one in the world whose membership consists entirely of women.

Trusting that you may be pleased to extend us a word of cheer,

We remain very truly yours,

Mary L. Hoffman,

Secretary C.M.S.

Frank Crisp, Esq., F.R.M.S., London.

Mr. Beck presumed that this letter would be suitably acknowledged and entered upon the minutes. He was very glad to hear of this Society's existence, for there was a very wide field in which ladies could work most efficiently and for which their manipulative skill particularly fitted them.

The President said it was quite in harmony with the subject to mention that a notice was that evening given for the next meeting of the Council as to ladies being admitted into this Society.

Mr. Crisp said that there was one other Ladies' Microscopical Society already in existence—the Wellesley College Society.

Mr. John Brennan's letter as to his discovery of the nature of the potato blight was read.

Mr. Crisp exhibited Schieck's No. 8 Microscope in which a fine adjustment was obtained by tilting the stage at one end. This plan had been commented upon unfavourably at one of the meetings of the Society some years back, but it was pointed out in answer by some German writers that sufficient attention had not been given to the fact that it was only applied to quite cheap forms of stand. High powers would not be used with these stands and therefore the deviation of the stage from a plane would be hardly perceptible, and it was alleged that no better form of fine adjustment could be found without departing from the essence of the problem, i. e. maintaining the low price of the instruments.

Col. O'Hara's further communication on some peculiarities of form in blood-corpuscles, with five enlarged photographs, was read.

Mr. Rosseter's paper "On an Annular Muscular Formation in *Stephanoceros Eichhornii*" was read.

Mr. Crisp said that the authorities whom he had consulted on the subject, including Dr. Hudson, had not observed any such circular muscles in a rotifer as were drawn by Mr. Rosseter, though they were not prepared to say such a *lusus naturæ* was impossible. Dr. Hudson thought it remarkable how experts differed. Ehrenberg as well as Rosseter gave four pairs of muscles in *Stephanoceros*. Gosse gives five, while he (Dr. Hudson) considers there are six pairs, one pair being almost invariably hidden from view, whichever position of the animal happens to be caught. It can be readily understood how, if a glass tube had lines ruled down its length, some (at the sides of the field of view) would always be projected on each other, and confounded with the two edges.

Mr. Massee's paper "On the Function and Growth of Cells in the genus *Polysiphonia*," was read by Prof. Bell (see p. 198).

Mr. Bennett thought that the great interest attaching to this paper was the illustration which it afforded of the continuity of protoplasm. The slides exhibited required, however, a higher power than was applied to them under the Microscope upon the table, in order to demonstrate the fact of their absolute continuity, but he might say that he had subjected them to examination with the highest powers, and could find no break in the continuity. Botanists would, he thought, be agreed that this theory of the continuity of protoplasm was without doubt the most important discovery of its kind which had been made of late years. Prof. Percival Wright, of Dublin, was the first to call attention to it, and from the observations of others who had followed, it seemed clear that the old idea that the cell was an element in itself, would have to be abandoned. The discovery was also of the greatest importance in explaining the irritability of the organs of plants, such as the leaves of the *Mimosa*, and he could only express a hope that the further attention called to the subject by this paper would lead to more conclusive evidence being obtained.

Mr. Groves said he had lately tried to repeat Mr. Gardiner's

experiments, but found at first a good deal of difficulty. He had, however, been more successful by treatment with dilute sulphuric acid, and then staining the cells, by which means he proved most conclusively that the cells were connected with each other. In reply to a question from Mr. Bennett, he stated that he had experimented with different parts of *Geranium*, *Vallisneria*, and other plants, and had been successful in every case.

Prof. Reinsch's paper on "Bacteria and Microscopic Algæ on the surface of Coins in currency," was read by Mr. Crisp, in which the author described the constant presence of large numbers of different species of bacteria and algæ on all silver and copper coins which have been several years in currency.

The President said that in the form in which these facts were presented, they were new to him, but he did not think the subject was in itself wholly new, for it had been observed by others that similar organisms existed on tool handles, such as pliers, &c. By taking off the slight deposit found in the cross lines, or on the handle of an engraver's tool, or of a saw, and putting it into water, an abundant supply of bacteria could be obtained. Whether those described were indigenous to the copper, or whether they were simply there as desiccated forms of deposited putrefactive organisms, he was unable to say, though he thought the latter to be the more likely.

Prof. Abbe's note "On the Distance of Distinct Vision" was read by Mr. Crisp, and discussed by Mr. J. Mayall, junr., Mr. Beck, and Mr. Crisp.

The following Instruments, Objects, &c., were exhibited:—

Herr E. Böcker:—Improved Freezing Microtome.

Mr. J. Cheshire:—Ovary of *Apis mellifica* (hive bee) showing the spermatheca at the junction of the oviducts.

Mr. Crisp:—(1) Schieck's No. 8 Microscope. (2) Watson's Revolving Stage. (3) Collins' Set of Fish Scales. (4) Section of Hydroid Polyp with extended tentacles (by Mr. E. Ward).

Mr. Massee:—Two slides illustrating his paper, and showing the continuity of protoplasm in *Callithamnion* and *Ptilota*.

Mr. J. Mayall, jun.:—Improved Nelson-Mayall Lamp.

Mr. E. Ward: (1) Wilks' Cells, for mounting without pressure in balsam; (2) 2 slides of young Sticklebacks.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. Frank E. Beddard, M.A., J. P. McMurrick, M.A., John Potts, T. B. Redding, William Tarn, John Terry, and W. H. Walmsley.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE 1884.

TRANSACTIONS OF THE SOCIETY.

VIII.—*On the Estimation of Aperture in the Microscope.*

By the late Charles Hockin, jun.*

(*Read 14th June*, 1882.)

Plate VII.

I have read with much interest the papers by Prof. Abbe and Mr. Crisp on the aperture of Microscope objectives, in which is shown the great increase in aperture obtained with immersion over dry objectives.

It is not a little strange that at a date so long subsequent to the introduction of immersion objectives, any microscopist should be found maintaining that it is impossible for an immersion objective to have an aperture in excess of that of a dry objective of 180°. As, however, this has been asserted (and apparently seriously), it may be worth while to add a few observations to those contained in the papers referred to, the form in which Professor Abbe has put both his definition of numerical aperture and also his proof of the identity of his formula for numerical aperture with his definition, allowing of further elucidation, and from a somewhat different point of view.

Professor Abbe defines the numerical aperture of an objective as "the ratio of the linear semi-opening to the focal length." This ratio is expressed in his notation by $n \sin u$, where u is half the aperture-angle of the objective, and n the refractive index of the medium in which the object is placed. In the proof of the identity of the formula $n \sin u$ with the definition, Professor Abbe has been as concise as possible, referring to other works for the demonstration of all those formulæ of which he has need, which have been already published; so that the exact sense of the terms used in the definition comes out only in the course of the demonstration.

* This paper has been delayed in publication in consequence of the lamented death of the author, and the want of two of the diagrams, now supplied. The late Mr. Charles Hockin, jun., was an electrician and mathematician of considerable repute, and was a high Wrangler of his year.

Professor Abbe remarks that his expression for aperture represents the "number of rays," and not only the amount or "mere quantity of light" admitted by the objective and utilized for the formation of the image. The "number of rays" and "quantity of light" are distinguished in the course of his demonstration, as I understand it, by the fact that the first is measured in one dimension of space, and the second in two dimensions.*

Prof. Abbe's definition of aperture may, I think, be treated as a strictly photometrical one, and that it expresses the relation of the total amount of light utilized by an objective of given magnifying power in an axial plane to the total amount of light emitted by an object supposed to be *in air* and *under a fixed illumination.*

The object is also supposed to be a small portion of a plane surface.

That this is the case appears from the assumption made by Prof. Abbe that the pencils of light of *small* angular aperture, which proceed from the objective to the image, are properly measured by their breadth at a fixed distance from their point of convergence. This assumption involves evidently the condition that the pencils of light in question have the same intensity over their breadth, and this condition is fulfilled approximately only if the object is nearly plane.

All this will appear, perhaps, more clearly in the course of the following demonstration which, following the lines of Prof. Abbe's proof, is somewhat more detailed, and supplies demonstrations of certain of the formulæ which Prof. Abbe omits as too well known to require further illustration.

Lemma.—An instrument collects all the rays that emanate from *some one point* in its axis in front of the instrument (and which are contained within a certain finite angle), and causes them to converge accurately to a point in its axis at the back of the instrument, and further collects, under similar restrictions, all rays from a second point in front of the instrument, indefinitely near the first and situate in a plane normal to the axis of the instrument and passing through the first point, and causes them also to converge accurately to a second point behind the instrument, lying in a plane normal to the axis, and passing through the point of convergence of rays incident from the first point.

Then the sine of the angle that any ray incident on the instrument from the first point mentioned makes with the axis, bears a constant relation to the sine of the angle that the corresponding emergent ray makes with the axis.

Let P, Q be the foci of incident and p, q the corresponding foci

* [See Note by Prof. Abbe, *infra*, p. 346.—Ed.]

of emergent rays; P Q and $p\,q$ being indefinitely small (Plate VII. fig. 1).

Let P S p s, Q S q s represent the course of two rays through the instrument, and let n, n' be the refractive indices of the media in which P Q and $p\,q$ respectively lie.

Then because every ray from P passes through p we must have

$$n \,.\, \mathrm{P\,S} - \overline{\mathrm{S}\,a\,s} - n'\,p\,s = \text{a constant for every ray through P;}$$

also

$$n \,.\, \mathrm{Q\,S} - \overline{\mathrm{S}\,b\,s} - n'\,q\,s = \quad ,, \quad ,, \quad ,, \quad \mathrm{Q.}$$

Here $\overline{\mathrm{S}\,a\,s}$ and $\overline{\mathrm{S}\,b\,s}$ represent the "reduced path" of the rays between S and s, or the sum of the product of the lengths traversed in each medium they pass through by the refractive index of each medium.

Again $\overline{\mathrm{S}\,a\,s} = \overline{\mathrm{S}\,b\,s}$ because these two rays start from and end at the same point and make an indefinitely small angle with each other.

$$\therefore \quad n\,(\mathrm{P\,S} - \mathrm{Q\,S}) - n'\,(p\,s - q\,s) = \text{constant},$$

or, in the limit, if u, v are the angles that S P and $s\,p$ make with the axis,

$$n \,.\, \mathrm{P\,Q} \sin u - n'\,p\,q \sin v = \text{constant} = 0 \text{ because } u \text{ and } v \text{ vanish together.}$$

Again, if N is the magnifying power of the instrument,

$$p\,q = \mathrm{N} \,.\, \mathrm{P\,Q}$$

and

$$n \sin u - n'\,\mathrm{N} \sin v = 0$$

$$\frac{\sin u}{\sin v} = \frac{n'\,\mathrm{N}}{n} \quad . \quad . \quad . \quad . \quad . \quad . \quad \mathrm{A.}$$

Had we assumed that rays from P converged to p, and that rays from P′ converged to p' where P′ and p' are points near P and p, but situate in the axis, we should have found

$$\frac{\sin \frac{u}{2}}{\sin \frac{v}{2}} = \sqrt{\frac{\mathrm{M}\,n'}{n}} \quad . \quad . \quad . \quad . \quad . \quad \mathrm{B},$$

where M is the ratio of the distances of two points measured in the direction of the axis to the distances of their images.

It is clear that the two laws A and B cannot hold at the same time unless $u = v$, and then $\mathrm{N} = \mathrm{M} = \frac{n}{n'}$ and the instrument has

no considerable magnifying power (it becomes in fact a plane mirror when $n = n'$).*

Now a Microscope has very little "depth of focus," that is to say two points P and P′ are not in focus at the same time; but it does give, by means of wide-angled pencils, a clear image of the central portion of a small plane object when placed at a certain position and normal to the axis.

The law A must therefore be nearly true for a good Microscope.

Law B will then hold approximately for small values of u and v and yields the condition

$$M = N^2 . \frac{n'}{n} \quad . \quad . \quad . \quad . \quad . \quad . \quad C.$$

This being premised, the aperture of the instrument is effectively defined by Prof. Abbe, as the number of rays that it admits in a plane passing through the axis of the instrument from a plane standard object supposed in air. Further, the number of rays emanating from an object or converging to the image are counted by the angular breadth of the pencils of light emanating from, or converging to, each small element of the object or image multiplied by the linear dimensions of the object or image—it being supposed that the pencils have small angular breadth and are of the same intensity throughout.

In other words, *the aperture is proportioned to the square root of the quantity of light admitted by the objective under the given conditions.*

Apply this definition of aperture and the convention of counting rays to the telescope. If the method is a rational one it must yield the same result whether the rays are counted as they enter the objective or as they converge to the image.

In the case of the astronomical telescope we are dealing with objects subtending always a small angle at the instrument, of unknown absolute dimensions in many cases, and always so distant that the light proceeding from them is of equal intensity over an area indefinitely larger than that covered by any instrument.

The dimension of the object in this case must therefore be measured by the angle that it subtends at the observer's position.

Referring to law A, it can readily be shown that, if P Q is

* *Note by Prof. Abbe:*—Mr. Hockin's new demonstration of the law of the sines is remarkable for its simplicity and generality; at the same time it includes a very simple and clever demonstration of a proposition, which I signalized in the article "Die Bedingungen des Aplanatismus," that a system of lenses which collects *wide*-angled pencils, *cannot* be aplanatic for a continuous row of foci along the axis, but can have only *isolated* pairs of conjugate *aplanatic* foci.

supposed to recede from the instrument while subtending a constant angle at some point near the instrument, the form that the equation ultimately takes is

$$n \,.\, d \,.\, \alpha = n' \,.\, p\,q \,.\, \sin v \quad . \quad . \quad . \quad . \quad . \quad \text{A}';$$

or since, in the present case, $n = n'$,

$$d \,.\, \alpha = p\,q \,.\, \sin v,$$

where d is the distance of any ray incident parallel to the axis from that axis, and α the angle that P Q subtends.

Fig. 2 represents this case.

Law A′ put in a geometrical form shows that the directions of any incident ray and the corresponding emergent ray cut on the surface of a circle centered at the image.

In practice the radius of the circle is so large in comparison with the diameter of the objective that v is always a small angle and v, sin v, and tan v for our present purpose may be treated as equal.

In the figure the equidistant parallel lines from a to b represent the direct incident pencil of uniform intensity, and the lines from a' to b' converging at C the corresponding emergent pencil. The directions of these rays meet within the objective on the circle $c\,d$ of large radius. The consecutive lines between a' and b' therefore make nearly the same angle with each other, and the light is nearly uniform in the pencil a' C b'.

The direct pencil only is drawn, but as the object subtends always but a small angle at the instrument, the breadth of all incident pencils may be treated as equal, and the total number of rays incident on the objective is measured on the convention adopted by

$$d \,.\, \alpha$$

where d is the diameter of the objective.

Counting the rays emergent from the objective, they consist of pencils of angle $\frac{d}{f}$ and converge to a line of length $p\,q$; their number on the convention is therefore

$$p\,q \cdot \frac{d}{f},$$

where f is the focal length of the instrument; or, since

$$p\,q = f \,.\, \alpha,$$

the number of the rays $= d \,.\, \alpha$, the same expression as before, and d represents the number of rays received from an object of unit angular dimensions and is the recognized measure of the aperture of the instrument.

Now apply the same method to the aperture of the Microscope. The instrument is suited for viewing at one time a small plane object, and a small plane disk must be taken as standard object. Again, this object may be in air or in some other medium, and a method of counting the rays must be adopted that will yield the same result whether they are counted in air or in any other medium through which they may pass. Let P Q be a section of a small body in a medium of refractive index n, $p\,q$ its image in a medium of index n', A B a small portion of the surface bounding the media, and C the centre of curvature of the arc A B (fig. 3).

The rays coming from P Q are measured by a number proportional to

$$\mathrm{P\,Q} \times \angle^{e}\mathrm{A\,P\,B},$$

and equal, suppose, to

$$\mathrm{A} \times \mathrm{P\,Q} \times \angle^{e}\mathrm{A\,P\,B}.$$

The same rays reach $p\,q$, and in the medium n' they are measured by $a \times pq \times \angle^{e}\mathrm{A}\,p\,\mathrm{B}$, and these two expressions are to be the same.

$$\therefore \quad \frac{\mathrm{A}\,.\,\mathrm{P\,Q}\,.\,\angle^{e}\mathrm{A\,P\,B}}{\mathrm{A}\,.\,pq\,.\,\angle^{e}\mathrm{A}\,p\,\mathrm{B}} = 1 \quad . \quad . \quad . \quad . \quad . \quad 1$$

but

$$\mathrm{P\,Q} = \mathrm{A\,P} \times \angle^{e}\mathrm{P\,A\,Q} \quad . \quad . \quad . \quad . \quad . \quad 2$$

$$pq = \mathrm{A}p \times \angle^{e}p\,\mathrm{A}\,q \quad . \quad . \quad . \quad . \quad . \quad 3$$

Suppose P A to make an angle θ with the normal A C, and p A to make an angle θ' with the normal A C; then, as usual,

$$n \sin\theta = n' \sin\theta' \quad . \quad . \quad . \quad . \quad . \quad . \quad 4$$

Again, P A Q is a small increment of the angle θ and $p\,\mathrm{A}\,q$ is the corresponding increment of the angle θ'.

$$\therefore \quad n \cos\theta\, \angle^{e}\mathrm{P\,A\,Q} = n' \cos\theta'\, \angle^{e}p\,\mathrm{A}\,q \quad . \quad . \quad . \quad 5$$

also

$$\mathrm{A\,P}\,.\,\angle^{e}\mathrm{A\,P\,B} = \mathrm{B}\,n = \mathrm{A\,B}\cos\theta \text{ ultimately} \quad . \quad . \quad 6$$

and

$$\mathrm{A}p\,.\,\angle^{e}\mathrm{A}\,p\,\mathrm{B} = \mathrm{A}\,n' = \mathrm{A\,B}\cos\theta' \text{ ultimately} \quad . \quad . \quad 7$$

$$\therefore \quad \frac{\mathrm{A}}{\mathrm{B}} \cdot \frac{\mathrm{P\,Q}}{pq} \cdot \frac{\angle^{e}\mathrm{A\,P\,B}}{\angle^{e}\mathrm{A}\,p\,\mathrm{B}} = \frac{\mathrm{A}}{\mathrm{B}} \cdot \frac{\mathrm{A\,P}\,.\,\angle^{e}\mathrm{P\,A\,Q}}{\mathrm{A}p\,\angle^{e}p\,\mathrm{A}\,q} \cdot \frac{\mathrm{A\,B}\cos\theta}{\mathrm{A\,P}} \cdot \frac{\mathrm{A}p}{\mathrm{A\,B}\cos\theta'}$$

$$= \frac{\mathrm{A}}{\mathrm{B}} \cdot \frac{\cos\theta\, \angle^{e}\mathrm{P\,A\,Q}}{\cos\theta'\, \angle^{e}p\,\mathrm{A}\,q}$$

$$= \frac{\mathrm{A}}{\mathrm{B}} \cdot \frac{n'}{n} = 1,$$

or we may put

$$\mathrm{A} = n$$
$$\mathrm{B} = n',$$

and the number of rays in any medium is counted by the length of the object × angular breadth of the small pencils coming from it × refractive index of the medium under the conditions implied in what goes before.

To return to the Microscope: Law A applied and interpreted geometrically shows that the direction of any incident ray cuts the directions of the emergent ray on the circumference of a small circle centered a little behind the object, but so near it, that for purposes of illustration it may be supposed to be centered at the object.* Fig. 4 represents this case.

P Q being a plane, the intensity of the light emergent from it at any angle varies as the cosine of the angle that the ray makes with the axis. If then the diameter A B is divided into equal parts, and lines through the subdivisions are drawn parallel to the axis cutting the circle in the points between a and b, the unevenly distributed lines in the pencil a P b represent the distribution of light in the incident pencil, and the nearly evenly distributed lines in the pencil a' p b', the distribution of the light in the emergent pencil, which is seen to be nearly uniform.

The number of rays forming the half-image is therefore measured by $pq \times \angle^{e} a' p b'$

$$
\begin{aligned}
&= \tfrac{1}{2}\,\mathrm{N} \,.\, \mathrm{P\,Q} \,.\, \angle^{e} a' p b' \\
&= \tfrac{1}{2}\, 2\,\mathrm{N} \,.\, \mathrm{P\,Q} \,.\, \sin \tfrac{1}{2} a' p b' \\
&= \mathrm{N} \,.\, \mathrm{P\,Q} \,.\, \frac{1}{\mathrm{N}} \cdot \frac{n}{n'} \,.\, \sin a\,\mathrm{P}\,p \\
&\qquad \text{or since } n' = 1 \\
&= n \,.\, \sin \tfrac{1}{2} a\,\mathrm{P}\,b \\
&= n \sin u \text{ in the notation of law A.}
\end{aligned}
$$

This is Prof. Abbe's formula for aperture, and the proof of it which has been given will not, I think, be found to differ essentially from Prof. Abbe's proof.

The only difference is that the form "ratio of clear opening to focal length is omitted." This definition seems, at first sight, somewhat arbitrary, but when we see that this expression, interpreted as it is in Prof. Abbe's demonstration, expresses the *square root of the light admitted from a standard object under fixed*

* If l is the distance between the object and the image, the centre of the circle is situated at a distance $= \dfrac{l}{\left(\mathrm{N}\frac{n'}{n}\right)^2 - 1}$ behind the image, and its diameter $= 2\,l \times \dfrac{\mathrm{N}\frac{n'}{n}}{\left(\mathrm{N}\frac{n'}{n}\right)^2 - 1}$.

illumination, it becomes evidently a rational expression for aperture.

Of course, in the comparison of lenses numerically, the square of $n \sin u$ must be used just as the square of the diameter of an object-glass is the true measure of its light-admitting power.

It remains to be shown that the convention adopted for counting rays is not merely one adopted because it yields consistent results geometrically, but that it is founded on physical facts. For this Prof. Abbe refers to Clausius. English readers will find Prof. Clausius' memoir on radiation in the last memoir of his work on Heat, edited by Hirst (J. Van Voorst, 1867). The nature of Prof. Clausius' argument may be illustrated thus.

Referring to the diagram fig. 3, let P Q be a section of a small circular disk radiating heat, $p\,q$ the section of another disk similar in all respects to the first and its "optical image." Suppose also that both are at the same temperature.

Let I be the intensity of normal radiation from P Q, and i be the intensity of normal radiation from $p\,q$; then the quantity of heat sent from P Q to $p\,q$ in unit time is measured by

$$\mathrm{I}\,(\mathrm{P\,Q} \cdot \angle^{e}\,\mathrm{A\,P\,B})^2,$$

and that sent from $p\,q$ to P Q in the same unit time is

$$i\,(p\,q \angle^{e}\,\mathrm{A}\,p\,\mathrm{B})^2.$$

The ratio of these quantities is

$$\frac{\mathrm{I}}{i}\left(\frac{\mathrm{P\,Q}\,\angle^{e}\,\mathrm{A\,P\,B}}{p\,q \angle^{e}\,\mathrm{A}\,p\,\mathrm{B}}\right)^2,$$

and this has been shown to be equal to $\frac{\mathrm{I}}{i} \cdot \frac{n'^2}{n^2}$.

Now unless $\frac{\mathrm{I}}{i} = \frac{n^2}{n'^2}$ this expression must differ from unity, and so a greater amount of heat would be sent from P Q to $p\,q$ than is sent from $p\,q$ to P Q, or *vice versâ*.

In either case one of the bodies would be heated at the expense of the other, and we should have in a short time a hot body heated by a cooler one without the intervention of any mechanism doing work. This would be contrary to the second law of thermodynamics, that heat cannot of itself pass from a colder to a hotter body, a law which is found to hold whenever tested by direct experiment, and one which has never led to false conclusions when used in predicting the phenomena that should result from given conditions, of whatever degree of complexity these may be.

Prof. Clausius treats of radiant heat as the means of transfer-

ence of sensible heat from one body to the other, but the nature of the radiation is not of importance to the reasoning, and what is true of radiant heat is true of light in the case in question.

It follows that an object under given illumination will radiate more light when in a medium of refractive index n than in one in a medium of lower refractive index n' in the proportion of $n^2 : n'^2$.

This leads to the only point not considered in the preceding investigation.

The aperture was measured by the angular breadth of the pencils forming the image multiplied by the number of pencils.

The absolute intensity of the light in each pencil was not considered.

It is evident from equation A that if I is the intensity of normal radiation of the object, the light in a *small* central incident pencil of angular breadth a is measured by a number proportional to $\mathrm{I}\, a^2$ and this pencil has on emergence the smaller angular breadth $\frac{1}{\mathrm{N}} \frac{n}{n'} a$, and the intensity of the light is proportional to $\mathrm{I}\left(\mathrm{N} \frac{n'}{n} a\right)^2$. But as I itself has been shown to vary as n^2 the intensity becomes proportional to $\mathrm{N}^2 . a^2$ as $n' = 1$, or for a given magnifying power it is constant.

The result is that Prof. Abbe's formula squared does give the true aperture of the instrument measured by the amount of light used to form the image of a plane object under fixed illumination.

The same formula is also proportional to the resolving power of the lens, for consider a series of dark and transparent bands of small equal breadth $\frac{1}{2} l$, on a glass plane illuminated from below.

The light in any direction A P coming from A is reinforced by that coming from B when A P − P B is equal to a whole number of wave-lengths (fig. 5). This is first the case when A P − P B is one wave-length, say λ, or when $\mathrm{A\,B} \sin u = \lambda = l \sin u$.

But λ varies inversely as the refractive index of the medium and is equal to $\lambda' \frac{1}{n}$ say.

Then $$\lambda' = l\, n \sin u \quad \text{or} \quad l = \frac{\lambda'}{n \sin u};$$

therefore the greater $n \sin u$ may be, the less may l be, in order that the first pair of diffracted rays may enter the objective, and so form with the central pencil a pencil of finite angular breadth emergent from the objective and incident on the eye-piece, through the image of the object giving a defined representation of the object.

Hitherto plane objects only have been considered. When we deal with objects of other shape it is self-evident that angular aperture as such will have a marked influence on the appearance of the object, and whether that influence is useful or not, it must of course be taken into account in interpreting what is actually seen on viewing an object.

It would seem then that the "angular aperture" of an objective should be stated as well as the "numerical aperture." When it is known that a lens admits a pencil of such and such angular breadth from an object in a medium of given refractive index, the complete description of the lens is given in all qualities except magnifying power, though we still want the standard of comparison afforded by the numerical aperture notation. Take the case referred to by Prof. Abbe, say a cubical crystal of common salt. We do not see clearly at the same time the horizontal face of the crystal and its vertical sides, but by lowering the objective a narrow band on the four vertical sides is fairly focused, and by observing the apparent dimensions of this square band we are able to say that the crystal is a true rectangular parallelopiped at any rate. Moreover the clearness of the image of the band will depend evidently on the angular aperture of the lens.

Again, if oblique illumination is employed, what was at first symmetrical about the axis of the instrument is now symmetrical about an axis forming a definite angle with that axis, and so angular aperture will be important as such.

These considerations are perhaps too evident to require notice, but they appear to me to have some weight.

Lastly, it may be remarked that by law C the "depth of focus" in an immersion lens is greater than that of a dry air lens in the proportion of N : 1, by formula C.

Note by Prof. Abbe.

On the preceding paper Prof. Abbe writes as follows :—

I agree that the measure of aperture is a photometrical one *in principle*. But by the expression, "number of rays" as opposed to "*mere* quantity of light," I desire to convey that the bearing of the notion is not *confined* to the photometrical functions of the lenses. The expression "quantity of light" would imply the *intensity* of the rays, which must be *excluded* in the estimation of aperture, because a greater intensity does *not* compensate for a smaller angle in regard to "aperture"; whilst it *does* so in regard to quantity of light, and a *purely* photometrical measure would have to be based on the estimation of the rays in the whole cone, not only in a plane section. In that respect the difference is, in fact,

that the one is measured in one dimension, the other "in two dimensions," as is said by the author. The author makes the same difference: (1) by excluding the intensity of the rays, and (2) by introducing the square root of the photometrical equivalents of the angles as the measure of "aperture."

This being understood, I should agree that it is better to base the definition of numerical aperture upon photometrical principles directly, instead of on an indirect demonstration, by means of the ratio of linear aperture to focal length, which ratio should be considered as a secondary expression of aperture.

IX.—*Note on the Proper Definition of the Amplifying Power of a Lens or Lens-system.*

By Prof. E. Abbe, Hon. F.R.M.S.†

(*Read 12th March*, 1884.)

The generally adopted notion of "linear amplification at a certain distance" is in fact a very awkward and irrational way of defining the "amplifying power" of a lens or a lens-system. Unfortunately, there is little hope that a more rational expression will be generally adopted, because it will seem to be "too abstract," but it may, nevertheless, be useful to consider the following:—

In the formula $N = \frac{l}{f}$ the "amplification" of one and the same system varies with the length l, or the "distance of vision," and an arbitrary conventional value of l (e. g. 10 in. or 250 mm.) must be introduced, in order to obtain comparable figures. The actual "linear amplification" of a system is, of course, different, in the case of a short-sighted eye, which projects the image at a distance of 100 mm., and a long-sighted one which projects it at 1000 mm. Nevertheless, the "*amplifying power*" of every system is always the same for both, because the short-sighted and the long-sighted observers obtain the *image of the same object under the same visual angle*, and consequently the same real diameter of the retinal image. That this is so will be seen from fig. 48, where the thick lines show the course of the rays for a short-sighted eye, and the thin lines for a long-sighted one, the eye in each case being supposed at the posterior principal focus of the system.

The semi-visual angle u^* under which an object of semi-diameter h is seen, is the *same* for both observers, as the change resulting from the different positions of the object concerns only the *degree of divergence* of the various pencils from the various points of the object (and the image), and does not alter the refraction of the principal (central) rays from the various points.

This consideration leads to an expression of the "power" which is in conformity to the last-mentioned salient fact. The quotient

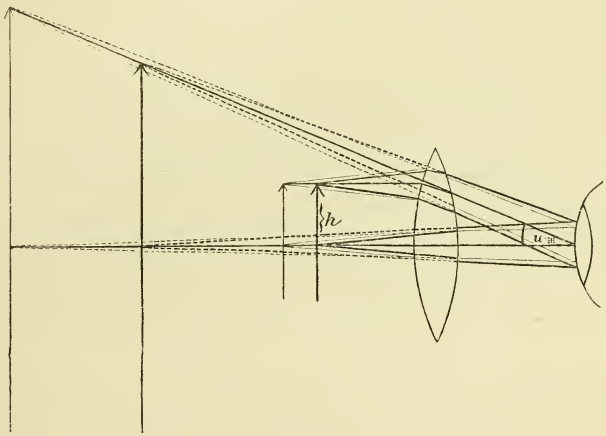
$$\frac{\tan u^*}{h},$$

where u^* is the semi-visual angle corresponding to h the semi-diameter of the object, is a constant quantity for every system, not depending on the particular circumstances of the observing eye; and this quotient indicates, obviously, the greater or smaller visual

† The original paper is written by Prof. Abbe in English.

angle, under which a given length h is displayed by the system to *every* eye. The numerical value of this quotient gives the tangent of the visual angle, under which the *unit of length* ($h = 1$) is shown through the system. This quotient, therefore—i. e. the ratio of tan u^* to h, or *the visual angle corresponding to the unit of length, measured by the tangent*—is the rational expression of the

Fig. 48.



magnification or "*power*" of an optical system, because *every* observer will see every object enlarged through different systems in the exact proportion of the value of that quotient.

From the fundamental definition of the "equivalent focal-length" of a lens-system results the identity of the above-mentioned quotient with the reciprocal value of f (focal length): we have

$$\frac{\tan u^*}{h} = \frac{1}{f}.$$

Consequently the reciprocal of the focal length of a system is, by itself, the proper expression of its amplifying power, because this reciprocal expresses numerically the visual angle (measured by the tangent) under which the unit of length appears through the system.

This very simple expression of the amplifying power of a lens-system is a strict one, it is true, under the supposition only which was mentioned above, that the place of the eye be at the posterior principal focus of the system, or, what is the same thing, that the *principal* rays from the various points of the object cross at that focus.

As far as the compound Microscope is in question, no other

case needs to be considered. For the "eye-point" of the Microscope coincides, practically, with the posterior principal focus of the total system. With a hand-magnifier, however, the eye may change its place to some extent, and the crossing-point of the principal rays will therefore be subjected to deviations from the posterior focus of the system. In regard to this more general case the exact formula for determining the power of a system in the manner indicated above is

$$\frac{\tan u^*}{h} = \frac{1}{f}\left(1 + \frac{d}{l}\right) = \frac{1}{f} + \frac{1}{f} \cdot \frac{d}{l},$$

in which l denotes once more the distance of distinct vision of the observing eye, and d the deviation of the said crossing point, or the place of the eye, from the posterior focus. (d must be introduced with positive sign if the focus is behind the eye, and with negative sign if it is in front.)

According to this general formula the exact ratio of the visual angle to the linear magnitude of the object is expressed by a principal term $\left(\frac{1}{f}\right)$, which is independent of all particular circumstances, and an additional term $\left(\frac{1}{f} \cdot \frac{d}{l}\right)$ which varies with the position and the accommodation of the observer's eye. As in all practical cases $\frac{d}{l}$ will be a small fraction, the additional term indicates merely a small correction, and this correction alone depends on the distance of vision and the place of the eye. The simple reciprocal of the focal length will therefore afford in *all* cases a proper measure of the amplifying power of a lens-system, because it expresses *that* component of the amplifying power which is inherent in the system itself, and independent of the variable circumstances under which it may be used.

The other generally adopted expression of the power by $N = \frac{l}{f}$ may be put on a *somewhat* more rational basis than is generally done, by defining the length l (10 in.) not as "distance of distinct vision," but rather as "distance of projection of the image." As far as "distinct vision" is assumed for determining the amplification, the value of N has no real signification at all in regard to an observer who obtains distinct vision at 50 in. instead of 10 in., and in fact many microscopists declare the ordinary figures of amplification to be useless for them, because they cannot observe the image at the supposed distance. It appears as if—and many have this opinion—the performance of the Microscope in regard to magnification depended *essentially* on the accommodation of the observer's eye.

This misleading idea, resulting from the common expression, is eliminated by defining the 10 in. merely as the distance from the eye at which the image is measured—*whether it be a distinct or an indistinct image*. For if an observer, owing to the accommodation of his eye, obtains a distinct image at a distance of 10 feet, I may nevertheless assume a plane at a distance of 10 in. from the eye on which the distant image is virtually projected, and measure the diameter of that projection. Now this diameter is strictly the same as the diameter of that image, which another observer would really obtain with distinct vision at that same distance of 10 in. The only difference is, that in the former case we must take the centres of the circles of indistinctness instead of the sharp image-points in the latter case.

If the conventional length of $l = 10$ in. is *interpreted* in *this* way (as distance of projection, independently of distinct vision) the absurdity at least of a *real* influence of the accommodation on the power of a Microscope is avoided. It becomes obvious, that for long-sighted and for short-sighted eyes the same N must indicate the same visual angle of the enlarged objects, or the same magnitude of the retinal image, because it indicates the same diameter of the projection at 10 in. distance. (See fig. 48.)

X.—*On Certain Filaments observed in Surirella bifrons.*

By John Badcock, F.R.M.S.

(*Read 9th April*, 1884.)

On the 5th April I collected some very fine diatoms from the noted Keston bog, among which examples of *Surirella bifrons* were very conspicuous, both by their abundance and size, and also by their very clean and active condition.

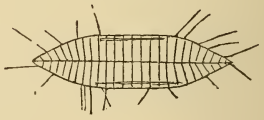
Selecting one for special attention, I noted that in its passage across the field it would occasionally *pass close to* certain small collections of vegetable débris (but without actual contact), when these small matters seemed to be caught by some projecting filament from the diatom, by which they were carried along with it for some distance. Then the diatom would free itself, but, coming in contact in the same manner with other similar material, the same thing would happen again.

Observing this very often with only a 2/3 in. objective, I tried a higher power. With the 1/4 in. I could not discover any more than before the cause of the phenomenon. At length, however, with a 1/2 in., which had been altered for use with the binocular arrangement, I discovered certain fine filmy processes projecting irregularly from the diatom, and which appeared to have caused this disturbance. Further and repeated observation confirmed my conviction of a correspondence between these projecting filaments and the disturbances noted, the significance of which could not be mistaken.

I now called my son, and asked him if he saw anything exceptional, and to sketch it for me. This he did, as shown in figs. 49 and 50. The filaments were seen repeatedly and very dis-

Fig. 49.

Fig. 50.



tinctly by both of us, whether the front or the side of the diatom was in view.

My attention was not confined to *one diatom* only. The appearance showed itself in many, but not in all, and there was a very perceptible difference in its development in different specimens.

I had been observing some *Arcellina* from the same gathering

in which the *Surirella* were found, and was struck with the similarity between the filmy projections in *Arcella difflugia* with those of the diatom. Although those of the *Arcella* were much larger, yet the fine *non-granular* character was the same, as also their variableness and irregularity. They were simply as fine pencil shadings or smoke-like semi-transparent films, which in the *Arcella* were larger and of a more pronounced character than in *Surirella*, yet of the same amœboid nature in both.

As I was thus led—accidentally as it were—to compare these two forms of life, it seemed to me that the only *essential* difference between them was one of size. In this light one could hardly regard the diatom as of the vegetable kingdom pure and simple. However, my object is not to raise this vexed question of animal or vegetable nature, but simply to put on record my observation of these filmy protuberances as corroborative of previous observations made and recorded by other and more eminent workers in this department, but which of late years have been generally either ignored or considered as of no special significance.

I will only say that had I not seen a diatom before, or known anything of its classification, I should certainly have regarded this *Surirella* as a testaceous *Amœba*.

The special optical power and arrangement necessary to see this phenomenon in the diatom may be a subject of interest. I have only one objective with which I can see it distinctly (a 1/2 in.). It was strange and inexplicable to me that neither a higher nor lower power revealed it.

Now, whether there is any physiological problem involved, or any special relation between the structure of the eye and this particular optical power, may be a question worth further investigation by those competent to undertake it. I merely throw it out as a suggestion, which may or may not be worth anything. One thing is, however, desirable, and that is that such special aids should be sought as would enable any one readily to verify such observations for himself, for it seems certain that disputes arise and contradictions are made which a little more attention to this point would probably prevent.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Contributions to the History of the Constitution of the Ovum.†—In this report C. Van Bambeke discusses the relations of the germinal vesicle to the periphery of the yolk. He finds that under the influence of certain reagents, the young ovarian eggs of bony fishes (*Leuciscus*, *Lota*) exhibit the presence of a membranous pouch, which incloses the germinal vesicle, and is attached to the periphery of the yolk. In *Leuciscus* the peripheral portion has the form of a nucleiform body (vitelline nucleus?), the long axis of which lies parallel to the surface of the egg. The apparent striation between this nucleiform body and the germinal vesicle is due to the folds of membrane; and it is probable that the arrangement described and figured by Schäfer as obtaining in the ovarian egg of the rabbit is of the same character. The pouch in question may be considered as a limiting layer, or condensation of the cellular reticulum, which, in the normal state, separates the internal from the external vitellus, to use the nomenclature of Pflüger; the nucleiform body will then correspond to the internal yolk. This disposition of parts has perhaps some relation to the maturation and fecundation of the egg, inasmuch as it may be the passage by which the directive corpuscles escape to the exterior, and the fecundating spermatozoon enters to unite with the female pronucleus. Further researches are necessary to decide whether there is any relation between the division of the yolk into two zones, and the mode in which the yolk-elements are deposited within the egg. The union of the nucleus with the periphery of the cell, which has

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Bull. Acad. R. Belg., vi. (1883) pp. 843–77 (1 pl.).

been observed by Leydig in various animal cells, and by Schäfer in the young ovarian ova of the fowl, seems to be a different phenomenon; for there is not then any limiting layer, nor any folds of membrane, but rather a condensation of the cellular reticulum.

The author is unable at present to say certainly what bearing his observations have on those lately made by Balbiani, Fol, and others, which have only come to his knowledge since his paper was completed.

Origin of Metameric Segmentation.*—In this suggestive essay A. Sedgwick discusses the origin of the metameric segmentation and some other morphological problems. To the hypotheses which he has already suggested—that the mouth and anus in most of the higher groups have been derived from some such elongated opening as is now seen in the Actinozoa, that the somites of segmented animals are derived from a series of pouches of the archenteron comparable to the pouches now found in Actinozoid polyps and Medusæ, and that the nephridia are derived from specialized parts of these pouches—he now adds a fourth, that the tracheæ are not developed from cutaneous glands of a worm-like animal, but are rather to be traced back to simple ectodermal pits, represented to-day by the subgenital pits of the Scypho-medusæ, by the pits into the cephalic ganglia of Arthropod embryos, and by the canal of the central nervous system of the Vertebrata.

It is pointed out that the essence of all these propositions lies in the fact that the segmented animals are traced back not to a triploblastic unsegmented ancestor, but to a two-layered Cœlenterate-like animal with a pouched gut, the pouching having arisen as a result of the necessity for an increase in the extent of the vegetative surfaces in a rapidly enlarging animal. In framing these hypotheses, support is found in facts of exactly the same nature as those which have been used in tracing the evolution of the nervous and muscular tissues.

The difficult problem of the homology of the mouth and anus with the mouth of the Cœlenterata is first attacked; their mode of development is shown to be coincident, and their relations to the archenteron and the neural surface of the body to be similar. The fact that in various higher forms the blastopore gives rise in some to the mouth and in others to the anus is to be explained by the supposition that the blastopore primitively gave rise to both mouth and anus, and that its specialization as a larval organ has caused the variability of its subsequent history. This doctrine is supported by the characters of the mouth of the existing Actinozoa where the two ends are open and the middle closed, and by the fact that in the primitive *Peripatus* the elongated blastopore does give rise to both mouth and anus. If this be true, it follows that Balfour was right in thinking that the stomodæum and proctodæum are not in all cases completely homologous.

The common ancestor of the Triploblastica and Actinozoa may be supposed to have been a diploblastic bilateral form with an enlarged oral surface, and an elongated mouth which, by the adhesion of its

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 43–82 (2 pls.).

middle portion, was functionally divided into two openings; the nervous system was distributed in the ectoderm over the whole body, but was probably especially concentrated on the oral surface.

The view that an enterocœle was derived from one pair of archenteric pouches has been given up since Hatschek discovered that, in *Amphioxus*, a series of diverticula are formed; the similarity between the embryo of *Amphioxus* and an Actinozoon polyp suggests that the mesoblastic somites of segmented animals are derived from a diploblastic cœlenterate-like ancestor with folded gut-walls, and the Cœlenterata differ only from segmented animals in that the alimentary or archenteric pouches (mesoblastic somites) and the alimentary canal do not become separate. Connected with this absence of a distinct cœlom is the low state of differentiation of such cœlomic structures as the excretory organs, and the absence of a separate vascular system.

Sedgwick is of opinion that the excretory organs were not at first used for the excretion of nitrogenous waste products, but for the riddance of the undigested and solid excretory products, and that this process was at first intracellular. Pores are certainly found in the Diploblastica; the circular canal of the Medusæ may be easily conceived as becoming the vertebrate segmental ducts, and a temporary longitudinal canal has been observed by Hatschek in *Polygordius*. The gill-slits are regarded as being serially homologous with nephridia.

The author concludes the first half of his paper by pointing out that his object has been to show that the majority of the Triploblastica are built upon a common plan; that that plan is revealed by a careful examination of the anatomy of Cœlenterata; that all the most important systems of organs of those Triploblastica are found in a rudimentary condition in the Cœlenterata, and that all the Triploblastica referred to (Annelida, Arthropoda, Mollusca, Vertebrata, *Balanoglossus*, *Sagitta*, and the Brachiopoda), must be traced back to a diploblastic ancestor common to them and the Cœlenterata.

In the second part Sedgwick applies his hypothesis to the just mentioned groups; from the ideal ancestor, a little more advanced than the common Cœlenterate ancestor, two stocks branched off. In one, the Invertebrata, the mouth and anus (which soon became separated) remained on the neural surface, and a præoral abneural lobe was developed which, being carried first in movement became specially sensitive. In the other stock the mouth and anus became terminal and a projection on the neural surface of the body overhung the mouth; this is the stock of the Vertebrata and of *Balanoglossus*. The further changes in the two stocks are next discussed, but space will not permit of our following the author.

In conclusion there are some observations on the structures known as primitive streaks; these are always connected with the formation of the mesoblast, are not found in free larvæ, are always median and unpaired, are always caused by rapid proliferation of cells, and vary in position in different animals. The differences which obtain are at present very difficult of explanation, but one is perhaps to be found in the supposition that owing to the early specialization of the enteron the mesoblast has to be formed in some other than the primi-

tive mode, and the proliferating cells of the streak do nothing else than divide and give origin to the mesoblastic bands.

In the newt the blastopore appears to persist as the anus, but examination of sections is still necessary to make this point certain.

Gastræa Theory.*—O. Bütschli criticizes the theories of Häckel, Lankester, and Metschnikoff, and puts forward some new views concerning the origin of the Metazoa.

The primitive form of the Metazoon is, according to this view, a two-layered disk, which may be termed a *placula*, and which is supposed to have originated from some such form as *Gonium*, a genus of Volvocineæ, consisting of a flat disk made up of many cells arranged in one layer. It may readily be imagined that this one-layered cell-aggregate soon undergoes differentiation, one side serving especially for locomotion, and the other for nutrition; and that these functions become localized one in each layer of the placula. Some difficulties arise about the way in which the gastrula takes its origin from this two-layered placula, but the clue is to be found in the development of certain nematodes: in *Cucullanus* and *Rhabdonema* the result of the egg-cleavage is the formation of a two-layered embryo exactly similar to the hypothetical placula; in many other animals, e. g. *Lumbricus*, which undergoes a developmental stage similar to that just described, a segmental cavity is formed between the two layers and the embryo becomes a blastula; in other animals the segmentation cavity is more highly developed and we get a typical blastula; these facts indicate that the blastula is not so ancient a developmental stage as the flat two-layered embryo of the Nematodes.

This two-layered placula reaches the gastrula form by a growing together of the two ends, and the reason for this process of growth is the hollowing out of the endoderm layer to form a receptacle for food, which would evidently be of advantage to the animal; also the approximation of the endoderm cells would also enable the animal to seize larger masses of food. This theory, therefore, renders intelligible the origin of the gastrula form, which the previous theories do not.

The marine organism *Trichoplax adhærens* recently described by F. E. Schultze, is a placula, and its discovery, Bütschli considers, lends great support to the theory advocated in his paper.

Changes of the Generative Products before Cleavage.†—M. Nussbaum describes his account of the changes undergone by the generative products prior to the cleavage of the ovum as an essay on heredity. He commences with an account of the copulation and development of the genital products of *Ascaris megalocephala*. Attention is directed to the absolute similarity between the early stages of either sex, and it is pointed out that both the primitive ova and the spermatogonia increase by indirect division of the nucleus; all stages of this process may be observed. Later on, changes are to be observed in both the nucleus and the cell-body; granules deposited in the proto-

* Morph. Jahrbuch, ix. (1884) pp. 415-27.

† Arch. f. Mikr. Anat., xxiii. (1883) pp. 155-213 (3 pls.).

plasm constantly increase in size, and the spermatocytes seem to be undergoing division; the later stages of the development of the spermatozoon are marked by the increase in number and fusion of the large refractive bodies, which, at first small and hard to count, end by forming a highly refractive body. As is well known, the spermatozoa of the Nematoids are not provided with a single tail; there are rather long, pseudopodioid tentacles, which are, at the body temperature of the host, actively mobile, and which consist of a hyaline ground-substance with finely granular deposits.

The only point of resemblance in the modes of development of the ova and spermatozoa (after, of course, the very earliest stages) lies in the fact that both kinds of genital products are disposed radially around a central rachis. The germinal vesicle becomes irregular in form, as the ovarian tube increases in thickness; the germinal spots become grouped into two or three grains, which, later on, undergo various changes, whether the egg is fertilized or not. If the ova are treated with acetic acid or with a mixture of alcohol and ether, so as to extract the contained spheres and crystals, a trabecular structure is to be detected; this is of some importance, as it explains the decrease in the size of the yolk after fertilization.

As a result of a large number of observations, Nussbaum states that only one spermatozoon enters each ovum; the egg becomes smooth in contour, but at the point where the spermatozoon had entered the ovum is a little swollen; the changes undergone by the male element are fully described.

As soon as the ovarian and spermatic nuclei have united, cleavage commences. The colourable substance of the nucleus becomes arranged in filaments which gradually thicken and diminish in number. The ordinary spindle-shaped figure appears, and four chief filaments are to be made out. At the poles of the spindles there is a distinct radiation in the protoplasm. In these animals a large number of ova are never fertilized.

The theory of fertilization is next considered under the several heads of the entrance of the spermatozoa and their changes within the egg, the formation of the polar globules, and the appearance of the two nuclei in the fertilized ovum. The conclusion is arrived at that the act of fertilization in the simplest and in the most complicated organisms consists in the union of the identical parts of two homologous cells.

The inheritance of individual or transmitted peculiarities is regarded as being due to the influences exerted on the generative cells of the individual, for they are subjected to conditions which had a modifying influence on the ancestral organism.

The author finally discusses the part played by the different portions of the seminal cell, and comes to the following conclusions:—

The nucleus of every seminal cell is thickened, and is in all cases retained by the mature seminal body; in spermatic filaments it forms the head. During impregnation of the ovum, the modified nucleus fuses with the ovarian nucleus. The protoplasm of the seminal cell forms the covering of the "head," the median portion,

and, where such are present, the processes of the spermatozoon; it either remains capable of amœboid movement or unites with the nucleus to form a ciliated cell. In many cases the rudiment of the investment of the "head" or of the median portion may be recognized as a secondary nucleus or a thickening in the protoplasm of the spermatocyte. This investment of the head does not play any essential part in fertilization, and is, indeed, ordinarily got rid of before the spermatozoon passes into the egg; when it does pass into the egg it becomes mixed up with the yolk like the other parts of the seminal body that are derived from the protoplasm of the spermatocyte.

Development of Spermatozoa.*—A. Swaen and H. Masquelin contribute a short abstract of results derived from a study of the development of spermatozoa; the types investigated were certain Selachians, the salamander, and the bull. The epithelium of the testicles of these animals is formed by two distinct types of cells, (1) "male ovules," (2) cells of the follicles; the former give rise to the spermatozoa in the following way: each of the cells divides and forms a number of small cells—the spermatocytes, which always remain united by a portion of the protoplasm of the mother-cell which persists as intercellular substance; the whole group of spermatocytes may be termed a spermatogemma; the spermatocytes are gradually metamorphosed into spermatozoa, being termed in the intermediate stages nematoblasts, the spermatogemma becoming therefore a nematogemma. During the course of development the spermatocytes and especially the nematoblasts are grouped in different ways, varying in the different types of animals studied, but finally unite into bundles of spermatozoa, in which all the elements are arranged parallel to each other.

The follicular cells form an envelope, which may be more or less complete and last for a longer or shorter time, to the male ovules and the spermatogemmæ; later they become fused with the intercellular substance of the nematogemma, and are no doubt actively concerned in the varied grouping of the nematoblasts, and also in the expulsion of the completely developed spermatozoa. Comparing the development of the spermatozoa and ova, the following similarities and differences may be noted; in both there is an ovule surrounded by a more or less complete layer of follicular cells; in the ovary this cell developes at once into the ovum, and the follicular cells multiply actively; in the testicle the ovule developes by indirect division, while the follicular cells hardly multiply at all, and more often increase in size.

The paper concludes with a more detailed description of the process of development in the several types.

Human Embryo.†—H. Fol makes an important contribution to our knowledge of the structure of the human embryo, obtained from the study of an embryo 5–6 mm. in length and probably about

* Bull. Acad. R. Belg., vii. (1884) pp. 42–51.
† Arch. Sci. Phys. et Nat., xi. (1884) pp. 93–5.

three weeks old; his results gain additional interest from the fact that no embryo of this age has ever been before examined.

The branchial clefts, three in number, were of a very complex form; the second, lying between the hyoidean and first branchial arch, was entirely open; the third descends in the form of a pouch on the sides of the tracheal artery; the origin of the thyroid gland is in front of the base of the tongue; the pancreas is represented by a short cœcum directed dorsally; the presence of a commencing rudiment of this organ is interesting from the fact that it has not been discovered yet in larger embryos as long as 7 mm.; the ureters open on the ventral side of the cloaca, and not dorsally as has been erroneously stated; two pairs of branchial arteries are present, the hyoidean and the first branchial, as well as an unpaired artery, up to the present unrecorded, which is given off from the aorta and accompanies the vitello-intestinal vessel; the heart as yet only shows two cavities; the posterior extremity of the body presents the appearance of a long tail, but it has no supernumerary vertebræ, in fact, not the full number, since the entire vertebral column only consists of thirty-three vertebræ.

Placentoid Organ in the Embryo of Birds.*—M. Duval directs attention to the sac which, in a chick, may be seen to be appended to the lower end of the umbilical vesicle. Sections of smaller ova show that both the outer and inner surfaces are formed by the chorion, and that the inner surface developes villous processes which are plunged into and absorb the mass of albumen; they are supplied with vessels from the allantois. Such an organ may, the author thinks, be well called a placentoid sac. After having played its part as an organ for the absorption of albumen, it undergoes atrophy. Duval thinks that the discovery of this sac shows new points of affinity between placental and aplacental forms, and that its special structure in the bird is due to the presence of a shell which forces the villi to be developed on the inner instead of on the outer surface of the chorion. While the inner surface has a nutrient the outer has a respiratory function, and therefore the sac is in all respects comparable to the placenta of the Mammalia.

Development of the Spinal Nerves of Tritons.†—M. Redot finds that, in Tritons, the spinal ganglion and the dorsal root of the nerve are formed by a prolongation of cells which arises from the upper part of the medullary tube and is never separated from it. The ventral root is developed later, and at the expense of the medullary tube; it is (from at first?) fibrillar in structure, and only becomes secondarily united with the spinal nerve. The author remarks that, although his conclusions differ from those of some very distinguished observers, he does not despair of finding them confirmed.

Poison of Batrachians.‡—G. Calmels finds in the poison of the toad a small quantity of methylcarbylamine, and describes the

* Comptes Rendus, xcviii. (1884) pp. 447–9.
† Arch. Sci. Phys. et Nat., xi. (1884) pp. 117–46 (1 pl.).
‡ Comptes Rendus, xcviii. (1884) pp. 536–9.

method by which it may be formed synthetically. In the newt the corresponding acid is contained in globules which have the microscopic appearance of milk-globules, but differ from them chemically by being soluble in water. The physiological properties of the poison of the salamander are the same as those of that of the scorpion, and resemble those which have been observed with amylcarbylamine. The author has not yet studied the poison of serpents, but he thinks that they have probably the same kind of constitution. The general biochemical mode of formation may be thus defined. Every amide-compound, whether simple or a peptone, may fix the elements of formic acid in the nascent state, and give rise to a carbyl-compound of toxic properties and unstable in composition. Every methyl group which is insufficiently destroyed by oxidation gives rise not to carbonic but to formic acid, and so furnishes the elements of the carbyl-compound.

Development of Lacerta agilis.*—H. Strahl gives a further account of the developmental process at the anterior end of the embryo of *Lacerta*. In a previous communication by the same author it had been pointed out that the head of the embryo consists up to a comparatively late period of ectoderm and endoderm only, the mesoderm being entirely absent.

Some of the more important results of the present communication are as follows:—The vascular area which is at first only developed at the sides of and behind the embryo grows forward and unites above the head to form a single oval disk; before this has taken place the cleavage of the mesoderm is visible in the anterior margins of the vascular area, and the fusion of the two cavities thus formed leads to the uniting together of the two sides of the vascular area. The larger anterior portion of the amnion is formed by growth from before backwards without any lateral folding of its ectodermic layer. The formation of the false amnion is very different from its formation in the chick; in the latter the folds of the splanchnic layer of the mesoderm and of the endoderm appear *before* the complete closure of the amnion, while in the embryo of *Lacerta*, these same folds which inclose the embryo, and may therefore be termed the false amnion, appear *after* the closure of the amnion. Another difference between the embryo chick and the embryo lizard is to be found in the relation between the closure of the body-cavity and the closure of the head intestine; in *Lacerta* the body-cavity closes almost immediately after the closure of the intestine, while in the chick the ventral sides of the body-cavity remain separate from each other long after the closure of the intestine. The twisting of the embryo on to the left side causes a like twisting of the anterior portion of the amnion, which is by this time entirely closed; at the posterior end of the embryo, where the two folds of the amnion have not yet become united, this twisting of the amnion does not take place, inasmuch as the left fold grows more rapidly than the right, and so the two, when they come to unite, remain in the same place as the egg membrane, and do not participate in the twisting of the embryo.

* Arch. f. Anat. u. Physiol. (Anat. Abtheil.), 1884, pp. 41–88 (2 pls.).

Development of Teleostei.*—C. Kuppfer continues his studies on the development of the Vertebrata, and treats of the Teleostei. Two varieties of trout were selected for study. The blastoderm on the eighth day presented a round area with a prominent knob at the posterior extremity (*Schwanzknospe*); in front of this lies the embryonic shield. The next step is an invagination upon the surface of the latter, exactly as in birds and reptiles, forming a longitudinal furrow which subsequently is crossed at right angles by another furrow; this transverse furrow is only a temporary structure, and presently vanishes, leaving only the longitudinal furrow; at the hinder end of the primitive streak, its margins unite to form a median axial band, which extends as far as the caudal knob. By the beginning of the twelfth day the primitive streak had disappeared, and the axial band a little wider at its anterior extremity occupied the middle line of the embryonic shield coinciding exactly with the anterior extremity of the primitive streak. The disappearance of the primitive streak coincides in point of time with the enclosure of half the yolk within the blastoderm; when the cells of the blastoderm pass beyond the equator of the egg, the primitive streak is entirely replaced by the axial band.

At the time of the appearance of the head, the axial band becomes slightly coiled; the "head" consists of the rudiment of the brain and eyes, and one pair of visceral arches; it is developed independently of the primitive streak; though the brain is continuous with the axial band, it is marked off from it by a constriction. The provertebræ which next appear are formed from the axial band, and the anterior ones are developed before the posterior ones; in many other Teleostei the first pair of protovertebræ are situated more in the middle and the process of growth extends forwards as well as backwards. No other pairs of visceral arches are developed in the neighbourhood of the first. The earliest rudiment of the spinal cord appears as a new formation upon the axial band, and is continuous with the brain; the central cavity of both, which is a secondary formation, commences in the eyes and passes down the brain into the spinal cord; this central cavity shows widenings here and there in the brain which do not correspond to the subsequently formed ventricles.

Influence of High Pressures on Living Organisms.†—P. Regnard has been able to make some experiments with a press giving a pressure of 1000 atmospheres; he finds that under such pressures as obtain on the bed of the ocean, plants, infusoria, molluscs, annelids, and crustacea fall into a somnolent condition, or one of "latent life"; fishes, when exposed to similar pressures, die. Experiments made show that muscles of the frog increase in weight after being subjected to a pressure of 400 atmospheres, but it is not yet known whether this change is chemical or physical.

Interesting points of resemblance are to be detected between these results and those obtained by the 'Talisman' deep-sea explorations;

* Arch. f. Anat. u. Physiol. (Anat. Abtheil.), 1884, pp. 1–40 (2 pls.).
† Comptes Rendus, xcviii. (1884) pp. 745–7.

Milne-Edwards has remarked that below 2000 metres the fauna changes. Observations should now be made on the characters of the animals that are brought up dead from great depths; the causes ought to be comparable, though of course of a converse nature, to those that operate on animals subjected to artificial compression.

B. INVERTEBRATA.

Intracellular Digestion of Invertebrates.*—E. Metschnikoff insists on the necessity of collecting physiological as well as morphological evidence before discussing the evolution of any system of organs. The author offers some answers to the question whether the lowest Metazoa have not retained the power of using any or all the cells of their body for the purpose of ingesting food, and commences with ingestion by ectodermal cells.

Sponges, unfortunately, are not well suited for observations on the activities of ectodermal cells, and as yet there is no very definite evidence in favour of intracellular digestion by the ectodermal cells of those Metazoa. If powdered carmine be suspended in the water surrounding a *Plumularia*, a considerable quantity will soon enter the substance of the ectoderm by the nectocalyces, which send out various kinds of pseudopodia; in some cases these may be seen eating up, by means of their ectoderm, the dying hydranths of a colony of *Plumularia*; the food thus taken in remains in the ectoderm and is not passed on into the endoderm. *Actiniæ* also exhibit ectodermal digestion, and gastrulæ have sometimes been observed which are asymmetrical in form and dirty in appearance, owing to the ingestion by their outer cells of a large quantity of foreign matter; the number of particles in the ectoderm diminishes as the gastric pouches become developed. Ectodermal nourishment may also be observed in the ovarian ova of animals whose generative cells are ectodermal, such as *Tubularia* and *Hydra*.

Wandering mesoderm cells perform intracellular ingestion and digestion not only in sponges, but in the larval forms of certain Echinoderms, where they digest the cellular débris of the disappearing organs, and phenomena of this kind are so constant among Echinoderms that they may be regarded as normal and necessary events in the life of their larvæ, where they play the same part as the osteoclasts of vertebrate bone. The author thinks that the same resorbent function is to be noticed in the larvæ of Ascidians, and may perhaps be found in Arthropods.

Metschnikoff has extended to *Aurelia aurita*, Schneider's observation of the resorption of generative products by amœboid cells in the Hirudinea. In attempting to define the extent of this property of intracellular digestion, the author has studied the transparent and hardy *Bipinnaria asterigera*, and *Phyllirhoe bucephalum;* giant cells appeared round foreign bodies injected beneath the epidermis, whether they were merely particles of carmine or a drop of human blood. In

* Arbeit. Zool.-Zoot. Inst. Würzburg, v. (1883) pp. 141-69 (2 pls.).

other words, in most though not in all cases we find that when mesoderm cells are confronted with a large mass of food-material which they cannot devour singly, they fuse into a plasmodium, which eats up the whole available food. Not only blood but milk also is absorbed by mesodermal cells, and further these cells appear to have some means of distinguishing between desirable and undesirable substances. The property of ingestion is not confined to the lower forms, for Koch has observed both *Bacillus anthracis* and the bacillus of septicæmia inclosed in white blood-corpuscles; the power of intracellular ingestion is, in other terms, used as a protection against harmful bodies which come to an organism from without. Septic organisms, then, must be a very old source of trouble, and some arrangements, such as the peculiar test of Ascidians or the nematocalyces of *Plumularia*, may owe their origin to their influence.

Metschnikoff hopes that the advances lately made by pathology will benefit zoology, which, in its turn, will help to form a comparative pathology based on the doctrine of evolution.

In a further communication* E. Metschnikoff discusses the ancestral history of the inflammatory process. He has lately applied the name of phagocytes to certain cells which have the power of ingesting and sometimes of absorbing food-particles; the intracellular absorption which goes on in the mesoderm of the Invertebrata, is found to obtain also in that of the Vertebrata. The tail of the Batrachia, during the early stages of its absorption, contains a number of cells, which, when left undisturbed, throw out fine radiating pseudopodia; these contained remnants of nerve-fibres and muscle-cells: phagocytes, then, play as important a part in the metamorphosis of Batrachians as of Echinoderms; and pathologists have afforded evidence of their agency in the so-called active degeneration of muscles and nerves.

A frog fed with bacteria was soon found to have them especially abundant in the phagocytes of the spleen, which, therefore, is probably a prophylactic organ, analogous in function to the nematocalyces of *Plumularia*. The author has tested in a *Triton* the theory he holds as to the phenomena of inflammation in invertebrates being primitively nothing more than a collection of phagocytes assembled to devour the exciting object; he touched a point of the tail of a *Triton* with a small piece of nitrate of silver, and then washed it with salt solution. Branched connective-tissue-cells collect round the inflamed spot, and eat up blood-corpuscles, carmine granules, and particles of pigment. In the frog there is evidently an active wandering of the white blood-corpuscles. When a fully gorged phagocyte dies, it is immediately devoured by another. Inflammation then is not, as is ordinarily supposed, due primarily to a morbid condition of the walls of the blood-vessels; it is a struggle between phagocyte and septic material, and it is in vertebrates alone that the vascular system, owing to the insufficient number of extra-vascular phagocytes, takes part in the struggle. The active passage of the white and the passive exit of the red blood-corpuscles is rendered possible by the changes in the cells of the walls of the capillaries due to the irritation set up by the poison.

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 112–7.

Mollusca.

Gustatory Bulbs of Molluscs.*—W. Flemming discusses the nature of the organs found on the tentacles of various molluscs which have the structure of gustatory bulbs. On the tentacles and marginal tactile organs of *Trochus cinerarius* the author has observed closely packed long papillæ, which are also scattered over the edge of the mantle and the head. In a fresh papilla there is an indistinct internal longitudinal striation which, on isolation, is seen to correspond to a central bundle of long cells; these cells are provided with fine short cilia, of which there are several on each cell; by far the largest part of the papilla is composed of epithelial cells. Gold-staining reveals the presence of primary nerves giving off a large number of lateral branches, sufficient apparently to supply each papilla with a terminal nerve. Structures of a similar character are to be found among the Lamellibranchiata.

The organs just described may, it is clear, be fairly compared with those which F. E. Schulze has spoken of as the gustatory organs of tadpoles, which are, likewise, freely projecting epithelial papillæ; nor do these, except in their position, differ essentially from the gustatory bulbs of mammals; the only important difference between the organs of the Mollusca and the Vertebrata is to be found in the fact that in the former the end-hairs of the central sensory cells project freely, while in the latter they still lie within the bulb; as, however, the ends of the hairs are, even in the latter case, in direct contact with the surrounding fluid, the difference is not one of much importance.

Although it is not certain that the end-organs described as existing in certain Mollusca have a gustatory function, yet Haller's suggestion to this effect has much to recommend it. From the point of view of developmental doctrines it is certainly of interest to observe that in some forms there are specific sensory organs at the very points where in most, and even in the most closely allied forms, there are only scattered ciliated cells. It is for the zoologist to extend the area of these observations.

Morphology of the Renal Organs and Cœlom of Cephalopoda.†—C. Grobben first deals with *Sepia officinalis*, then with *Eledone moschata*, and next treats of *Nautilus* in a comparative way. As is well known, the last-named cephalopod has four instead of two renal sacs, but it is not yet certain whether this arrangement is the more primitive or not. Those who regard *Nautilus* as phylogenetically the more ancient form would be naturally inclined towards the former view; against this, however, there are certain facts to which Ihering has already directed attention. That anatomist has pointed out that the anterior renal sac has no connection with the cœlom, and that, therefore, it is a structure which has not been reduced in the other or dibranchiate Cephalopoda; Grobben now suggests that it is an offshoot of the primitively simple, and in *Nautilus* posteriorly placed, kidney;

* Arch. f. Mikr. Anat., xxiii. (1884) pp. 141–7 (1 pl.).
† Arbeit. Zool. Inst. Wien, v. (1883) pp. 179–252 (3 pls.).

an explanation for its presence is to be found in the supposition that the renal sac underwent division in consequence of the development of the new gill and the correlated appearance of a second branchial artery.

If Grobben's view of the origin of the double kidney be correct, it follows that the two kidneys on either side of the body of *Nautilus* correspond to the single kidney of the Dibranchiata. The great cavity which contains the heart, stomach, and genital gland is, as Vigelius has already shown, the homologue of the secondary cœlom of the rest of the Cephalopoda; and it is a matter of fact that the development of this cavity is similar in *Sepia* and in *Nautilus*. The author agrees with Lankester and Bourne in regarding the pyriform appendage of Owen as the rudimentary genital duct of the left side.

The secondary cœlom of the other Mollusca is next discussed. It is shown that in *Sepia* this cavity is a large space which communicates with the kidneys by the two ciliated funnels, that it is lined by epithelium and contains in its anterior part the heart with its afferent and efferent vessels, the branchial hearts, and the pericardial gland; and in its hinder part the genital gland and the stomach. Between the two halves there is an incomplete septum. If we carefully bear in mind these relations, it is not difficult to discover the secondary cœlom of other molluscs. It may be seen both in Gastropods and Lamellibranchs, where the epithelial investment of the pericardium has already been detected by various observers. In the former (e. g. *Helix*) it contains the heart and its auricle, in the latter (e. g. Naiades) the heart and auricles and part of the intestine. This pericardium, however, is not the sole homologue of the secondary cœlom, the cavity of the genital gland must be also regarded as being originally a portion of it, just as it is permanently in *Sepia*.

Another organ which, in the Lamellibranchs, also belongs to the cœlom is the reddish-brown organ of Keber, which is made up of cæca lined by an epithelium which is a direct continuation of that of the pericardium. It may be regarded therefore as the homologue of the pericardial gland of the Cephalopoda and have the same name applied to it. It has probably an excretory function.

In the Solenogastres, as Hubrecht has already pointed out, the body-cavity is much reduced; the only modification to be made in his account is to include the cavity of the genital gland as part of secondary cœlom. In Chitons the space is larger and incloses part of the digestive tract.

After a summary of the views of preceding naturalists on the affinities of the Cephalopoda, Grobben states and expounds the view that *Dentalium* is the remnant of a primitive form from which the Cephalopoda took their origin. *Dentalium* resembles them in its only slightly disturbed bilateral symmetry, its elevated visceral sac, and in the development of the pallial cavity behind that sac; it differs especially in having the mantle cavity open above. Other resemblances are pointed out in detail. The characters of *Dentalium* justify the establishment of a separate group of Solenoconcha.

Grobben does not agree with those who regard the Pteropoda as

close allies of the Cephalopoda; he looks upon them rather as closer to the Gastropoda, and thinks that the most primitive Pteropods are those that are asymmetrical externally, the bilateral symmetry of a number of forms being due to their pelagic mode of life; other resemblances to the Cephalopoda are of an atavistic nature.

In conclusion, the question whether the Mollusca are "Pseudocœlia" or "Enterocœlia" is answered in favour of the latter view.

Procalistes: a young Cephalopod with Pedunculate Eyes.*—*Procalistes Suhmii*, which Prof. E. Ray Lankester describes and figures, is a young cephalopod with pedunculate eyes, whose general aspect closely resembles a clionid pteropod, for which, indeed, the late R. von Suhm, in his preliminary investigation of a living specimen, mistook it. The genus is similar to *Cranchia*, excepting that the eyes are pedunculate, that the shorter perioral arms are aborted, and that the longer (so-called prehensile) arms are devoid of suckers. In the youngest stage observed there are two rows of suckers on the long arms and six isolated and pedunculate suckers surrounding the mouth, which appear to represent the shorter arms of other cephalopods.

Gill in some Forms of Prosobranchiate Mollusca.†—H. L. Osborn describes the gill-structure of several genera (*Chiton*, *Fissurella*, *Fulgur*, *Sigaretus*, *Crepidula*, &c.) of Prosobranchiate Mollusca.

In *Chiton* and in *Fissurella* the gills are leafy blades attached to a rachis and joined to the body only for a short distance, the base of this rachis; in the prosobranchs generally the gill consists of independent plates, each one attached to the roof of the mantle cavity, and not placed upon a stalk and borne free from the mantle wall. The few forms which are divergent from this plan of structure are readily seen to be only secondarily different from it.

The author briefly summarizes the results of his studies as follows:—The gill of *Chiton* and *Fissurella* is closely like the *ctenidium*, which Lankester considers the primitive type of molluscan gill. In ctenobranchs, almost universally, the gill is not a *ctenidium*, but a very much simpler organ. Its form compares closely with the gill which we have come to regard as the primitive lamellibranch gill. Incomplete study of ctenobranchs and ignorance of the history of the development of the ctenidia in *Chiton* and *Fissurella* prevent more than a conjectural conclusion. It does not seem, however, safe to accept the conclusions of Spengel and Lankester that the ctenobranch gill is derived from a feather-form gill like that of *Fissurella* by the fusion of one side with the body-wall.

Kidney of Aplysia.‡—J. T. Cunningham has recently cleared up the confusion that exists as to the position and relations of the renal organ in *Aplysia*. This organ—the "triangular gland" of Delle Chiage—is situated beneath the shell and behind the pericardial cavity; the reno-pericardial opening was demonstrated by injecting the pericardium with Berlin blue and cutting the kidney into a series

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 311–8 (2 figs.).
† Stud. Biol. Lab. Johns Hopkins Univ., iii. (1884) pp. 37–48 (3 pls.).
‡ MT. Zool. Stat. Neapel, iv. (1883) pp. 420–8 (1 pl.).

of sections; by these means it was ascertained that the reno-pericardial opening was continuous with a canal running back through the substance of the kidney and opening below into its cavity. The external aperture of the kidney is situated below the line of attachment of the gill which traverses the surface of the organ, and close to its posterior extremity. In structure the kidney consists of a number of trabeculæ forming a network; in the interior of the trabeculæ are numerous blood lacunæ which are sometimes traversed by delicate strands of connective tissue; on either side of the trabeculæ are the renal cells, none of which appear to be ciliated. The kidney of *Aplysia* corresponds morphologically to the *left* kidney of Zeugobranchia and *Patella*.

Visual Organs of Lamellibranchs.*—B. Sharp has examined the edge of the mantle of *Ostrea virginica* and *Mitilis edulis* of the Asiphonata, and the siphons of *Venus mercenaria*, *Mya arenaria*, *Mactra solidissima*, besides the forms already described for *Solen ensis* and *S. vagina*.† The pigmented cells found in these parts are essentially the same as those found in *Solen ensis* and *S. vagina*. The smallest of all the cells were found in *Ostrea*, and the largest in *Venus*. Experiments on these forms show their sensitiveness to light and shadow, and the cells showing the retinal character described leave little doubt as to the power of vision. No nerves could be demonstrated passing direct to these cells, and probably those distributed to the general epidermis serve in transmitting the impressions. The visual power is so low, that nerves have not been yet specialized for this purpose.

Molluscoida.

Development of Salpa.‡—In the second part of his researches into the development of *Salpæ*, Prof. W. Salensky deals with four species, viz. *S. punctata*, *S. fusiformis*, *S. bicaudata*, and *S. democratica;* the differences observed between the species are very considerable, and a general *résumé* is given at the close of the memoir of the differences in all the species studied. The ovum is contained in a follicle which is a diverticulum of the respiratory chamber and connected with it by a canal, the so-called oviduct; in *S. pinnata* and others, this cavity disappears in time, but in *S. bicaudata* it persists as a brood pouch; the "oviduct" opens upon the summit of a fold of the walls of the respiratory cavity; in some species (e. g. *S. pinnata*, *S. africana*) another fold of the respiratory cavity of the mother rises round the aperture of the oviduct; these are termed *Salpæ thecogonæ;* in others again there is no such fold, and this group may be termed *Salpæ gymnogonæ;* corresponding to this difference are other differences both in the structure of the embryo and the development of its several organs.

In the first group the fold which immediately surrounds the

* Proc. Acad. Nat. Sci. Philad., 1884, p. 10. This is the same article which was given in brief abstract, *ante*, p. 213.

† See this Journal, *ante*, p. 39.

‡ MT. Zool. Stat. Neapel, iv. (1883) pp. 327–402 (6 pls.).

aperture of the oviduct (*epithelhugel*) gives rise to the ectoderm of the embryo and to the wall of the placenta; the walls of the follicle are developed into the mesodermic organs of the embryo, the intestinal canal, pericardial cavity, and nervous system, together with the "roof" of the placenta and vascular tufts; in this group the oviduct is transitory and soon disappears.

In the second group (*Gymnogonæ*) there is no outer fold; the inner fold (*epithelhugel*) is transitory and the placenta is formed from the follicle or is merely transitory and commences to degenerate by assuming the appearance of a protoplasmic network in which the separate cells are indistinguishable; the oviduct persists, either taking a share in the formation of the embryo (*S. democratica*) or serving as a brood cavity (*S. bicaudata*) for a short time and then disappearing.

The developmental process of *Salpa* is so peculiar that it is very difficult to compare it with other known types of development; the fact that the follicular cells take a share in the production of the embryo (the process of development being therefore both sexual and asexual) is not, however, confined to this group. Lankester has described a very similar state of things in Cephalopoda, where the "inner capsular membrane"—the follicle itself—grows into the ovum and partly forms the nutritive yolk; recent researches also into the Vertebrata tend to show that the yolk is partly formed from the cells of the follicle. *Salpa bicaudata* appears to represent the most simple development of all the species, while further complications, such as the formation of a part of the embryo by cells of the oviduct, tend to remove other *Salpæ* further from the normal mode of development exhibited in the animal kingdom.

Budding of Anchinia.*—A. Korotneff has observed a colony of *Anchinia* to be covered with small corpuscles of two kinds, and with two modes of movement; one was wavy in outline, the other pyriform; the former had vesicular contents and moved rapidly by means of lobate pseudopodia, very much like those which are seen in such a form as *Amœba palustris*. In the second form the pseudopodia, which were confined to the narrower end, were fine and filamentar; their contents were compact and not granular, and there was an aggregation of corpuscles at their centre; they appeared to be completely analogous to the primitive buds found by Uljanin in *Doliolum*, and were not, as the other kind of bodies, unicellular, but multicellular. The author has been able to convince himself that the simpler are developmental forms of the more complex forms, and that the change is effected in the following way. The nucleus of the cell gradually divides, and at the same time the body of the cell loses its vesicular character and becomes finely plasmatic; a separation of ectoderm and endoderm is very early apparent; the cells of the body gradually grow, and endodermal cells with large vesicular nuclei become apparent—these form the future ovary, while the remaining three cells go to form the rudimentary intestine. As the ectodermal becomes separated from the endodermal layer, a lumen appears which is the true body-cavity.

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 50–61 (2 pls.).

The internal mass becomes divided into two sets of cells—the enteric and ovarian. The former becomes differentiated into the stomach and pharynx, and from the latter the endostyle soon becomes developed. The nervous system commences as a thickening of the ectoderm, which gradually becomes converted into an independent lens-shaped body, the ganglion. Within this ganglion a lumen arises which enters into connection with the lumen of the pharynx, in such a way that an outgrowth of the pharynx is directed towards the ganglion; this is the so-called hypophysis of the Tunicata. The nerve-ganglion grows out and forms a nerve-cord.

The author's observations on the development of the gills were not very complete, but he has been able to see that the cloaca forms two lateral outgrowths which bend round the intestine and become applied to the pharynx; the neighbouring cells of the latter grow rapidly in size and form special groups; where these groups are formed openings appear—the rudiments of the future gills. The mesoderm appear to have no other function in *Anchinia* than that of forming five muscular bands.

The ovarian cells, after having attained a certain size, undergo absorption; from them there appear to arise new cells, each of which has a large nucleus and soon becomes divided; the function of these is very problematical, but we have at present no right to regard it as being renal. After some further observations on the germinal cells, Korotneff passes to a discussion of the significance of the phenomena.

He commences by pointing out that the maternal organism to which the outgrowth and buds belong is completely unknown. We must, therefore, in any further discussion of the question, base ourselves on the analogy of the allied *Doliolum*. If this be justifiable, then we may suppose that the unknown mother had a rosette-shaped organ from which the primitive buds became separated; these are the parts which have given rise to the buds here described. The forms observed by Barrois and Kowalevsky were sexual, those seen by Korotneff had the genital organs reduced, and indeed only ovaries were detected by him. It would seem, then, that the maternal organism is of the second asexual generation, and we have then the following alternation. The problematical asexual generation which possesses a rosette-shaped organ, produces from the primitive buds special buds which are fixed on the outgrowth. On this follows a series of similar buds, which develope parthenogenetically until at last some of the buds give rise to sexual organs. These last, by sexual means, give rise to the first problematic individual. The case is complicated by the extension of the asexual stages, and is analogous to what obtains among Aphides.

The most remarkable of all the phenomena in the development of *Anchinia* is the change which has taken place in the relation of the organs to the germinal layers. The pharynx is developed from the endoderm, and the same layer gives rise to the heart. How are these very remarkable facts to be explained? We must either suppose that the germinal layers of the organism derived from the ovum are not homologous with those here described, or that the germinal layers have not, in the development of the different organs, the special significance that has hitherto been attributed to them.

Morphology of Flustra membranaceo-truncata.*—W. J. Vigelius makes this essay an introduction to a proposed work on the morphology of the marine Bryozoa. The species of *Flustra* which he has examined offers another proof of the truth of the doctrine that the mode of growth of the Bryozoan stock is of no value as a means of distinguishing the families. The nutrient animal and the avicularium are alone distinctly differentiated individuals; the brood-capsules are only organs, not individuals. The nutrient animals may be (1) budding: these are found on the marginal zone of the colony; (2) perfect: these are the reproductive forms; (3) resting; and (4) decaying. The two last are only found near the proximal part of the stock, and are much rarer than the others. The cystid and polypid make up the complete nutrient animal, and in the normal condition consist of integument, nutrient apparatus, and parenchymatous tissue. The author has not been able to convince himself of the existence of a nervous system, but he thinks that its centre is perhaps represented by the small rounded mass of cells, which lies on the anal side of the anterior wall of the pharynx. Like other writers at the present time, the author has made some observations on spermatogenesis, and finds that the spermatoblasts are derived from the repeated division of the spermatospores, but they do not form rounded or oval masses of regularly arranged cells placed on a nutrient blastophore. Vigelius is uncertain whether the explanation of the absence of the blastophore is to be found in the occurrence here of a more primitive condition of things, or in the fact that the surrounding perigastric fluid is highly nutritious. When the spermatoblasts become converted into spermatozoa they are at first pyriform; the tail then arises at the narrow end, and becomes of some length.

The histolysis of the digestive tract is described, and the brown body is regarded as having certainly a nutrient function. The view that the cystid and polypid are parts of one and the same individual is supported by the observations of Barrois, the organization of the complete nutrient animal, and the history of the process of germination. The objection that the living cystid appears separately is of little weight, now that Vigelius has shown that the modifications of the cystid are not so numerous as Nitsche supposed—for example, the primitive avicularia are not cystids but polypocystids, the root-filaments are organs, and not individuals, and the same is true of the brood-capsules. As to the objections based on the periodical disappearance and subsequent regeneration of the enteric canal, an answer is to be found in the general dictum that morphological facts must not be looked at from a physiological standpoint, as well as in the fact of the wide distribution of the phenomena of regeneration among lower animals.

The perigastric space is regarded as being a true cœlom, but at the same time Vigelius adopts the view of the Brothers Hertwig, that the Polyzoa are pseudo-cœlia.

* Biol. Centralbl., iii. (1884) pp. 705–21.

Arthropoda.

a. Insecta.

Coræbus bifasciatus.*—A. Laboulbène discusses the sexual differences of this Coleopteron, and the characters of its so-called eggs. He finds that the male has been mistaken for the female, and that the oviform bodies are true Acari, in the body of which developing ova were to be detected; the oviform body, then, is nothing but the globular abdomen of the mite, which is swollen out into a vesicle more like that of Termites or *Pulex penetrans* than anything which is found in any other acarid of the same family.

Mouth Parts of Diptera.†—The descriptive part of H. J. Hansen's work is preceded by a full historical account of the work of others, from Swammerdam to the recent writers, such as Dimmock, Becher, Meinert and Kräpelin. It is written in Danish, with a Latin abstract, or "Conspectus systematicus," of the chief results, and the explanations of the plates are both in Danish and Latin.

Mouth-Organs of Lepidoptera.‡—P. Kirbach, after an account of what is generally known as to the structure of the mouth-organs of insects in general, and of Lepidoptera in particular, proceeds to his own observations. With regard to the histological structure of the proboscis, he points out that the lowest portion is distinctly lamellar, and consists of thin transparent layers, while the upper portion has chitinous bodies deposited in its otherwise homogeneous ground substance; these bodies are set at pretty regular distances, and always have their broadest surface turned outwards. True scales, completely analogous to those of the wings and other parts of the body, are to be found on the maxillæ of many moths and of some butterflies.

The author has been interested in the formation of the rod-like bodies found within the closed sucking canal; he was at first inclined to ascribe to them a gustatory function, but this was opposed by their possession of a chitinous membrane, and by the presence of true gustatory organs within the mouth. Nor can they have an olfactory function, but must rather be tactile organs which test the fluidity and viscidity of the fluid—a not unimportant function, as the quantity of saliva that has to be mixed with the food depends on the degree of its viscidity.

In answer to the very interesting question as to how the sucking canal is formed, the author points out that, owing to the close apposition of the two maxillæ, a tube is formed through the whole length of the proboscis, and this is nearly circular. How are the maxillæ kept closely united and the canal so closed as to be air-tight without restraining the powers of movement of the proboscis? A series of closely-applied, thin, chitinous plates are inserted into the chitinous ridges which are placed near the sides of the groove; these plates are

* Comptes Rendus, xcviii. (1884) pp. 539–41.

† H. J. Hansen, 'Fabrica Oris Dipterorum,' part 1 (Tabanidæ, Bombyliidæ, Asilidæ, Thereva, Midas, Apiocera), 8vo, Copenhagen, 1883, 250 pp. and 5 pls. See Amer. Natural., xviii. (1884) p. 274.

‡ Arch. f. Naturg., l. (1884) pp. 78–119 (2 pls.).

set horizontally and are much longer than broad; they are so arranged that the clefts between the separate plates are covered over as completely as possible; in *Vanessa*, the marginal plates are beset with lateral teeth. In *Pieris*, the last eighth of the proboscis has its plates smaller, and their course is oblique and upwards, instead of horizontal; the spaces between the plates are larger, but a compensation is afforded by the development of spines. The differences which obtain in various Lepidoptera are noted, but in all it is clear that a maximum of strength obtains with a maximum power of movement.

The mechanism of sucking may be thus described:—When a butterfly thinks it has lit upon suitable food it tests it with the tactile corpuscles of the protruded proboscis, and then slips the top of the proboscis into the fluid; with this it mixes a certain quantity of saliva. The frontal, lateral, and dorsal muscles contract, and so draw up the operculum of the pharynx; by this means a large cavity is formed. At the same time the elevator muscle of the oral valve contracts, and the oral and proboscidial canal are put into communication with the pharynx, which is almost empty of air. The pressure of the atmosphere drives the fluid into the canal of the proboscis. As the opercular muscles relax, the longitudinal and transverse muscles contract, and by this means the fluid is forced into the œsophagus. When the latter muscles relax, the opercular muscles come together, the œsophageal valve closes the hinder opening, the oral valve rises, and a second stream of fluid enters the pharynx. These acts follow one another so quickly and so regularly that a continuous stream enters the canal of the proboscis. It will be seen that the author's account differs from that of preceding writers, and he is, apparently, justified in contending that it is the only one which falls in with the anatomical facts.

Malpighian Vessels of Lepidoptera.*—M. Cholodkovsky has lately added *Tineola biselliella* to the list of the few insects that are known to have only two Malpighian vessels; these are of some size, and are folded along the course of the digestive canal, and end by a distinct enlargement. Suckow has described four Malpighian vessels in a species of *Pterophorus*, and of *Hyponomenta*, but later investigations show that they really agree with the great majority of the Lepidoptera in having six. As embryological research has shown that a small number of Malpighian tubules is a primitive character, and that with progressive development the number increases either by branching or by histolysis, succeeded by a fresh development of a larger number, it is clear that the Microlepidoptera in which there are but two, while their caterpillars have six, exhibit just the reverse to what we should expect—or, in other words, we have here a case of atavism, and one which, as it obtains in the imaginal state only, is a periodic rather than a constant atavism.

Abdominal Muscles of the Bee.†—G. Carlet distinguishes three regions in the abdominal musculature of the bee—dorsal, lateral, and

* Comptes Rendus, xcviii. (1884) pp. 631-3.
† Ibid. (1883) pp. 758-9.

ventral. All of them, with the exception of the alæ cordis, which subserve the function of circulation—and they are more numerous than is generally supposed—take part in respiration, and consequently in the production of heat, which is so important a function in the economy of the bee. The mechanism is more complicated than is ordinarily believed, for when the abdomen shortens or elongates the dorsal and ventral surfaces approach or separate from one another; in other words, the abdomen dilates or contracts along three axes to admit or expel air by its stigmata.

Flight of Insects.*—Dr. Amans has a second essay † on the flight of insects, in which he describes the organs of the Orthoptera.

Aphides of the Elm.‡—J. Lichtenstein records some observations which have enabled him to establish the fact of the migration of the Aphides of the elm (*Tetraneura ulmi*) to the roots of grasses, and their return to the trunks of the trees in autumn.

β. Myriopoda.

Head of Scolopendra.§—This memoir (in English) treats in detail of the external anatomy of the parts of the head in *Scolopendra subspinipes* Kohlr., as most typical of the Chilopods. The details appear to have been worked out with care, while the drawings seem to have been very carefully made by the author, and beautifully engraved.

In the course of his lengthy review of the works of his predecessors, the author criticizes and disproves Newport's views that the head of the Chilopods is composed of eight subsegments. Four pages of the memoir are devoted to an elaborate and useful tabular view of the opinions of forty-six authors as to the morphology and nomenclature of the mouth-parts. Dr. Meinert gives a new explanation and nomenclature of the mouth-parts. He also claims that they are analogous with those of biting insects, or, to use his own words, "it is purposed to serve me to show the coincidence of the head of Chilopoda and its parts of the mouth with the head of the Insect and its parts of the mouth, especially in the Orthoptera, that is to say, in insects with free biting parts of the mouth, and four pairs of these parts or four metamers in the head." He does not regard the antennæ and the antennal segment as homologues of the other mouth-parts and segments. In his own words, "The real head then must be said to consist of the three foremost metamers, together with their exponents or limbs; that is to say, the labium, the maxillæ and the mandibles, and besides of the lamina cephalica, which latter, as well as its appendages, the antennæ, I by no means can consider to be homonomeous with the other metamers of the body and of the head, and with their exponents."

* Rev. Sci. Nat., iii. (1883) pp. 121–39 (2 pls.).

† See this Journal, iii. (1883) p. 832.

‡ Comptes Rendus, xcvii. (1883) p. 1572.

§ F. Meinert, 'Caput Scolopendræ. The Head of the Scolopendra and its Muscular System,' 77 pp. and 3 pls. 4to, Copenhagen, 1883. See Amer. Natural., xviii. (1884) pp. 270–2.

γ. Arachnida.

Skeletotrophic Tissues and Coxal Glands of Limulus, Scorpio, and Mygale.*—E. Ray Lankester points out the necessity for a detailed and comprehensive study of the connective and other tissues of the skeletotrophic group in both Arthropoda and Mollusca "before we can pretend to offer any satisfactory account of the vascular system in those groups, and of the 'lacunar' connection between arteries and veins, which is confidently described and discussed by all zoologists, but has never yet been demonstrated to exist in a manner satisfying the requirements of modern histology."

In the account of the structure of the entosternites, the author says that it seems possible to morphologically define "cartilage" by the isolation of each one of its constituent cells in a firm matrix, and by the triaxial multiplication of those cells, whether the matrix be homogeneous, fibrillated, or penetrated by reticular condensations. A well-marked entosternite has for the first time been found among the Crustacea, and, curiously enough, in the most archaic form, *Apus*. After a careful description of the various forms of connective tissue the author passes to the blood-corpuscles of *Limulus* and *Scorpio*, which agree remarkably in form, size, and granulation; both contain a large quantity of hæmocyanin, and are both, in bulk, of a deep indigo-blue colour.

The coxal glands are next dealt with; their minute structure points to their forming an active secretory apparatus, the materials for which are brought to them by the intercæcal tissue; they may well be compared with the green glands (antennary coxal glands) of the Decapod Crustacea, from which, however, they differ in having no definite outlet, and in the structure of the epithelial cells. The author justly points to the occurrence of "these glands in their characteristic position, and with their characteristic corticated secretory cells in *Limulus* on the one hand, and in *Scorpio* and *Mygale* on the other," as another argument in favour of that classificatory alliance of *Limulus* with the Arachnida, of which he has, in earlier essays, afforded so many instructive demonstrations.

δ. Crustacea.

Liver of Decapods.†—J. Frenzel gives a short account of the results of his investigation of the gland of the mid-gut, or liver, of twenty-six species of Decapods. The epithelium of this gland consists of fat-cells and ferment-cells; the size of them does not seem to differ with that of the individual, but to be pretty constant in each species. In *Carcinus* they are ·07 mm. and in *Palinurus* ·06 mm. in diameter. In section, each tube of the gland is seen to be invested by a delicate fringe, which is more or less distinctly striated, and which has the function of a porous cuticle. The longitudinal striation seen in the upper part of the cells calls to mind that which obtains in the cells of the mid-gut of insects and

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 129–62 (7 pls.).

† SB. K. Akad. Wiss. Berlin, xlii. (1883) pp. 1113–9.

of certain Crustacea. Within the cells there are spheres or drops, which vary in size and number, but almost always occupy nearly the whole of the cell; they are generally, though not always colourless, and their exact chemical composition has not been definitely made out, though they present in some cases the reactions of fatty bodies.

Between these cells lie others, the number of which varies considerably, but is always in direct relation to the nutritive condition of the individual. They present the same fringe and longitudinal striation as the fat-cells; the greater part of each is filled by the true secretion-bodies which are almost completely spherical, surrounded by a delicate membrane, and containing crystals which appear to be formed of tyrosin. When the ferment-cells are set free the vesicles and their contents make their way into the stomach and intestines. If the animal is in a normal condition the contents are gradually extracted and dissolved; but if the nutrition or digestion is in a disturbed condition, as is often the case with animals in confinement, then the ferment-vesicles pass almost unchanged from the intestine with the fæces.

The organ of the mid-gut cannot rightly be called a liver, for it has not that which is the prime characteristic of a liver—colouring matters, nor can bile-acids or bile-colouring matters be detected in its secretions. It is possible that the fatty cells also contain a ferment, but the presence of it has not as yet been definitely proved.

'Challenger' Copepoda.*—G. S. Brady's report on the 'Challenger' Copepoda has just appeared; it contains a description of 43 new species and 11 new genera. One of the latter, *Pontostratiotes*, which contains but a single species *abyssicola*, is an undoubted deep-sea form, having been dredged in a depth of 2200 fathoms; it is characterized by an unusual development of spines upon the carapace and anterior antennæ; it is possible that a certain number of other forms, *Calanus princeps*, *Hemicalanus aculeatus*, *Phyllopus bidentatus*, which came up in the dredge from great depths, are also abyssal, but in these cases it is not positively certain that the specimens really came from the bottom. The other Copepoda were all taken in the surface net at the actual surface and at various depths below. Like most other pelagic organisms, the genera and even the species are very widely distributed. An accurate analysis of the localities in which all the species were obtained is given, and the geographical areas into which the ocean is divided are the same as those used in the report on the Ostracoda, viz. North Atlantic, South Atlantic, South Indian Ocean, Australasia, South Pacific, North Pacific, East Asia. Of the 90 free-swimming species here tabulated, only one (*Enchæta prestandreæ*) was found in all the seven districts, but no fewer than nine species occurred in all but one of the areas. The area producing the smallest number of species (15) is the South Indian Ocean; from the North Pacific the number is not much greater, 22. Leaving out of consideration the fish parasites, which

* 'Report, &c., H.M.S. Challenger,' Zoology, xxiii. (1883) 4to, 142 pp. (55 pls.).

were extraordinarily few in number, the largest number of species were obtained from the North Atlantic, South Atlantic, Eastern Asiatic, and Australasian seas.

The Arctic and Antarctic oceans seem more favourable to the growth of the Copepoda than other regions, the number and size of the individuals being larger here than elsewhere. The Tropical and Sub-tropical seem, however, to maintain the largest number of species and genera, though no one form is so abundant as is *Calanus finmarchicus* of the Polar seas.

The report contains a description of all the new species as well as of several others already known to science, and is illustrated by a number of woodcuts and 55 plates.

Longipedina Paguri.*—W. Müller describes a new Copepod of the family of the Harpactidæ, for which he forms a new genus as above. It was found living parasitically on species of *Pagurus*.

Cytheridæ.†—W. Müller has some observations on the generative organs of these Crustacea. The penis is composed of a number of movably-connected chitinous ridges with bundles of muscular tissue; the differences presented by different forms are, probably, of greater interest to the systematist than the morphologist. The following table shows the relations of the parts in *Cypris* and *Cythere*:—

Cypris.		*Cythere.*	
Female.	*Male.*	*Female.*	*Male.*
Vagina.	Penis, hinder part?	Vagina, or rudimentary vagina (lobi abdominales).	Hinder part of penis.
	Penis.	External appendage of the rudimentary organ.	Penis, without hinder appendage.
	Mucous gland.	Rudimentary organ.	

A list is given of the species found in the North and Baltic Seas, and a new genus *Cytherois* is formed for *C. virens* n. sp. It approaches, but is not so much modified as *Paradoxostoma* in the character of its mouth-organs; it is, however, clearly adapted for taking in fluid nutriment, the mandibles being unarmed, and there being no organs which serve to comminute the food.

Deep-Sea Crustacea.‡—Among the remarkable forms of deep-sea Crustacea collected by the 'Talisman' is one to which A. Milne-Edwards has given the name of *Nematocarcinus gracilipes;* it is distinguished by the extraordinary length of its antennæ, and by the attenuation of its ambulatory appendages.

* Arch. f. Naturg., l. (1884) pp. 19–23 (1 pl.).
† Ibid., pp. 1–18 (2 pls.).
‡ Nature, xxix. (1884) pp. 531–3.

Vermes.

Development of Worm Larvæ.*—J. W. Fewkes has some rather scattered observations on the development of certain worms.

1. *Prionospio tenuis.* It is pointed out that defensive setæ or spines are only found on free-swimming annelid larvæ, and this fact leads to the suggestion that they are special organs for defence, rather than "ancestral features," descended from fossil forms, which, according to A. Agassiz, they sometimes closely resemble.

2. *Spio* sp. This larva is telotrochal, and has a large preoral lobe with an equatorial ring of cilia and embryonic spines, which arise from ear-like backward projections of the head. Scattered pigment-spots, but no cephalic eye-spots are present. When the larva is alarmed the spines on its body are raised, and project at all angles to their point of origin.

3. *Aricidea* sp. There is a resemblance to *Spio*, but also certain points of distinction; the oldest larvæ have the long provisional setæ, but not the other cephalic appendages of the larval *Spio*.

4. A polytrochal larva, taken about the end of the summer, had two flat circular ear-like appendages ("auricles") on the sides of the head.

5. *Telepsavus* (?). The larval forms doubtfully referred to this genus are very common at Newport; it is so large as to be easily distinguished by the naked eye as it swims about in the water.

6. *Phyllochætopterus* sp. This larva closely resembles the preceding, but is distinguished by the absence of lateral cephalic tentacles.

7. *Nephthys* sp. The youngest larvæ have a great resemblance to those of *Polygordius*, but the pattern of colour on the anal pole is characteristic. A movement of the eye-spots from the head to the fourth body-segment was noticed, but the means by which it was accomplished were not quite clear.

8. *Lepidonotus squamatus* (?). The youngest larvæ were monotrochal.

9. *Nereis* sp. The mandibles were seen to be well developed at an early stage.

10. *Pilidium recurvatum.* This name is provisionally given to an interesting form, which has many structural relationships to *Tornaria* (*Balanoglossus*) and *Actinotrocha* (*Phoronis*). The interior of the larva is occupied by an œsophagus, and "an amniotic cavity, which contains a growing Nemertine worm"; the œsophagus is continued into the intestinal cavity of the young Nemertine. This form passes through a remarkable metamorphosis in which, however, no part of the nurse is unabsorbed, even the pigmented regions of the amnion being detected in an enlargement at the hinder end of the worm. The author regards this absorption of the larval envelope as one more characteristic pointing to the close affinities of the Nemerteans with the Echinodermata.

11. *Polygordius.* The Lovenian larvæ are among the commonest of those found at Newport; in the figures here given attention is

* Bull. Mus. Comp. Zool. Camb., xi. (1883) pp. 167–208 (8 pls.).

directed to the peculiar brown bodies found near the "bell margin," which seem to be characteristic, and to the ventral nerve-cords which have never yet been represented.

12. *Capitella*. 13. *Lumbriconereis*. The jaws of this larva, when simplest, have a remote resemblance to the chitinous teeth of *Branchiobdella astaci*.

14. *Nectonema agilis*[*e*]. Some observations are made on this worm, the affinities of which are, as Verrill suggests, probably with the Nematoidea.

Excretory Apparatus of Hirudinea.*—F. Vejdovsky gives some new facts respecting the segmental organs of leeches; these organs consist of a terminal vesicle into which opens a simple duct connected at its dorsal extremity with a gland consisting of a number of large cells traversed by a winding branched duct. In *Clepsine bioculata* and other species the central duct of the glandular portion of the organ breaks up here and there into a fine network. The whole of the segmental organ which has no cilia is surrounded by a rich network of blood capillaries in *Hirudo medicinalis* and *Aulostoma gulo*; in *Nephelis* and other genera this vascular sheath is entirely wanting. The segmental organs of the Hirudinea resemble those of *Chætogaster* more closely than any other form; in neither is there a ciliated funnel or cilia developed along the course of the duct; the glandular portion of the organs is, however, but slightly represented in *Chætogaster*, and it is not known whether the duct is branched in this region. Both these families are degenerate Oligochæta, and the segmental organs are evidently traceable to the type found in Oligochæta and have no connection whatever with those of *Gunda* and other Planarians; the branched ducts of the latter are not comparable to the fine ramifications in the leech's segmental organs, since they are provided with independent walls, while the ramifications of the central duct of the nephridium in the Hirudinea are contained within the substance of the glandular cells themselves. An additional proof of the direct relation between the segmental organs of the Hirudinea and the Oligochæta is to be found in the close similarity of the development.

Function of Pigment of Hirudinea.†—R. Saint-Loup finds that when a young *Nephelis* has been eating, the three hinder portions of the four into which its intestine may be divided are covered on their surface with small yellowish-brown granulations which gradually become closely packed; they are arranged on the walls of the capillaries which, clearly, carry to the blood the digested food. In the adult the tunic of yellowish-brown spherules lies on the inner face of the musculo-cutaneous layer, but remains in relation to the intestine by means of the fine vessels which invest its walls. The author has been able to demonstrate the continuity between the yellowish spherules and the pigment-granules, and there appears to be in the Hirudinea a special excretory or pigmentary function in these yellowish-brown cells. A further question arises on the relations which exist between

* SB. K. Böhm. Gesell. Wiss., 1883, pp. 273–80 (1 pl.).
† Comptes Rendus, xcviii. (1884) pp. 441–4.

the pigmentary and the hepatic functions; with regard to the latter we have to note that in the Vertebrata, the liver has two functions; the first and most important is the reception of certain matters from the blood which are deposited in it; the second is the excretion of these products. The function of these parts may lie in separate organs, and Saint-Loup thinks that the former is, in the Hirudinea, effected by the cells which line the capillaries in contact with the intestine of *Nephelis*, and by the yellow globules which are found in the parenchyma of *Clepsine*. But the elimination is not effected by bile-ducts but by the pigments; the function of the bile as a fluid accessory to the digestive juices is performed by the secretion of the walls of the digestive tube.

The study of the development of the liver in certain invertebrates and in the vertebrata has shown that it is formed at the expense of the walls of the intestine, and sometimes from a diverticulum of it; the author thinks that, in the Hirudinea, it is formed not only by this portion of the intestine, but also by yellowish-brown spherules, and it is from this point of view only that we can give to the *tunica villosa* and homologous organs of worms the definite name of liver.

Otocysts of Arenicola grubii.*—E. Jourdan describes the otocysts of *Arenicola grubii* as being placed in the middle of muscular bundles at some distance from the hypoderm, and as surrounded by the connective envelope of these bundles. They are united to the œsophageal commissures by several nerves, and are placed at the side of the dorsal surface. The otocysts are always perfectly circular, and their cavity measures ·14 mm. in diameter, while the sphere itself is ·22 mm. in diameter, so that the walls are of some thickness. These walls are formed by a layer of fusiform cells, a plexus of fibrils, and a connective envelope. Only feeble indications of cilia could, with difficulty, be detected. The cells narrow at their base and curve about in various directions, anastomosing to form a very delicate layer of fibrils which, at the base of the epithelial layer, unite to form a zone intermediate between the nerve-fibres and the base of the cells. The otoliths, like the otocysts, are always spherical, but they vary greatly in size and number.

Manayunkia speciosa.†—E. Potts supplements Dr. Leidy's description of this genus (erroneously recorded as *Manyunkia* at p. 231) by former observations of his own, demonstrating its strictly freshwater habitat, the apparent grouping of the tentacles on two processes on the lophophores, and the difference in the effect produced by the motion of the cilia as compared with a polyzoon. In the latter a powerful "incurrent" bears food to the mouth as a vortex; in the former, while the motion draws the particles from without or behind the circle towards the tentacles, when they pass by them they are influenced by an "excurrent" bearing them forcibly away. A specimen isolated in a microscopic stage tank, for some reason, left its old tube and formed another, giving him the opportunity of observing

* Comptes Rendus, xcviii. (1884) pp. 757–8.
† Proc. Acad. Nat. Sci. Philad., 1884, pp. 21–4.

the character of the latter, and the method of its construction. In its earliest stages it is a transparent, smooth, and homogeneous slime-like excretion, within which the worm may be very clearly seen, as it works its way forward or drags itself backward by means of its pedal hooks and spines. Later on, the anterior extremity thickens and becomes more and more opaque, and, as Dr. Leidy has observed, "feebly annulated," presumably from the adherence of effete particles, and their compression by the repeated withdrawal of the ciliated tentacles into the mouth of the tube. This method of prolongation must continue during the residence of the worm, and in consequence, if supported, it may sometimes reach a length which is several times that of its inhabitant.

Miss S. G. Foulke has also examined * the worm and describes the pulsation of the green tentacles.

To ascertain how long the cilia upon the tentacles would continue their motion after separation from the body of the worm, both lophophores of an adult were cut off above their junction.

At first the tentacles remained closed from the shock, but soon they were expanded, the cilia displaying active motion, and presently the two separated lophophores began to move about in the zoophyte trough. This motion was produced by the action of the tentacles, which bent in all directions, the tips touching the glass, and was not a result of the currents produced by the cilia. In a few minutes one lophophore had *crawled* in this manner quite across the trough, while the other remained floating in the water near its first position. In the case of this latter the motion was produced by the ciliary currents, and was entirely distinct from the crawling above noted. During this time the decapitated worm had sunk to the bottom, and, though turning and twisting a good deal, did not attempt to protrude the mutilated support of the lophophores. Its body was so much contracted that the segments were not above one-third their usual size.

At the end of five hours the worm was apparently dead, numbers of infusoria had collected to prey upon it, and the surface of the body presented a roughened appearance as though covered with tubercles. The lophophores were still crawling and swimming about. At the end of the eighth hour the lophophores had ceased to crawl, but the ciliary action, though feeble and uncertain, still continued. The body of the worm was then covered with a thick fungoid growth, consisting of transparent rod-like filaments 3/16 in. in length; some of the filaments presented a beaded appearance. All motion of the cilia upon the tentacles had ceased, and these also were being devoured by infusoria.

Life-History of Thalassema.†—H. W. Conn describes (in a preliminary paper) the early stages of development of *Thalassema mellita* that inhabits empty "sand-dollar shells." Its anatomy is much the same as that of *Echiurus* described by Sprengel. It is dicœcious. The ova and mother-cells of spermatozoa are simply modified cells of the peritoneal lining of the body-cavity, in which, whilst developing, they

* Proc. Acad. Nat. Sci. Philad., 1884, pp. 48–49.

† Stud. Biol. Lab. Johns Hopkins Univ., iii. (1884) pp. 29–35 (1 pl.).

float freely, being driven, when mature, into two sexual pouches at the anterior end of the body.

In about fifteen minutes after fertilization two polar globules are protruded from the egg, exhibiting a rhythm precisely similar to that of the segmenting ova. Segmentation is, exceptionally among Annelids, perfectly regular and uniform. About the 6th hour a gastrula is formed by a typical invagination, and at the same time the region opposite the blastopore becomes marked off as the anterior extremity and already functions as a head. A preoral band of cilia appears and is subsequently replaced by a *row* of longer and more powerful cilia. The transformation of the gastrula into a trochosphere larva takes place by a peculiar method of growth whereby the direction of the long axis is changed. The mesoderm has a dual origin resulting in two different systems. First there is formed the two mesodermal bands so common to Annelid larvæ, and the second part of the mesoderm consists of a large number of unicellular muscles that separate from the endoderm at the time of the invagination, having thus an origin very similar to that of the mesoderm in Echinoderms.

Three other ciliated bands soon make their appearance, one immediately behind the mouth, a second just in front of the anus, and a third is found upon the ventral median line in precisely the place where the ventral nerve-chain is to arise. It is thus seen that both the cerebral ganglion and the ventral nerve-chain are preceded by the development of cilia from the very cells from which the nervous elements are to arise, an interesting point as indicating that already these cells are differentiated as nervous elements, although at first there is no trace of any nervous system. The further changes observed were the segmentation of the mesodermal bands and the origination of the ventral nerve-cord from the ectoderm as a bilateral structure.

Spermatogenesis and Fecundation in Ascaris megalocephala.*—P. Hallez finds that the spermatospores of *Ascaris megalocephala* are at first formed of a homogeneous, extremely transparent, and nucleated protoplasm. Increasing in size they give rise by division of the nucleus to four protospermatoblasts which become separate. These similarly produce a second generation of cells—the deutospermatoblasts, and have a central blastophore in young, though not in old, males. When the deutospermatoblasts attain to a size of 6 μ in diameter their protoplasm, which was before homogeneous, becomes finely granular. When they have a diameter of about 18 μ they divide into two, and henceforward their protoplasm is filled with refractive granules. Before they pass into the seminal vesicle the spherical cells conjugate by pairs, and the nuclei fuse with one another. Two cells again separate, and at this moment corpuscles like polar globules are to be observed; these, which the author calls waste-corpuscles (*corpuscles de rebut*) finally entirely disappear.

The deutospermatoblasts are then introduced into the organs of

* Comptes Rendus, xcviii. (1884) pp. 695-7.

the female, and are at this time 18 to 19 μ in diameter, spherical in form, having their protoplasm filled with refractive granules, which call to mind the vitelline granules, and they have a nucleus which is easily stained. In the female organs the refractive or nutrient granules diminish gradually and finally disappear. The deutospermatoblasts now present the most varied forms, and look more like *Amœbæ*. It is at this time they become spermatozoa, the substance of which is formed from the interior of the cells, and appears first as a differentiation of the protoplasm, and surrounded by a delicate granular layer —the remains of the deutospermatoblast; it is remarkable that the deutospermatoblast is constantly outside the spermatozoon. This latter has at first the form of a rounded cylinder, but its surface rapidly becomes spiral and one end enlarges as the other diminishes.

At the moment of fecundation the ovum is surrounded by a finely striated zone, to which the conical spermatozoon becomes attached by its base; the yolk contracts slowly, the spermatozoon enters, but there is apparently no micropyle; the peripheral part of the yolk forms a granular zone which surrounds the male element, part of which advances as a fusiform male pronucleus to fuse with the female pronucleus. The yolk again contracts and a polar globule is formed.

Structure of Derostoma Benedeni.*—P. Francotte, after an historical review of the characters of the genus *Derostoma* and its rhabdocœlous allies, gives a short diagnosis of the new species he has discovered at Andenne, where it was found in a stream, in the midst of a number of *Tubifex rivulorum* on which it feeds. In the anterior part of the body the epithelial cells are higher than elsewhere, their cilia are longer, and between the cells the ends of nerve-fibres could be detected, though their exact relations were not made out. The pharyngeal bulb is largely formed of muscular fibres, and is moved by a set of thick fibres which are attached to its dorsal and ventral surfaces and so produce movement in all directions. The muscular fibres in all parts of the body are smooth and non-nucleated; they appear to be formed of a large number of delicate fibrils.

When a specimen has been rendered transparent it is possible to see, in the anterior region, two ganglia united by a transverse commissure; each of these ganglia gives off two nerves which pass to the epithelium, and two others which are longer and pass backwards to innervate the various organs of the body; on the ventral surface of the worm there is yet another pair of nerves. The two ganglia and the commissure are formed externally by ganglionic cells, while the centre is filled with nerve-fibrils; on the course of the nerves large nerve-cells, similar to those of the central nervous system, are not rarely met with. The cells which line the digestive tract are stated to be globular during digestion, and to be elongated in sections made from fasting specimens.

The penis is not, as in some species, chitinous, but is formed of muscular fibres. Between the ovary and the receptaculum seminis

* Bull. Acad. R. Belg., vi. (1883) pp. 723–35 (1 pl.).

there is a cæcal glandular tube, which appears to be a degenerating ootype, which now probably serves as the organ which secretes the fluid which, on hardening, forms the chitinous shell of the egg. In addition to what the author has already discovered in the characters of the excretory system, he is now able to state that the large trunks are formed of flattened clear cells, that the lacunæ are filled with corpuscles, and that there are very delicate canaliculi, without any proper wall, which unite the lacunæ with one another. In opposition to Lang, the author still regards these lacunæ as representing a true cœlom. Hæmoglobin has been detected in the anterior part of the body.

Opisthotrema, a New Trematode.*—P. M. Fischer describes a new Trematode, which he calls *Opisthotrema cochleare*, and which was taken from the tympanic cavity of *Halicore dugong*; it is remarkable for the characters of its generative organs, and especially for the fact that they open at the hinder end of the body—hence the generic name. These openings are separate from one another, ventral in position, and placed at the base of a circular pit with well-defined margins.

The testes are paired and symmetrical, rounded in form, but more or less distinctly lobed at their periphery; as the production of spermatozoa increases, the lower segment of the testes approaches nearer and nearer to the ventral surface. The testes consist of tubes, often closely packed, and bounded by a homogeneous structureless envelope, which is, apparently, a direct continuation of the cuticle. The separate tubes are connected together by a fibrous connective tissue, and are covered by a common envelope which appears to be of the same structure as that of the separate tubes. In young examples, naked, epithelial, finely granulated cells are to be found within the tubes; these, by division, give rise to the cells which, in older forms, are found grouped into rosettes: with these are associated thick cords of compressed mature seminal filaments.

Like the testes, the seminal ducts are paired, and have the common testicular investment continued on to them, while the extremely delicate muscular layer is now better developed. As the ducts enter the penial sheath they become united, and their lumen widens out, being here homologous to the so-called vesicula seminalis anterior of other Trematodes; the width of the coiled tubes varies with the maturity of their contents. The penis is so arranged that, on its extension, there is a pressure on its cavity and on the full seminal reservoir, the contents of which are thereby forced into the vagina. The penis has no armature of spines.

As in other Trematodes, the unpaired ovary is followed by the yolk-glands and the complex of shell-glands; connected with the oviduct is a receptaculum seminis, which is of very regular ellipsoidal form in young, though not in old individuals.

In discussing the mode of fertilization of the Trematoda, the author points out that there may either be self-impregnation or conjugation with another individual. The former may be effected by

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 1–41 (1 pl.).

a third vas deferens, or there may be self-copulation, the erected penis being received into the adjoining female duct, or, lastly, the genital cloaca may come into function, its opening to the exterior being closed by muscles, the contraction of which drives the expelled sperm into the vagina. As to the form now under consideration, we know that there is no third vas deferens, and that the penis would have to be extraordinarily bent to be able to enter the adjoining female orifice; while, finally, the absence of a genital cloaca excludes the possibility of self-fertilization by its aid. The author describes the mode by which he supposes two of these hermaphrodite Trematodes may fertilize one another.

The system of excretory vessels may be, in Trematodes, ordinarily divisible into three parts; the first of these, the central organ, which is distinguished from the other parts by its muscular investment, was not detected in the new genus. At the hinder pole of the body there are to be seen two well-developed canals, which pass forwards and are, at about the middle of the body, provided with lateral branches, two of which are much longer than the third; from these there again arise fresh lateral branches, which end blindly and never anastomose with one another; these ducts are bounded by a doubly-contoured membrane, which is regarded as being certainly a continuation of the external cuticle. Within this, and, especially, applied to its walls, are granules of some size, and high refractive power. The author was unable to detect the ciliated infundibula described by Fraipont and Pintner.

In his account of the nervous system, Fischer directs attention to structures which appear to represent ventrally placed and peripheral ganglionic cells, the presence of which is of especial interest when we know that the ventral body-muscles are particularly well developed in this form.

The parenchyma of the body is composed of cells which vary greatly in form and appearance; at the anterior pole of the body they are smaller and rounder than at the hinder end; when largest, they have a striking resemblance to those of plants.

The specimens for examination were hardened in absolute alcohol, coloured with picrocarmine or hæmatoxylin, sometimes with an ammoniacal solution of carmine. They were rendered transparent by oil of cloves, and by being set up in Canada balsam and chloroform for permanent preparation, or in glycerine when the sections were not intended to be preserved.

Polycladidea.*—A. Lang has published the first half of his monograph on these worms. It will be remembered that the author has divided the Turbellaria (the Nemertinea being excluded) into Polycladidea, Tricladidea, and Rhabdocœlida. He now subdivides the first suborder into two tribes:—I. *P. acotylea*, where we have the three families of Planoceridæ, Leptoplanidæ, and Cestoplanidæ; and II. *P. cotylea*, including the Anonymidæ, Pseudoceridæ, Eury-

* Fauna u. Flora des Golfes von Neapel, Monographie xi. (1884) part i., 240 pp. (24 pls.).

leptidæ, and Prosthiostomidæ. He arranges the bibliographical portion under epochs; the first of these begins with O. F. Müller, 1774 (or Stroem, 1768), and ends with Mertens 1832. Mertens begins and Quatrefages (1845) ends the second period; the third ends with Keferstein in 1868; and the fourth with Graff in 1882. In all, we have the titles of 153 books and papers.

The work proper commences with an account of the methods of investigation; the best preparations were obtained by the following means:—

Prepared animals were placed for from 3 to 14 days in picro-carmine; much of the picrin was then removed by alcohol of 70 per cent.; they were then placed for from one to four days in Grenacher's borax-carmine, and then in feebly acidulated alcohol. In this way the protoplasm was distinctly coloured by picrocarmine, and the nuclei by the borax-carmine, while the long-continued action of the former produced a slight maceration, which was an extraordinary assistance in making out the boundaries of the cells. Mayer's cochineal method is the best for the investigation of glands. As usual, Beale's carmine was very successfully used.

A general review of the organization of the Polycladidea leads to a series of chapters in which the different organs are discussed; the epithelial investment, which is always very distinctly marked, and consists of more or less high cylindrical cells, is separated from the tissues of the body by a resisting basal membrane, and is always covered with closely packed and relatively short cilia, which are set on a resisting cortical layer of the cells, which may be regarded as the cuticle.

Contrary to what happens in most Triclads and all Rhabdocœlids, the "rhabdites" always lie in the epithelium and never in the parenchyma of the body; and this is the most primitive arrangement. The mucous rods or pseudorhabdites are next considered; those found in the Triclads differ in many important points from the similarly named parts found by Graff in the Rhabdocœlidæ. Some forms are very elegantly coloured. True nematocysts are known in one species only, and the calcareous bodies described by Schmarda do not seem to have a real existence.

In the next chapter the dermomuscular system is first dealt with; the external layer of diagonal fibres on one side of the body is shown to be the direct continuation of the internal layer of the opposite side. Suckers are of two kinds; the first, found in all the *Cotylea*, is to be distinguished from those which, in the Leptoplanidæ, lie between the generative orifices, and have clearly a relation to the reproductive function. Dorsoventral muscular fibres are ordinarily well developed. All the fibres of the Polycladidea are thin, elongated, more or less highly refractive, and exhibit no differentiation into an axial substance and a peripheral layer. The dorsoventral fibres are delicately branched at either end, but this would not seem to be the case with those of the dermal system, except in the walls of the suckers.

The body parenchyma is next described, and it is stated that

Minot and Hallez are quite right in believing that the interspaces between all the organs are completely filled up with this substance; the appearance of spaces, such as was seen by Keferstein in his sections, is obviously due to imperfect conservation.

In the chapter on the digestive apparatus we have an account of the external mouth of the pharyngeal pouch, which is separated from the intestine by a "diaphragm," and of the pharynx, the origin of which is explained by some diagrammatic figures; the gastro-vascular apparatus, as the rest of the digestive tract is called, is described in considerable detail; the functions of this region would appear to be manifold, for not only has it a digestive function, but Lang agrees with Graff in ascribing to it a respiratory one also.

The investigation of the excretory or water-vascular system was attended with considerable difficulties; the author was able to convince himself that no connections obtained between the central cavity of the excretory cell and the lacunæ in the parenchyma of the body. On the whole, this system in the Polyclads agrees with the typical arrangement of other Turbellaria and of the Platyhelminthes; its highly ramified condition is to be explained as due to the absence of a special body-cavity and of a blood-vascular system. "The excretory system is compelled to seek out the excretory products in every part of the body."

The historical review of what has been taught as to the nervous system, similar to that which precedes the discussion of all the organs, is of considerable length. The cerebrum is a transversely oval mass of some size, and is indistinctly divided behind into two lobes; it gives off a number of nerves which are large in proportion to its size, so that the origin of these is somewhat difficult to follow out. At a short distance from the cerebrum the ten strongest nerves are all connected by a commissure; the six anterior nerve-trunks soon branch and anastomose; the two longitudinal trunks give off a number of trunks which supply all the hinder parts of the body, and, like the rest, are connected by a number of anastomoses. The ganglionic cells of the central organ may be multi-, bi-, or unipolar, and vary considerably in size; the largest are the multipolar, and these are larger than any other cells of the body, with the exception of the ova; the nucleus is in all cases large and vesicular. The central part of the brain is occupied by a finely fibrous substance, in which no nuclei or ganglia can be made out, and the constituent fibres anastomose with one another. The nerves themselves are composed of extremely delicate fibres, which are only feebly stained by reagents.

The sensory organs may be tactile, optic, or auditory; all the Polycladidea do not possess tentacles, for they are absent in the Leptoplanida and the Cestoplanida; some of the former have, however, rudimentary tentacles. The tentacles may be either dorsal in position and confined to the anterior part of the body ("nape-tentacles"), or they may be marginal. In the Planocerida the former are always movable, and in all cases they may be regarded as parts which have been inherited. The marginal tentacles, on the other hand, are structures which clearly have arisen since the Polyclad-stock was

differentiated, and are to be referred for a cause to the creeping mode of life of these worms; some of these marginal tentacles have the form of a fold, and are indeed nothing more than permanent folds of the anterior margin of the body in which the primitive (and in *Anonymus* the persistent) sensory organs were more numerously aggregated. From these folded tentacles the pointed ones appear to have been derived. Auditory organs have been found only in *Leptoplana otophora*. In addition to the special organs, it is to be noted that the whole surface of the Polyclad body is extremely sensitive.

In the tenth chapter the author commences, but does not complete his account of the generative organs, a notice of which must therefore be postponed till the second part of this important work is published.

Early Stages in the Development of Balanoglossus.*—W. Bateson describes with great minuteness the early stages in the development of an undetermined species of *Balanoglossus*, up to the formation of the layers and the commencement of the nervous system. Especial stress is laid on the points of difference between this larva and *Tornaria*. The *Balanoglossus* larva is opaque, has no preoral or longitudinal postoral bands of cilia, water-vascular system, eye-spots, or contractile string, thereby differing remarkably from *Tornaria*, which it resembles on the other hand in the possession of a transverse band of cilia and an apical tuft of cilia. A striking similarity is observed to exist between the general history of the early development of this larva, and that described by Hatschek for *Amphioxus*, this resemblance being more particularly strong in the situation and mode of origin of the central nervous system and of the mesoblastic somites.

New Rotatoria.†—Dr. E. v. Daday, after devoting several years to the study of the Hungarian Rotifera, especially those of Transylvania, in 1882 visited the groups of pools in the Mezöség, and found in the Mezö-Záher pool several new species, one of them representing a new genus.

Brachionus Margói n. sp. most nearly approaches *B. amphiceros*, especially as regards the processes of its carapace; but in that species the processes are all of equal lengths, while they differ in length in the new one. The essential distinction between the two species is to be sought in the rotatory organ, the musculature, the jaws, and salivary glands.

Schizocerca n. gen. *S. diversicornis* n. sp. resembles *Brachionus* in internal organization, but differs so much from the Brachionea, and, indeed, from all Rotatoria, in the structure of its foot, that the author regards it as the type of a new genus.

Asplanchna triophthalma n. sp. is one of the largest of the Rotifera, and very similar to *A. Sieboldii* (*Notommata Sieboldii* Leyd.) in the form of the body, the digestive apparatus, and the ovary. But the nervous system, the aquiferous vessels, and the construction of the rotatory organ show such considerable differences that the author has no hesitation about separating the two species, and he gives the new

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 208–36 (4 pls.).

† Math. Naturwiss. Ber. aus Ungarn, i. p. 261. See Ann. and Mag. Nat. Hist., xiii. (1884) pp. 309–10.

one the name of *A. triophthalma*, because besides the frontal eye, seated upon the œsophageal ganglion, it possesses two other smaller eyes placed at a distance from the ganglion, and provided with visual nerves. The male of *A. Sieboldii* possesses on each side of its body a triangular process; but no such appendages occur in the male of the new species.

Echinodermata.

Echinoderm Morphology.—Dr. P. Herbert Carpenter,* and W. Percy Sladen,† have essays dealing respectively with the apical system of the Ophiurids, and the homologies of the primary larval plates in the test of brachiate Echinoderms. The latter sketches the difference in the history of the development of the different groups, after noting that during growth there is a more or less centrifugal movement of plates, and that there are two natural sets of plates—a basi-oral or interradial, and a radio-terminal or radial series. In the earliest stages of the Crinoid the former primarily constitutes the whole calyx; during growth the radial series developes with disproportionate rapidity, and at a comparatively early stage predominates over the basal series. In the Ophiurid the radials are formed first, and the basals appear later. In the Asterid, as in the Crinoid, there is a retarded radial growth. In both Asterid and Ophiurid the outer plate of the retarded series appears earlier than the inner, and in both the representatives of the under-basals are not formed until the other plates are well developed. Sladen thinks the facts now known point to the conclusion that the Ophiurid is derived from a more highly developed Crinoid than the Asterid, which arose from a more primitive ancestor, and the two forms have advanced along collateral lines of descent. In both Asterids and Ophiurids, plates—the terminals—are found at the end of the arms, which are apparently without any homologues in the Crinoid. Dr. Carpenter urges very strongly the use of a reasonable terminology in the description of Crinoids. Against the view that the under-basals represent the dorsocentral plate of the young urchin, he puts forward the additional argument that not only has *Marsupites* a dorsocentral plate as well as under-basals, but the same is true of some Asterids and Ophiurids.

Development of Comatula.‡—E. Perrier recognizes three phases in the life-history of *Comatula*—the Cystidean, Pentacrinoid, and free Comatulid.

At the end of the first phase the young has no buccal tentacles or arms, its digestive tube forms a half-spire, and there is an anus at the side of the body. A U-shaped tube serves to introduce water into the tentacular apparatus, but it is not certain that it is the homologue of the sand-canal of other Echinoderms. The stalk contains six cords of cells, one of which is central, and is prolonged into the swollen part of the body, so as to occupy the axis of the

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 1–23 (1 pl.).
† Tom. cit., pp. 24–42 (1 pl.).
‡ Comptes Rendus, xcviii. (1884) pp. 441–6.

spine formed by the digestive tube; it occupies just the same position as the sand-canal of Echinids. The swollen upper portions of the other five cords give rise to the chambered organ. The arms do not appear simultaneously, but successively.

In the Pentacrinoid stage, in which there is no trace of a vascular system, the axial organ retains the histological structure of the ovoid organ of the preceding phase; the cirri arise from the central cord of the stalk, and the arms from the five peripheral cords. In the last phase, the axial organ, which has the structure of the sand-canal of Asterids and the position of the similarly-named canal in Echinids, is clearly seen to have a nutrient function in relation to the cirri.

Pharynx of an unknown Holothurian.*—Prof. H. N. Moseley minutely describes the pharynx of an unknown Holothurian belonging to the Dendrochirotæ, in which the calcareous skeleton is remarkably developed.

The specimen was dredged in the Sulu sea, no traces being found of the body to which it belonged. It measures about $1\frac{3}{8}$ in. in length, thus exceeding in size any of the previously known examples with which the author compares and contrasts it. Additional interest attaches to its possible palæontological significance as the publication of the present account and figure may lead to the recognition of fossil Holothurian remains hitherto undetected.

Cœlenterata.

Mesenterial Filaments of Alcyonaria.†—The chief results arrived at by E. B. Wilson from a study of the structure and development of the mesenterial filaments in numerous Alcyonaria are as follows:—

The six short filaments are formed as local thickenings of the septa, the rudiments appearing often before the breaking through of the stomodæum and "while the invaginated ectoderm was still everywhere separated from the entoderm by the supporting lamella"; this shows clearly that these filaments are of entodermic origin, though later they become continuous with the inner ectodermic wall of the œsophagus. It appears from the investigations of the Hertwigs and Krukenberg that these structures are the only organs of digestion, and this result is abundantly confirmed, diatoms and other foreign bodies being continually seen within the substance of the entodermic filaments, and occur within the entoderm-cells covering the septa or the dorsal filaments.

The two long dorsal filaments, on the contrary, are purely ectodermic in origin, being downgrowths from the stomodæum; the structure of these filaments is quite different from that of the entodermic filaments; the dorsal filaments are concerned in the production of currents, the cilia always working upwards. The dorsal filaments are developed earlier and more rapidly in the buds than the entodermic filaments, and the reasons for this are to be sought in the

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 255–61 (1 pl.).
† MT. Zool. Stat. Neapel, v. (1884) pp. 1–26 (2 pls.).

"physiological conditions existing in the bud and not in the egg embryo," where the entodermic filaments are the first to be developed; this condition is evidently the need for food; the bud embryo, unlike the egg embryo, has no deutoplasm, and is therefore dependent upon food brought to it from the nutritive zooids; thus the early development of the dorsal filaments which, as already stated, serve as circulatory organs; and since the nutritive supply must evidently come from below, the currents produced by the dorsal filaments work upwards.

The paper concludes with some general comparisons which are of the highest interest; it is suggested that the dorsal filaments are not merely the analogues but the homologues of the alimentary canal of higher animals; if the two became fused "we should have a digestive tube surrounded by closed cavities, in the walls of which are developed the muscles." This fusion does actually take place temporarily during digestion, and in *Alcyonium* the filaments appear sometimes to fuse permanently. In this case the "radial chambers of an Anthozoan correspond to the mesodermic diverticula of Enterocœla," a view which has already been set forth by several morphologists. With the exception of the Haimeida, all Alcyonaria show a marked bilateral symmetry, and the radial chambers may be considered as the unpaired diverticula and a series of lateral paired diverticula; the latter may perhaps be compared to the somites of segmented animals. It is well known that a ciliated groove exists on the ventral side of the œsophagus, and if this portion were to become separated off from the rest of the œsophagus and the mesenterial filaments fused, the result would be an "animal with a stomodæum and proctodeum, a closed mesenteron, and paired mesoblastic somites."

Anatomy of Peachia hastata.*—M. Faurot recommends that this Anthozoon be first rendered insensible by water charged with carbonic acid. He finds twelve mesenterial folds, perforated at the level of the œsophagus; two neighbouring folds, instead of floating freely in the general cavity, unite to form a grooved organ, which has externally the appearance of a papilliform lip, and ends in the general cavity a short distance from the inferior orifice, which *Peachia*, like *Cerianthus*, possesses. Eight muscular bands project on the internal wall; these are arranged by pairs, so that four only of the twelve chambers are provided with them. These four chambers are placed asymmetrically, two of them being situated on either side of the grooved organ, and the other two being set opposite, on an axis perpendicular to that which passes through the papilliform lip and the inferior orifice.

Ephyræ of Cotylorhiza and Rhizostoma.†—C. Claus has been able to study a swarm of *Cotylorhiza* in all stages of the Ephyra phase; the youngest were from 1½ to 2 mm. in diameter, with eight long slender lobes, the cleft pieces of which were rounded rather than pointed. They are to be distinguished from the ephyræ of *Aurelia* or *Chrysaora* by the yellow algal cells, which, when accumulated in

* Comptes Rendus, xcviii (1884) pp. 756–7.
† Arbeit. Zool. Inst. Wien, v. (1884) pp. 175–83.

the radial canals, give rise to the appearance of two streaks in each of the main lobes, by the numerous spindle-shaped crystals which are found in the terminal division of the ocular lobes, and by the large size of the intermediate radial vessels. During growth the umbrellar disk of the larva grows out of proportion to the eight lobes, new structures appear on the buccal part of the oral tube, which seem to be of great importance in the future rhizostomatous condition of the animal. A closed annular canal is developed. Buccal tentacles appear in the Cannostomous stage, and their early development may be regarded as the "primary process superinducing rhizostomism"; this is then followed by the peculiar form of the four arms with their extended distal margin, and these by paired foldings of the brachial processes.

The chlorophyll-corpuscles already mentioned are regarded as belonging to symbiotic algæ, and the balls they form are thought to be due to the continued division of a single cell; they are present in such quantities, that one is tempted to suppose that there is no independent animal nourishment, but that the superfluous assimilation-products of the algæ are sufficient to support the medusæ. After long search, Claus has found Rhizostomata in an Ephyra-stage, but he is anxious for smaller and younger specimens than those which measure 3½ mm.

Porifera.

Calcisponges of the 'Challenger' Expedition.*—This, the first report on the 'Challenger' representatives of any group of sponges, is from the pen of a Russian naturalist, Dr. N. Poléjaeff. The Calcarea were considered by Häckel as essentially littoral forms, and the fact that two species were found by the 'Challenger' at a greater depth than 100 fathoms (viz. 450 fathoms, off the Azores), scarcely invalidates this conclusion, and at the same time accounts for the small number of species (30, of which 23 are described as new) obtained by the expedition.

A great importance attaches to the report from the fact that the author, having well-preserved materials and considerable time at his disposal, and a good training in the subject, has devoted himself to making the first thorough examination of the anatomy, and of the principles of a natural classification, since Prof. Häckel brought out his memorable work, the 'Kalkschwämme.' With regard to his predecessor's results, he is led to the conclusion that, although Häckel's "natural system" may be more natural than his "artificial" one, it is still very far from absolute agreement with nature; a conviction which has been more or less strongly felt by other observers. He rejects Häckel's system of defining the genera solely by spicular characters, pointing out that they are too variable for the purpose. Considerable alteration is found necessary in Häckel's account of the canal system. Thus, the assertion that inter-canals (the incurrent canals leading from the pores) of the *Sycones* are wanting in a large

* 'Report, &c., H.M.S. Challenger,' Zoology, xxiv. (1883) 76 pp. (9 pls.).

proportion of these forms, is shown not to hold for a number of these very species, and hence is probably untrue of all. Again, the "dendroid," "retiform," and "vesicular" modifications of the canal-system described by Häckel in various *Leucones* are in reality not present there. Poléjaeff agrees with Vosmaer in regarding the radial tube of the *Sycones* as simply a form of flagellated chamber, and not, like Häckel, a "person" equivalent to an individual *Ascon;* the *Olynthus* is simply a common form, out of which may be developed, by different processes, either a *Sycon* or an *Ascon*, the mesoderm in the former being more developed than in the latter, and thus giving capacity for a more differentiated canal-system. From their minute characters, in combination with Von Lendenfeld's observations on *Aplysinidæ*, he is led to ascribe the function of receiving food to both the ecto- and entodermal pavement-cells of the canals.

The mutual relations of *Leucones* and *Sycones* are elucidated by the discovery of a *Sycon* (*Amphoriscus elongatus*) in which the radial tubes, instead of opening directly and singly into the cloaca, debouch by groups of three, four, or more, into secondary chambers which in turn open into the common cloaca; the secondary chamber has only to be exaggerated to form the excretory canal which leads from the flagellated chambers of a *Leucon;* the skeleton of the radial tube of this and other primitive *Sycones* is non-articulated, i. e. does not form a succession of septa in the parenchyma surrounding the tube, and thus affords another point of connection with the similarly circumstanced *Leucones*.

The canal system, as thus elucidated, is taken as the basis of the modified classification, which runs thus:—

Class Calcarea.	Order 1. *Homocœla.*	Family 1. *Asconidæ.*
	„ 2. *Heterocœla.*	„ 2. *Syconidæ.*
		„ 3. *Leuconidæ.*
		„ 4. *Teichonidæ.*

(The last family is Carter's, whose reasons for establishing it are adopted.) The genera of the class are entirely reconsidered on the basis of allowing to all the elements of the organization a share in the systematic distinction, and the law of priority in the nomenclature, set aside by Häckel, is reasserted. The genera, as revised, are—

Fam. *Asconidæ: Leucosolenia*, provisionally adopted as the only genus.

Fam. *Syconidæ: Sycon, Grantia, Ute, Heteropegma* n. gen., *Amphoriscus, Anamixilla* n. gen. The chief distinctions employed are the articulation or non-articulation of the tubar skeleton, the mutual independence or not of the tubes, and the form of the spicules. *Heteropegma* differs from *Grantia* in having a cortex composed of spicules of a different size from those of the parenchyma. *Anamixilla* has no special tubar skeleton.

Fam. *Leuconidæ: Leucilla, Leuconia, Leucetta, Pericharax* n. gen. They are based on the form of the ciliated chambers, the arrangement of the spicules, the presence or absence of a cortex, or (*Pericharax*)

on the presence of subdermal cavities, such as are found in siliceous sponges.

Fam. *Teichonidæ: Teichonella* Carter, and *Eilhardia* n. gen., the latter distinguished by a cup-like form, the oscular and pore-surfaces respectively bearing spicules of a different character.

The general histology is not overlooked. In two species the mesoderm was found to contain some large flattened cells whose protoplasm forms a network upon large spicules, and perhaps contributes to their formation. Ova were found abundantly only in two species. The author's former observations on the spermospores of Calcarea are confirmed; they are undoubtedly of mesodermic origin.

Australian Monactinellida.*—R. v. Lendenfeld has chosen a rich and comparatively unworked field for systematic work among the sponges, viz. Australia and New Zealand, from which he claims to have specimens of about 500 species at his command. He gives a preliminary account of his classification, with genealogical and structural considerations suggested by the study of this large collection, but appears, unfortunately, not to have attached sufficient importance to the work of previous labourers in this field, for although he refers frequently to the work of Schmidt and F. E. Schulze, whose generalizations are based almost exclusively on the Mediterranean and Atlantic faunas, we find no allusion (as such) to Mr. Carter's very full and carefully constructed system, which embodies the results of the examination of, *inter alia*, very large Australian collections, such as his eminent German colleagues have probably never had access to. Von Lendenfeld derives the *Monactinellida* from the Horny sponges; the two fundamental families of his system are obtained by the subdivision of the older family *Chalinidæ*, viz. into (1) *Chalarchidæ*, characterized by a horny network with scanty and very slender biradiate (acerate) axial spicules. (2) *Chalcœnidæ*, by a horny network with dense masses of large biradiates. From (2) he derives, on one side, (3) *Renieridæ*, containing biradiate spicules, but devoid of perceptible horny substance, and on the other, (4) *Echispidæ*, distinguished by spined spicules projecting from the horny fibre from between them (co-extensive with *Ectyonida* Carter). (5) *Chlathridæ*, with horny network, containing acuate spicules (almost co-extensive with *Axinellida* Carter). From (5) is derived, (6) *Suberitidæ*, with uni-radiates, and without horny substance.

He denies to the flesh-spicules any share in the demarcation of the large groups, but reserves them for generic distinctions; hence Schmidt's and Vosmaer's family *Desmacidinidæ* does not appear. These spicules he regards as of common origin, but as quite distinct from the skeletal spicules. He has, however, been induced to lay less weight on them from having found them in sponges otherwise very distinct from each other—a fact probably due (as his discovery of them in a *Hircinia* shows) to their occurrence as *foreign* bodies in some of the sponges in question.

The skeleton spicules commence with a biradiate form, and proceed by reduction of a ray to the formation of (i.) acuates, and (ii.)

* Zool. Anzeig., vii. (1884) pp. 201-6.

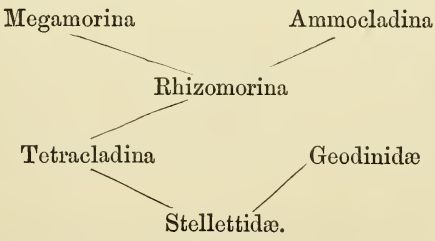
spinulates and spined acuates. The *Myxospongiæ* are regarded as the ancestors of allies of the *Spongiidæ* (s. str.), which have given rise to the *Aplysinidæ* and *Hircinidæ*. Throughout the Monactinellid series there is a tendency to form flesh-spicules, which are divisible into (1) *Monactinellid*, e. g. anchorates, &c., and (2) *Polyactinellid*, as stellates. They remain insignificant when a fibrous skeleton was already in existence, but where this is wanting they assume its functions and form continuous skeletons.

The boldness of attempting to construct a fresh classification of sponges, and to describe 500 Australasian species when separated by some thousands of miles from the only sound basis for systematic work in this group—viz. collections of authentic types of previous writers—seems scarcely justified by this sample of the results, and must, it is to be feared, lead to the further complication rather than the elucidation of this difficult subject.

Japanese Lithistidæ.*—L. Döderlein describes some new Lithistid sponges from Enoshima:—*Seliscothon chonelleides*, *Discodermia japonica*, *D. calyx*, and *D. vermicularis*. In the description of these latter he has avoided the use of the expressions individual and colony, but it has been difficult not to use them, for while *D. japonica* has in its simplest condition the form of an individual, it may by budding give rise to other individuals, and to the whole mass the word colony might be properly applied. *D. calyx* has not a single large osculum, but a number of smaller ones, so that here the limits of individuality are at once passed, and *D. vermicularis* has the oscula appearing quite independently of the division, so that the buds that are formed have no individuality. This last, indeed, is neither a simple sponge nor a sponge-colony, but rather a branched sponge.

After an account of the siliceous spicules and of the sarcode, the author refers to the difficulty raised by the fact that, while some of his sponges contained very few embryonic corpuscles, others had a great many; this is to be explained by the periods of vegetation, to which these sponges are subject, and from which is due the maximal and minimal conditions of their growth; they do not live in such deep water as to be free from the influence of the surrounding medium.

After briefly noting the characters of the now twelve known species of this genus, and discussing various points in their physiology, the author passes to the affinities of the Lithistidæ, of which he gives the accompanying phylogenetic table.



* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 62–104 (3 pls.).

The author recommends the study of the form and development of the embryonic parts of the skeleton as affording the best criterion of the correctness or want of correctness of the alliances here suggested.

Fossil Sponges in the British Museum.*—This fine work from the pen of Dr. G. J. Hinde, a pupil of Prof. Zittel, the great leader in the modern development of the palæontology of sponges, is a fitting tribute to the excellence of the principles of classification which have been laid down by the distinguished professor. Its classification is based essentially on the principle of the employment of the minute structure of the skeleton for its fundamental distinctions. While the adoption (in the Introduction) of the older, Häckelian, grouping of the tissues of living sponges into syncytium (ectoderm and mesoderm of Schulze) and ciliated cells (entoderm of Schulze) is not a happy feature, yet, on his own ground, Dr. Hinde does good service in his careful account of the mineralogical characters of fossil sponges. He upholds the ready replacement of organic silica by calcite. Diagnoses are given of the British species and the new foreign ones; references are given in the case of the remaining described species from foreign horizons; the rich collections of William Smith, Toulmin Smith, Mantell, and Bowerbank render the British part of the collection particularly interesting, and the work may be regarded as a manual of British fossil spongology.

The new genera are 27 in number; of these, *Climacospongia*, *Lasiocladia*, and *Acanthorhaphis* are siliceous Monactinellids; the first strongly resembles *Reniera* in the recent series. *Acanthorhaphis* is perhaps related to the recent *Metschnikowia* of the Caspian Sea. The Lithistidæ, as might have been anticipated, contribute largely to the long list of new types, viz. 10 genera. Of these, the Megamorina are represented by *Placonella*, *Holodictyon*, *Pachypoterion*, *Nematinion*, chiefly distinguished by general form or by points in the arrangement of the internal "canals." To the Tetracladine group of Lithistids Dr. Hinde adds no less than six new types, viz. *Bolospongia*, *Kalpinella*, *Thamnospongia*, *Pholidocladia*, *Phymaplectia*, *Rhopalospongia;* in the last alone does any considerable divergence from the normal character of Tetracladinæ appear in the spiculation, viz. a part of it inclines towards the Rhizomorine type. It is noteworthy as illustrating the advance made by the new system of classification, that a close resemblance is to be traced between the external form of some of these genera and that of genera belonging to quite different groups.

Considering its wider range in time and its greater comprehensiveness, the order Hexactinellida is not so richly represented by new types in this collection as the Lithistidæ. Among the forms with a continuous skeleton (Dictyonina), the Euretidæ contribute two such types, viz. *Strephinia*, which forms irregular or cup-shaped expansions—a habit unusual in the recent members of this family, and *Sestrodictyon*. Ventriculitidæ are represented by a new form, *Sestro-*

* 'Catalogue of the Fossil Sponges, in the Geological Department, &c., with descriptions of new and little known species.' 4to, London, 1883, 248 pp. (38 pls.).

cladia, which is remarkable for its dendroid growth; the branches are hollow. Of the Staurodermidæ of the collection the new forms are *Placotrema* (allied to *Porospongia*), *Cnididerma* (distinguished by having the level dermal surface divided up regularly into squares by the arrangement of its spicules), and *Plectoderma*, differing slightly from *Dictyophyton*, but of which the form is unknown. The Callodictyonidæ have *Porochonia*, based on an old species of *Ventriculites* provided with a delicate surface-tissue besides the usual dermal layer, and *Sclerokalia*, a nest-shaped sponge, with vertical rows of apertures on the inner surface, and shallow canals leading from them. No new Lyssacine Hexactinellid genera are described.

The Calcarea, as defined by Dr. Hinde, are very numerous, owing to the inclusion by him of the *Pharetrones* (distinguished by the possession of a fibrous skeleton) in the group, in which course he follows Zittel and the more recent views of Steinmann and Dunikowski; this step is in partial opposition to Carter and Sollas, who regard some, at any rate, of its members as siliceous. Unlike Dunikowski, who places them under the Leuconidæ, he regards them as constituting a distinct family; he relies largely on the character of the fibre and the methods of arrangement of the spicules in it, for his definition of genera. Few species are described as new. The new genus *Tremacystia* unites a number of already known species, distinguished by a metameric segmentation of the sponge. *Inobolia* is distinguished by its form and the absence of canals. *Trachysinia* has a cylindrical form and may be compound; it is based on three new Jurassic species. *Diaplectia* has the growth of *Pharetrospongia*, but contains tri- and quadriradiate spicules. *Raphidonema* has elongate triradiate spicules like those of *Corynella*. Among the Calcarea, but as *incertæ sedis*, is introduced *Bactronella* n. g., from the Upper Jura; it resembles the recent Leuconidæ, but the spicules are spinous. No Horny sponges find mention.

Tables and lists are given showing the known distribution in time of all the species, from which it appears that the Cretaceous beds contribute to the collection by far the greatest number, viz. the large total of 250 species, of which 103 are Lithistidæ, 85 Hexactinellida, and 46 Calcarea (including *Pharetrones*); the total number of species enumerated is 399. A bibliography is given.

Vosmaer's Manual of the Sponges.*—G. C. J. Vosmaer completes the review of the literature of sponges commenced in the first instalment of this work.† He devotes seven pages to an account (A) of the best methods of investigation, under the heads (1) *Investigation of the soft parts.*—Killing and preserving, staining, preparation and preservation of sections, decalcification and desilicification. (2) *Investigation of the skeleton.*—Skeleton of the Calcareous Sponges, of the true Horny Sponges, of the Siliceous Sponges. (B) Preservation for collections. (C) Rearing larvæ under the Microscope. For hardening, absolute alcohol, picro-chloric and osmic acids, and corrosive sublimate;

* 'Dr. H. G. Bronn's Klassen und Ordnungen des Thierreichs. Band ix. Porifera.' Lief. 3–5, 1884, pp. 65–144 (10 pls.). See this Journal, ii. (1882) p. 797.

† See this Journal, i. (1881) p. 611.

for staining, hæmatoxylin, picrocarmine, iodine, chloride of gold, and nitrate of silver are respectively recommended. Under the heading *Morphology* is given a general sketch of the range of shape, size, colour, consistency, and character of the surface in the group. Under *Anatomy* is given an account of the different parts of the canal system of sponges, and their chief modifications. The four types under which the leading modifications of this system are arranged by the author in a previous work are adopted here also.

Protozoa.

Nucleus and Nuclear Division in Protozoa.*—A. Gruber passes in review the different groups of the Protozoa; commencing with the Rhizopoda, he points out that, though their nuclei differ considerably, they are all referable to the type of the so-called vesicular nucleus. There is a more or less distinct nuclear membrane, and a clear and apparently homogeneous nuclear substance in which are deposited one or more nuclear corpuscles. Such nuclei are to be found in the lowest myxomycetoid plasmodia, and Bütschli is probably right in regarding this form of nucleus as the primitive one; previous to this, however, there was, in all probability, a stage in which small granules of nuclear substance were scattered through the whole of the protoplasm, and these were only later collected into a proper nucleus. As a fact, there are organisms which exhibit such characters; as, for example, some of the forms described by Maupas, the very low *Trichosphærium sieboldi* (*Pachymyxa hystrix*), and, probably, the *Pleurophrys gennensis* discovered by the author. In all these we find small spheres which are strongly coloured by certain reagents scattered through the body. Moreover, as Brandt was the first to show, *Amœba proteus* contains not only a definite nucleus, but also small granules of nuclear substance.

Amœba verrucosa is cited as an example of a form which, though it seems to have a very definite vesicular nucleus, is found on examination with higher magnifying powers (e.g. Hartnack Oc. 3, Obj. 12 Imm.) to have its nuclear corpuscles made up of smaller spherules. When stained, these bodies gradually become less distinctly visible; there appear in the substance of the nucleus excessively fine granules, so fine as to have the appearance of a red dust; these would seem to be true chromatin particles, which may become united into fine filaments; they form lines arranged radially around the nucleolus. They are best seen in specimens that have been treated with absolute alcohol or picrocarmine. Although, therefore, there is a nuclear network in *Amœba verrucosa* it is very incomplete, and, as observation has shown, takes no part in the division of the nucleus. Multinucleolar nuclei are derived from the uninucleolar by repeated division of the nucleolus.

The division of the vesicular nucleus is effected by constriction or by cleavage. In the former case, the chromatic substance is first diffused through the whole nucleus; in the latter case the nucleolus

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 121–53 (2 pls.).

divides first, the halves separate from one another, and then the rest of the nucleus is cut through.

Among the Rhizopoda two other kinds of nuclei are also seen; in one of them we distinguish a nuclear membrane, and substance, within which are scattered, more or less irregularly, particles of chromatic substance. On division these become arranged into filaments, which, at first coiled, become later on arranged parallel to the long axis of the extending nucleus, and so are equally divided on its constriction. The other form is distinguished by the presence of a cortical zone, generally consisting of granules, which lies just beneath the nuclear membrane. Here there is but little nuclear substance and a large central nucleolus. In division, the nucleolus divides first, and the parts separate from one another; the cortical zone is then divided equatorially, and finally the whole nucleus is cut through.

Lastly, the nuclei of some Foraminifera are remarkable for being distinguishable into two halves, one of which is quite filled with chromatic substance, while the other has one or more nucleoli. The mode of their division is as yet unknown.

The Heliozoa are next taken up, and their nucleus found to consist of a nuclear membrane, clear nuclear substance, and a central nucleolus, or there are several nucleoli; or, finally, there is a membrane, a cortical layer, nuclear substance, and central nucleolus. In this last, division always begins; when there are several they unite into two plates, which separate from one another.

In the large nuclei of the intermediate Radiolaria, we find (α) vesicular forms, exactly like those of many Rhizopoda and Heliozoa, (β) nuclei with a cortical layer (as in *Actinophrys*); (γ) nuclei with a very strong membrane, dark and often granular nuclear substance, in which radiating bands may sometimes be seen; and (δ) nuclei with a plexiform arrangement of the chromatic substance, and nucleoli imbedded in the meshes; the fissive methods of none of these are satisfactorily known.

The small nuclei of the multinucleate Radiolaria are either amœboid and divide by simple constriction, or are quite round or oval when division commences with the radiate arrangement of the chromatic substance.

The nuclei of the Gregarinida have a vesicular structure, and one or more nucleoli; their mode of division is not known. The nuclei of the spores are quite homogeneous and divide by constriction.

The different groups of the Infusoria are discussed separately; in the true Flagellata we find vesicular nuclei, which divide by the regular constriction of all the parts, and the formation of parallel longitudinal lines in the nucleolus. In *Noctiluca* the nucleus forms a granular mass in which nucleoliform corpuscles are distributed; but in *Leptodiscus* the nucleus is formed of a larger, darker, and granular portion together with a smaller and clearer part. Unlike *Rotalia*, the hyaline part here contains the chromatic substance. In *Noctiluca*, as observed by Robin, the nucleus elongates, and the central part becomes longitudinally striated. In the Cilio-flagellata

the nucleus is formed on the "massive" type; that is to say, the nuclear membrane incloses a thick mass of nuclear substance, which, in all probability, contains the chromatin in the form of small granules. So far, the nucleus of the Cilio-flagellata resembles that of the next group—the Ciliata.

The description of the nuclei of the Ciliata offers considerable difficulties in consequence of the numerous variations which are to be seen in the structure of even closely allied species. The nuclear substance may be so dissolved in the cell-substance, and the granules may be so fine as to be only distinguishable with the highest powers; or the constituents of the nucleus may be larger, and formed (as in *Oxytricha*) of spherical corpuscles which, before division, unite into a mass. This substance may form bands and plexuses, and sometimes, as in *Benedenia* and *Plagiotoma*, break up into pieces; this leads to the rosette-like nuclei of *Stentor*, or the band-like nuclei of *Vorticella*. It is rare for an Infusorian to have more than one nucleus, but the number of the paranuclei is by no means so constant. The nucleus is generally "massive" and surrounded by a membrane; its substance is very rich in chromatin-granules, which are very variously arranged; the paranuclei are likewise massive, and apparently always granular. On division, the chromatin-granules form filaments which lie parallel to the long axis of the nucleus, and become constricted in the middle.

The nucleus of the Suctoria, the last group of all, is either branched or rounded; there is a thick massive nuclear substance, in which chromatin-granules are often very distinctly visible. On division, the nuclei break up into filaments which undergo constriction.

The author thus sums up the results of this important investigation:—

There are Protozoa in which the nuclear substance may be distributed through the protoplasm of the cell in the form of numerous granules; and these are often so small that after staining they only appear, on examination under high powers, as a precipitate. In others there are nuclear particles of this kind, but they are not only more numerous, but are also larger, and, in fact, more regularly arranged, so that they may be better spoken of as small nuclei; these lead us to the truly multinucleate forms. He thinks it possible that in those Protista which appear to us to be non-nucleate, the nuclear substance is more or less completely dissolved in the cell-substance; and that in the history of race development there was not at first a definite and formed nucleus, but rather fine nuclear granules. In any case, the formation of a true nucleus is intimately associated with the process of reproduction, and, primarily, with regular division.

A most important piece of evidence is afforded by those Protozoa which, after conjugation and division, are for a time filled with small nuclear particles. It would appear that there is a regular distribution of the chromatin in the daughter-individuals.

The nuclei of the Protozoa belong, as a rule, to one of two types: they are either vesicular, as in most Rhizopods, Heliozoa, Sporozoa, and all true Flagellata, as well as in some Radiolaria and Ciliata, or

massive as in almost all Ciliata and Suctoria; the paranuclei, which are probably confined to the Ciliata, are also formed on this type. The process of nuclear division consists in the aggregation of the chromatin mass into a form which is capable of exact division by equatorial constriction. This process is best known, and is most clearly seen in the ciliated Infusoria, when the chromatic substance becomes arranged into filaments of equal length, which are broken through in the middle on the division of the nucleus.

Nuclear division in the Protozoa is a much simpler matter than in the Metazoa, where the arrangement of the chromatic substance is much more complicated; there too the mechanism is quite different, for there is not a division of the nucleus *in toto*, but a breaking up of the nuclear substances followed by their separation. At the same time, Gruber is of opinion that among the Metazoa there are to be found nuclei which are formed on the Protozoic type, and in which division is effected in the same mode as in the Protozoa.

New Infusoria.*—C. S. Dolley describes a Cilio-flagellate Infusorian in Baltimore drinking water apparently constituting an intermediate species or variety between *Peridinium tabulatum* and *P. apiculatum*.

A. C. Stokes describes † a new Choano-flagellate, *Codosiga florea*, found on dead and decaying leaflets of *Myriophyllum* from an aquarium.

Miss S. G. Foulke describes ‡ a new *Trachelius* (*T. Leidyi*), the second true species of the genus, the principal difference between it and *T. ovum* being that while the latter is egg-shaped, the new form is globosely convex dorsally, but flattened with a deep indentation ventrally.

Stentor cæruleus.§—"J. W." claims to have discovered that "the blue *Stentor* not only takes small food-particles through the oral aperture but that it has the means of projecting portions of its protoplasm to serve the purpose of capturing its prey, for the rotifers and *Paramecia* under observation were slowly drawn into the body still surrounded by a transparent envelope and were gradually absorbed. Sometimes two or more rotifers were seen together in the same *Stentor* undergoing absorption. All movements of the prey ceased when caught by the rhizopod-like extension of the *Stentor*."

Chlorophyll-corpuscles of some Infusoria.‖—By way of supplement to Prof. E. Ray Lankester's paper on a form of chlorophyll-corpuscle present in *Spongilla* and *Hydra viridis*,† Miss J. A. Sallitt describes the chlorophyll-corpuscles in several green forms of infusoria.

In *Paramecium bursaria* the corpuscles are very numerous, and are scattered through the endoplasm of the animal. They are usually spherical and vary in size from ·0025 mm. to ·006 mm. in diameter.

* Johns Hopkins Univ. Circ., iii. (1884) pp. 60–1.
† Amer. Mon. Micr. Journ., v. (1884) pp. 43–5 (1 fig.).
‡ Proc. Acad. Nat. Sci. Philad., 1884, pp. 51–2.
§ Amer. Mon. Micr. Journ., v. (1884) pp. 50–1.
‖ Quart. Journ. Micr. Sci., xxiv. (1884) pp. 165–70 (2 pls.).
¶ See this Journal, ii. (1882) pp. 322–4.

Each consists of two parts, 1st a ball of clear protoplasm; 2nd an investing cup-like layer of chlorophyll-containing protoplasm (to which the author gives the name of chloroplasm) of a bright green colour. Subdivision of the corpuscles into two, three, and four parts was observed to take place. In *Stentor polymorphus*, *Vaginicola grandis*, and *Phacus triqueter*, *P. longicaudis* and *P. glabra* the corpuscles generally resemble those of *Paramecium*. In *Vorticella chlorostigma* no corpuscles are present, but the chlorophyll is apparently diffused through the endoplasm. In *Euglena viridis* the corpuscles are much flattened and are irregular in outline, and in many cases the chlorophyll appears diffused through the endoplasm; but the author does not agree with Saville-Kent in considering this to be the normal state, and the chlorophyll-bodies to be due to its splitting up previous to multiple division.

If the function of the chlorophyll in animals is the same as that ascribed to it in plants by Prof. Pringsheim, the disposition of the chlorophyll in the animal corpuscle is better adapted to shelter the central colourless protoplasm than that of the substance of the cell. So the greater saving of oxidizable material should take place in the corpuscle itself. No trace of starch is to be found in the corpuscles or in the endoplasm.

Life-history of Clathrulina elegans.*—Sara G. Foulke states that the modes of reproduction of the Heliozoan *Clathrulina elegans* are four in number, by division, by the instantaneous throwing-off of a small mass of sarcode, by the formation and liberation of minute germs, and by the transformation of the body into flagellate monads. The fourth mode is significant in bringing to light a new phase in the life-history of the Heliozoa. The *Clathrulina* in which the phenomena were first observed, withdrew its rays, and divided into four parts, as in the ordinary method; but the sarcode, instead of becoming granular and of a rough surface, grew smoother and more transparent. Then followed a period of quiescence, in this case of five or six hours' duration, although in other instances lasting three days and nights, after which one of the four parts began slowly to emerge from the capsule, a second following a few moments later. While passing through the capsule, these masses of sarcode seemed to be of a thicker consistence than the similar bodies which, in the ordinary method, instantly assume the *Actinophrys* form. After both had passed completely through for nearly a minute they lay quiet, gradually elongating meanwhile. Then a tremor became visible at one end, and a short prolongation of the sarcode appeared waving to and fro. This elongated at the same time into a flagellum, the vibrations becoming more rapid, until, at the same moment, both the liberated monads darted away through the water. They were followed for about ten minutes, when both were lost to sight among a mass of sediment, and the fear of mistaking one of the common monads for them led the observer to abandon the search. Another monad was followed through various movements,

* Proc. Acad. Nat. Sci. Philad., 1884, pp. 17–9.

and finally seen to attach the top of its flagellum to the glass, and revolve swiftly for a few moments, when instantly the whole body became spherical, rays were shot out, and the transformed monad was in no point, except that of size, to be distinguished from its *Actinophrys*-like cousin. The whole development, from the time when the monad began its free life, occupied two hours and some seconds.

This mode of reproduction secures a more widespread distribution of the young than would be possible did they depend on the sluggish *Actinophrys* form. It seems reasonable to suppose that this is a wise provision for the perpetuation of the species should adverse conditions of life arise and also to prevent an undue accumulation of the animals within a circumscribed space.

Aberrant Sporozoon.*—J. Kunstler describes an aberrant sporozoon for which he suggests no name. It is a kind of monocystid Gregarine, found in the body-cavity of *Periplaneta americana*. It is at first placed to the exterior of the epithelial cells of the mid-intestine, in front of the insertion of the Malpighian tubules. It grows in the cell, crosses the muscular tissues, and drives before it the peritoneal investment; the sac thus formed becomes stalked. The Gregarine, after further growth, breaks through the peduncle and escapes into the body-cavity. At first it consisted merely of a single cell with a central nucleus; later on it consisted of two similar bodies, so that it appeared like a pair of conjugated monocystids; here, however, there has been no conjugation, for the nucleus was often seen to be elongated and more or less constricted in its middle, as if it were about to divide. Sometimes there are three lobes. The adult exhibits no movement of translation, and only feeble contractions result from the application of acids. The adult has, when encysted, two envelopes; before encystation it becomes transparent, whereas all other forms are opaque.

Noctilucidæ.†—F. Ritter v. Stein in Pt. III. of his 'Infusionsthiere,' gives some new interesting facts respecting *Noctiluca miliaris* and other allied forms. This Infusorian is unusually large, sometimes having a diameter of 1 mm.; although spherical in shape a dorsal and ventral surface may be recognized, as Dönitz first pointed out, by the presence of a rod-like structure (*stabplatte*) which lies in the outer membrane; this body has a shovel-like flattened anterior end and lies on the ventral side of the mouth. The tentacle is supported by two skeletal pieces, and is not apparently a sensory organ as has been thought, but assists in bringing food to the mouth. The protoplasm of the body is not uniformly distributed but lies in a mass between the mouth and the *stabplatte* sending out branched protoplasmic filaments which are attached to the outer membrane. Closely allied to *Noctiluca* is the genus *Ptychodiscus* which has, however, a simpler organization. The body is inclosed by two thick-walled shells of parchment-like consistency united along their margin by a more delicate membrane; the dorsal shell is distinguished from the ventral

* Comptes Rendus, xcviii. (1884) pp. 633-4.

† 'Organismus der Infusionsthiere,' Abth. iii. Hälfte ii.

by a more or less sickle-shaped body corresponding to the *stab-platte* of *Noctiluca*; the ventral shell has an anterior notch in which lies the mouth-slit; the protoplasmic contents entirely fill up the space between the two shells; there is no trace of a tentacle present.

Another Infusorian, *Pyrophacus horologium*, belongs to the same family, and like *Ptychodiscus* was found by Stein in the stomach of *Salpa*; the body is inclosed in a shell which has the appearance of being made up of a number of pieces united in a mosaic fashion; in the same way the shell is made up of a dorsal and ventral half united by membrane; the former is distinguished by the presence of a *stabplatte*; in addition to a mouth-opening there is another opening which is analogous to an anus.

Noctiluca miliaris, as is well known, has a great share in producing phosphorescence of the sea on our own coast and elsewhere; but in the neighbourhood of Kiel this Infusorian is not to be found and the phosphorescence there is chiefly due to *Ceratium* and *Prorocentrum micans*.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Continuity of Protoplasm.*—E. Russow declares his belief that in all plants during their entire life the whole of the protoplasm is continuous. He bases this conclusion on a series of observations carried out on a plan slightly modified from that of Hillhouse. Fresh sections of the plant to be examined are laid in a solution of 0·2 p.c. iodine and 1·64 p.c. potassium iodide, to which is added a mixture of 3/4 sulphuric acid, and a small quantity of the same acid more concentrated. The sections are then repeatedly washed and stained by anilin-blue; before staining they are sometimes laid in picric acid.

Tangential sections of the cortex of many plants treated in this way showed very clearly the strings of protoplasm connecting adjoining cells. The periphery of the cell-contents is wavy on the longitudinal sides, more or less uneven on the transverse sides. The concavities, which are usually rounded, correspond to the pits; and between the corresponding prolongations of two adjacent cells are seen from three to five moniliform threads of protoplasm, usually strongly curved. In each thread are several granules, usually at regular distances. These threads are met with also between the parenchymatous cells of the bast, and between these and the cells of the medullary rays; in the latter case they are extremely delicate. The threads are seen especially well in *Rhamnus*, *Fraxinus*, *Humulus*, and *Gentiana cruciata*; also in the cortex of numerous other woody plants, as *Prunus*, *Quercus*, *Populus*, *Alnus*, *Æsculus*, &c., and in some herbaceous or climbing plants, such as *Lunaria rediviva*, *Lappa*, *Cucurbita*, &c.

* SB. Dorpat Naturf. Gesell., 1883. See Bot. Centralbl., xvii. (1884) p. 237. Cf. this Journal, iii. (1883) pp. 225, 524, 677, *ante*, p. 76.

It is noteworthy that, in all the plants examined, the conducting cells do not appear to be in connection, by means of protoplasmic threads, either with one another or with adjacent cells, such as the sieve-tubes and bast-parenchyma; but the author believes that the pits are perforated by very fine threads, which are invisible in consequence of being composed of a homogeneous transparent albumen.

Russow maintains that the perforations in the pits of cell-walls are cotemporaneous with the formation of the cell-wall. During the last stages of the division of the nucleus, in which the protoplasmic threads are stretched between the daughter-nuclei, already at a distance from one another, the cell-wall has the form of a perforated plate, the threads remaining unbroken, and forming a connection between the daughter-cells. He finds that in some cases the radial walls of the cambium-cells have a single row of primordial pits; before each division these about double in diameter; the fine perforations of the closing membranes also increase; the connecting threads of protoplasm probably split lengthwise, and cellulose is formed between them. The perforations between the tangential and transverse walls are formed in the same way, as also the sieve-like perforations in the transverse and longitudinal walls of sieve-tubes.

The author finds also a mucilaginous protoplasmic substance in the intercellular spaces of young cortex, which is strongly developed in the motile organ of *Mimosa*; and here again a communication is effected by means of threads between this protoplasm and that of the cells.

Continuity of Protoplasm.*—Since his previous experiments on this subject, W. Gardiner has been chiefly employed in testing and improving his methods, and in adding to the number of plants in which he has been able to demonstrate the existence of a continuity of the protoplasm between adjacent cells.

In certain endosperm cells, e.g. *Bentinckia Conda-panna*, where the protoplasmic threads traversing the cell-walls are particularly well developed, it is possible to see the threads perfectly clearly by merely cutting sections of the endosperm and mounting them in dilute glycerine.

The method of swelling with chlor-zinc-iod and staining with picric-Hoffmann-blue is in every way perfectly satisfactory, since but little alteration of the structure occurs, and the staining with the blue is limited to the protoplasm. The sulphuric acid method is in the main unsatisfactory, although it is valuable in the case of thin-walled tissue, where violent swelling must be resorted to; and it is also valuable as affording most conclusive evidence of a protoplasmic continuity in those cases where the protoplasmic processes of pits cling to the pit-closing membrane. The author believes, however, that the results obtained can only be rightly interpreted in the light of the results obtained with chlor-zinc-iod. The possibility of seeing the threads depends on their degree of tenuity,

* Proc. Royal Soc., xxxvi. (1884) pp. 182–3; also, Arbeit. Bot. Inst. Würzburg, iii. (1884) pp. 52–87 (English). Cf. this Journal, iii. (1883) pp. 225 and 677.

and on the thickness of the pit-closing membrane; and in many cases the only evidence of such perforating threads is afforded by the general staining of the membrane. Every transition occurs between clearly defined threads in the substance of the closing membrane, and the mere staining of that structure as a whole.

The author has found in all pitted tissues a pit-closing membrane which is made evident by staining thin sections with iodine and mounting in chlor-zinc-iod, and has never seen open pits. The continuity of the protoplasm is always established by means of fine threads arranged in a sieve-structure, and not by means of comparatively large processes which the occurrence of open pits would necessitate.

A continuity of the protoplasm between adjacent cells occurs in *Dionœa muscipula*, and is especially pronounced in the most central layers of parenchymatous cells. The parenchyma-cells of the petioles of certain plants, which are often thick-walled and conspicuously pitted, afford favourable material for investigation. In *Aucuba japonica* and *Prunus lauro-cerasus* distinct threads can be made out crossing the pit-closing membrane. In *Ilex Aquifolium* there is a doubtful striation, and in others examined a mere coloration of the pit-membrane.

The author believes the connection of cells with one another to be a universal phenomenon, and the functions of the filaments to be as follows:—In sieve-tubes and in endosperm-cells they make possible a transference of solid materials; but in ordinary cells their only purpose is to establish a communication of impulses from one part of the plant to another.

By means of the methods described Mr. Gardiner has examined the seeds of about 50 species of palms, as well as those of representatives of the orders Leguminosæ, Rubiaceæ, Myrsineæ, Loganiaceæ, Hydrophyllaceæ, Iridaceæ, Amaryllidaceæ, Dioscoreæ, Melanthaceæ, Liliaceæ, Smilaceæ, and Phytelephasieæ, in all of which he found that the cells of the endosperm are placed in communication with one another by means of delicate threads traversing their walls.

Living and Dead Protoplasm.*—O. Loew makes a final defence of his views as to the essential difference between living and dead protoplasm, and the aldehydic nature of the former. The facts relied on are mainly the following:—(1) the rise of temperature on the death of the cell; (2) the sudden setting in of an acid reaction; (3) the fact that living protoplasm does not precipitate any pigment, while dead protoplasm does. The author states that the substance described by Reinke under the name of plastin, is an impure albuminoid soluble with difficulty in dilute potassa; and that nuclein is also chiefly composed of an albuminoid combined with phosphoric acid.

Occurrence of Protoplasm in Intercellular Spaces.†—G. Berthold notices several instances of the occurrence of this phenomenon:—in

* Bot. Ztg., xlii. (1884) pp. 113–20, 129–32. Cf. this Journal, i. (1881) p. 906; ii. (1882) pp. 67, 361, 440, 522; iii. (1883) p. 225.

† Ber. Deutsch. Bot. Gesell., ii. (1884) p. 20.

the primary cortex of first-year twigs of *Cornus mas*, *Ligustrum vulgare*, and *Staphylea pinnata*; in the small intercellular spaces between the collenchymatous peripheral cells of the leaf-hinge of *Epimedium alpinum* and of the leaf-stalk of *Pittosporum Tobira*; in the primary cortex of *Rhus glabra*, &c. In order to detect this intercellular protoplasm, uninjured pieces of the plant must be laid in alcohol, or must be first hardened in potassium bichromate. One of the best objects is *Ligustrum vulgare*, where the small intercellular spaces of the young leaves of the winter-buds, as well as those between the young medullary cells, may be found to be filled with a protoplasmic substance.

Division of the Cell-nucleus.*—The following are the main results of a series of experiments on this subject by E. Heuser:—

The only point which distinguishes the material of the nucleus from the surrounding protoplasm is that it consists to a large extent of nuclein. When at rest the substance of the nucleus consists of granules of various sizes imbedded in the nuclear hyaloplasm which has the form of a framework composed of strings. The granules do not all agree in chemical and physical properties. The nuclear hyaloplasm is surrounded by nuclear sap, apparently identical with the cell-sap, and is in continuous connection with the cyto-hyaloplasm through the membrane of the nucleus. The nuclear membrane consists of an extremely fine-meshed net of cyto-hyaloplasm, in which a few microsomes may be imbedded. This network is entered on one side by the delicate threads of cytoplasm, on the other side by the fine strings of the interior of the nucleus.

The nucleoli are larger collections of nuclear hyaloplasm, which serve as reservoirs for the substance of the nucleus, possibly in solution. The substance of the nucleus is divided, even while it still has the form of a ball, transversely into a number of loops. A further segmentation also occurs in the pollen-mother-cells of *Tradescantia*. The loops consist of nuclear substance, which, both in this condition and in that of rest, is surrounded by a sheath of hyaloplasm. These sheaths are still partially connected with one another after the transverse division of the substance of the nucleus, but afterwards only with the nuclear membrane. Immediately after the disappearance of this membrane, the threads of the hyaloplasmatic figure (the spindle-fibres of Strasburger and the achromatic figure of Flemming) arise out of the sheaths of hyaloplasm by the addition of cyto-hyaloplasm.

The elements of the nuclear substance, before splitting longitudinally into the equatorial plate of Strasburger, are not distributed equally on both sides of the equator; there cannot therefore have been up to this time any "double decomposition" of the equatorial plate or bisection of the nucleus. To render possible the formation of two daughter-nuclei of equal size a further complete division of the nuclear substance must therefore take place. This is effected by longitudinal splitting and re-disposition of the elements under the influence of the hyaloplasm, which is applied as "spindle-fibres" to

* Bot. Centralbl., xvii. (1884) pp. 27–32, 57–9, 85–95, 117–28, 154–7 (2 pls.).

the ends of the separate rays which lie nearest the centre of the equatorial plane. The separate rays behave differently according to their position and surroundings.

After the rays of the daughter-plane have bent at their polar ends in the form of a hook, the fibres of hyaloplasm leave the pole, and appear again on the equatorial side of the rudiments of the daughter-nuclei as "connecting threads." While they are developing, the young daughter-nuclei assume the form of a turban, which favours the absorption of nutriment from the polar side by means of the "polar rays." In consequence of this the transformation of the ball of threads into the framework commences from the polar side. The successive processes of formation of the mother-nucleus are repeated in reversed succession after the longitudinal splitting of the rays.

Apical Cell of Phanerogams.*—P. Korschelt confirms the statement of Dingler that the cone of growth in flowering plants is developed from a single tetrahedral apical cell, by the separation of daughter-cells. This general law is derived from the observation not only of Gymnosperms (*Pinus Abies*, *P. orientalis*, *P. canadensis*, *Taxodium distichum*, and *Ephedra vulgaris*), but also of Angiosperms (*Elodea canadensis*, *Lemna minor*, *Ceratophyllum submersum*, and *Myriophyllum verticillatum*).

Nettle-fibre.†—J. Moeller has made a histological examination of the fibres of the common stinging nettle, *Urtica dioica*, with the following results:—

The primary bast-bundles of the stem do not form a connected ring, and its fibres are mostly separated by intermediate parenchyma. The cortical parenchyma is not sclerenchymatous. At the base of the stem the fibres are mostly about 0·12 mm. in diameter; higher up they are thinner; but even at the summit they have a diameter of 0·04 mm. The thinnest fibres of the nettle are therefore as thick as the thickest of hemp. In consequence of their isolation they are seldom polygonal. At the commencement of the time of flowering, the fibres in the upper portion of the stem only are completely thickened; those in the lower part have still large cavities. There are no pore-canals. Fibres were measured 22 mm. in length; they are very irregular in form. They consist of nearly pure cellulose; their behaviour with cuoxam is characteristic. They swell with extraordinary rapidity from without inwards; a sharply differentiated internal layer resists the action for some minutes; but this is also at length dissolved; and, in addition to a small quantity of the contents of the fibres, a delicate network remains, the primary membranes of the parenchyma-cells which surrounded the fibres.

In the opinion of the writer, the want of secondary bast-bundles, and the difficulty of separating the fibres completely from the surrounding parenchyma, present insuperable difficulties in the way of

* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 472–7 (1 pl.).

† Deutsch. Allg. Polytechn. Ztg., 1883. See Bot. Centralbl., xvii. (1884) p. 53.

using the fibres of the nettle for technological purposes; and the same objections apply to *Laportia pustulata*, which has been attempted to be naturalized in Germany from North America.

Laticiferous Tissue of Manihot Glaziovii (Ceará Rubber).*—D. H. Scott describes the laticiferous tissue of *Manihot Glaziovii*, and states the result of his observations to be that in *Manihot* the laticiferous tubes are not *cells* as in the members of the order Euphorbiaceæ hitherto investigated, but *vessels*, agreeing in most points of distribution, structure, and development with those of the Cichoriaceæ.

At the same time this high development of the laticiferous system is not inconsistent with the presence of numerous large and well-developed sieve-tubes. Hence the prevalent views as to the mutual substitution of these two classes of organs are, to say the least, of limited application. Dr. Scott considers it probable that even within a comparatively narrow circle of relationship the development of laticiferous tissue has had more than one starting-point, and he is disposed to assume a distinct origin in the order Euphorbiaceæ for the laticiferous cells and for the laticiferous vessels.

Laticiferous Tissue of Hevea spruceana.†—D. H. Scott describes the laticiferous tissue in the stem of *Hevea spruceana* to be similar in its general distribution to that in *Manihot*, and though his observations are not yet complete, its structure seems likewise to take the form of laticiferous *vessels* and not *cells*.

Development of Root-hairs.‡—E. Mer has made a fresh series of observations on the conditions favourable for the development of root-hairs, and retains his previous opinion, in opposition to the conclusions of Schwarz, that it is promoted by retardation of the growth of the root. If grains of lentil are made to germinate on the surface of water fixed on a float made of cork, the growth of the rootlets is at first slow. They grow either obliquely or horizontally, or even rise towards the surface of the water, and become covered with long hairs. As their length increases they are more governed by geotropism, and grow in a more vertical direction. The hairs with which they are covered then become gradually shorter. The seeds of the pea, oat, and wheat present similar phenomena. The rootlets which spring from the bulb-scales of the onion are generally destitute of hairs, whether developed in water, moist air, or the soil. But, if allowed to grow for a time in moist air, until their growth has become retarded, a tuft of hairs will make its appearance at the extremity of each.

Symmetry of Adventitious Roots.§—Adventitious roots may spring either from a node, in connection with a leaf or axillary bud, or from an internode. Nodal adventitious roots are classified by D. Clos as follows:—

1. *Latero-foliar.* From the edge of a leaf, either on one side

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 194–204 (1 pl.).
† Ibid., pp. 205–7.
‡ Comptes Rendus, xcviii. (1884) pp. 583–6. Cf. this Journal, *ante*, p. 79.
§ Ibid., xcvii. (1883) pp. 787–8.

(*Sedum album*, *Berberis cretica*) or from both sides (*Aristolochia rotunda*).

2. *Subfoliar.* Either a single one from the point of insertion of the leaf (*Mühlenbeckia complexa*), or several in a whorl (*Houttuynia cordata*).

3. *Substipular.* From the lower surface of the stipule (*Modiola caroliniana*).

4. *Axillo-foliar.* From the axils either of aërial leaves (*Crassula perfossa*) or of underground scale-leaves (*Mahonia Aquifolium*).

5. *Axillo-stipular.* From the axil of stipules (*Urtica dioica*).

6. *Latero-gemmar.* In connection with the axillary bud, either on one side (*Calystegia sepium*) or on both sides (*Spiræa sorbifolia*); sometimes only from one of two opposite buds (*Paronychia capitata*).

7. *Supragemmar.* From immediately above the axillary bud (*Lythrum Salicaria*, *Lysimachia verticillata*).

8. *Subgemmar.* From below each bud (Equisetaceæ, *Menispermum canadense*).

Penetration of Branches of the Blackberry into the Soil.*—J. Wiesner finds that the winter-buds of species of *Rubus* growing in woods with creeping branches are drawn into the soil by the shortening of the roots which spring from the apex of the shoot. This shortening takes place in the roots of the zone above the growing region, and results from increase of turgidity, in consequence of which the growing part of the root lengthens. On the boundary of these two zones of the root which behave in opposite ways are the root-hairs, which fix the root firmly into the ground by becoming closely attached to particles of soil. In consequence of this, the upper zone of the stem becomes shorter, and the apex and growing region of the root cannot be drawn out or injured. The traction on this lower part resulting from the shortening of the upper part, is, however, weakened by the fact that, under the conditions in which the upper apex of the root becomes shorter, the lower or growing region stretches. The traction caused by the shortening is exerted simply in dragging the apex of the root into the soil. The shoots which root at their apex become also thicker at their upper end, which could only result from a reversal of the stream of water and from a movement of the protoplasm in a direction opposite to the normal one.

Circumnutation and Twining of Stems.†—J. Baranetzki argues in favour of Schwendener's view that the twining of stems is due to circumnutation and geotropism, rejecting de Vries's theory of the influence of the weight of the terminal bud.

Vegetable Acids and their effect in producing Turgidity.‡—According to H. de Vries, organic acids are never absent from the growing parts of plants; they are the principal, and frequently the only causes of turgidity. They are not usually free, but most commonly

* SB. K. Akad. Wiss. Wien, lxxxvii. (1883) pp. 7–17.

† Mém. Acad. Imp. Sci. St. Petersbourg, xxxi. See Bot. Ztg., xli. (1883) p. 855.

‡ Bot. Ztg., xli. (1883) pp. 849–54.

united with bases, forming either neutral or acid salts. By far the most widely distributed of the organic acids is malic; the bases are either organic or inorganic; the latter chiefly potassa and lime; the former comprise various nitrogenous compounds. The proportion of acids present varies greatly; it is dependent on external circumstances, but is usually greatest in the young growing parts, diminishing gradually with the age of the organ. In young organs they are most commonly present in the form of salts of potash, which is, at a later period, replaced by lime. In addition to their function in producing turgidity, these acids also play an important part in being the agents by means of which potash is absorbed through the root.

Metastasis and Transformation of Energy in Plants.*—A. Famintzin publishes an elaborate handbook on this subject, founded on the researches of Pfeffer, Detmer, and others. He classifies the subject under four heads, as follows :—(1) Chemical composition of plants; (2) Organic sources of nutriment; (3) Synthesis of organic compounds; and (4) The interchange of material between plants and their environment.

Under the first head the author includes not only the organic but also the inorganic constituents of plants; as also the crystalline deposits and cystoliths. The second treats of germination and nutrition, including that of insectivorous plants; and of parasites, whether containing chlorophyll or not. The theory of fermentation and structure of ferments is also included here; and the phenomena connected with fermentation are again discussed more in detail in the third part. The fourth section treats of the properties of naked protoplasm, the interchange of substance in a cell inclosed in a cell-wall (diosmose), the absorptive powers of roots and leaves, the movements of gases and water, and the transport of protoplasmic substances. The author does not agree with Sachs's view that metastasis is always accompanied by a loss of weight.

Action of the different Rays of Light on the Elimination of Oxygen.†—J. Reinke has designed an apparatus for determining this much-disputed question, which he calls a *spectrophore*.

A horizontal bundle of rays passes from the heliostat through a vertical slit into the dark chamber, and then through a telescope objective at a convenient distance to a sufficiently large prism, placed at the least possible deviation from an angle of 60°, producing a sharp objective spectrum on a screen. The screen consists of two vertical level boards, which can be so moved in a slot that their edges can either be brought close together or placed at any distance from one another; any required portion of the spectrum being then allowed to pass through the opening. Immediately behind the screen is a large convex lens on which the rays fall, and are collected into a focus in a small image of from 1 to 2 sq. cm. By this means any required area of the spectrum can be cut off. When the screen is entirely opened,

* Famintzin, A., 'Metastasis and Transformation of Energy in Plants,' (Russian), 816 pp., St. Petersburg, 1883. See Bot. Centralbl., xvii. (1884) p. 97.

† Bot. Ztg., xlii. (1884) pp. 1–10, 17–29, 33–46, 49–59 (1 pl.).

a white image of the sun is obtained in the focus; when the refrangible portion as far as the green is cut off, a red image; and in the same way a green or blue image can be obtained. In order to bring exactly equal areas of the spectrum under observation, a scale is placed exactly before the screen adapted to the dispersion of the prism, and prepared therefore to suit each particular prism; and the screen is then put in position. The prism was made sometimes of flint-glass, sometimes of bisulphide of carbon; and the action of the various rays of light was determined by measuring the number of bubbles of gas given off in a unit of time from a shoot of *Elodea* growing in water containing carbon dioxide.

The result of the experiments is depicted by Reinke in curves; the absolute maximum of evolution of gas was found to be unquestionably between Fraunhofer's lines B and C, and nearer to the former, corresponding to a wave-length of about λ 690–680. From this maximum the curve falls sharply towards the line A, somewhat less sharply towards E, and from these more gently towards H. If the absorption-spectrum of living leaves is compared with this curve, it is seen that the maximum of evolution of gas coincides with the absorption-maximum in the red, or with the absorption-band I, while no secondary maxima of evolution correspond to the secondary absorption-maxima II and III. The maximum of evolution of oxygen, and probably also that of decomposition of carbon dioxide, belongs therefore to those rays of the refrangible half of the spectrum which are the most strongly absorbed by chlorophyll.

From these facts Reinke draws the conclusion that the action of chlorophyll on the elimination of oxygen by plants is a chemical one; although the physical action of chlorophyll on which Pringsheim insists is not altogether excluded, since the strong absorption of the refrangible portion of the spectrum may be connected with this physical function.

Movements caused by Chemical Agents.*—W. Pfeffer has observed that the motions of motile organisms and parts of plants are to a large extent brought about by the exciting action of special chemical substances, which, in very small quantities, exercise an attracting influence. The substance which exercises the most powerful influence in this way is malic acid, an acid very widely distributed through the vegetable kingdom. It is the presence of malic acid in the archegonium of ferns and Selaginellaceæ which attracts the antherozoids into the open channel; while the specific attracting substance for the antherozoids of mosses is cane sugar. The author was unable to detect the attracting substance in the cases of *Marsilia*, the Hepaticæ, and *Chara*. In the Schizomycetes there is no one specific attracting substance; but any good nutrient fluid has this power; they will move towards the substance which supplies them with most nutriment.

The proportion of malic acid in the fluid in which the antherozoids of ferns are swarming required to influence the direction of their

* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 524–33; also, Unters. aus d. Bot. Inst. Tübingen, i. (1884); 120 pp.

movements is very small, viz. from 0·01 to 0·1 per cent., in combination with any base (sodium malate was most commonly used); it is perceptible even when the proportion is so small as 0·001 per cent. Free malic acid has the same effect as an alkaline salt in very dilute solutions; but when more concentrated it has precisely the opposite effect, causing repulsion. A repulsion is effected by a mixture of 0·01 per cent. malic acid and 0·2 per cent. citric acid; or by 5 per cent. neutral sodium malate.

The presence of so small a quantity as ·001 per cent. of cane sugar has a corresponding attractive force on the antherozoids of mosses. The specific attracting medium has not yet been ascertained which causes the collection of antherozoids around oospheres, as in the case of *Fucus*.

Bacterium Termo and *Spirillum undula* were powerfully attracted by a 1 per cent. solution of extract of meat or of asparagin; a higher degree of concentration repels the latter.

The author suggests that the familiar bending of organs in the case of carnivorous plants is due to similar causes.

Direct Observation of the Movement of Water in Plants.*—G. Capus gives the following account of experiments on this subject, chiefly on the dahlia.

By means of a flat razor a tangential section is made in an internode, a few centimetres in length, cutting into the stem nearly to the depth of the vascular bundles; this cut must be slightly concave. On the opposite side of the stem, and at the same height, two notches are made penetrating to the pith, allowing this part of the stem to be raised so as to expose the medullary canal or pith. This is carefully taken out without cutting the primary wood at the bottom; a transparent section is thus obtained in which the vessels may be examined intact.

The Microscope is placed horizontally in front of the section prepared in this way on a cathetometer. The plant may be observed either growing in the open soil or in a pot. On the section is placed a drop of water flattened by a cover-glass fixed to the stem by a drop of Canada balsam, or held simply by capillarity. The section is then placed opposite the light, when the vessels and fibres of the wood are seen to be full of bubbles of air more or less numerous in strings. When the weather is damp, the sky cloudy, and the ground saturated, the plant contains more water, and there are but few bubbles of air. They are in greater numbers and larger when the weather is dry, and the plant directly exposed to the sun. As soon as the sun no longer shines on the plant, the bubbles of air diminish in size in the vessels and finally disappear, absorption from the roots exceeding transpiration. When, on the contrary, transpiration is relatively active, the index indicates the ascending movement of water in the vessels.

Rheotropism.†—This term is applied by B. Jönsson to the influence of running water on the direction of growing plants and parts

* Comptes Rendus, xcvii. (1883) pp. 1087–89.

† Ber. Deutsch. Bot. Gesell., i. (1883) pp. 512–21.

of plants. To this cause he attributes the motion of the plasmodia of the Myxomycetes. If a plasmodium is placed on a piece of blotting-paper which dips into water at one end, it moves towards the source of water, attracted by the current of water caused by the capillarity of the blotting-paper. Plasmodia are therefore positively rheotropic. Spores of *Phycomyces* and *Mucor* sown on blotting-paper and fed by a current of a nutrient fluid, put out hyphæ which grow with the stream, and which are therefore negatively rheotropic. *Botrytis cinerea* is, on the other hand, positively rheotropic. Roots of seedlings of maize and other cereals which hang down into a free current of water grow towards the stream; they are, like other roots, positively rheotropic.

Transpiration.*—A. Leclerc has performed a series of experiments to determine the laws which regulate the amount of transpiration from the surface of leaves. In a perfectly saturated atmosphere he asserts that leaves do not transpire; they may even acquire a not inconsiderable increase in weight. If the figures obtained from experiments are represented in a system of rectangular co-ordinates, the curve of transpiration is found to correspond much more with the psychrometric than with the actinometric curve. The following are the general conclusions arrived at by the author:—

1. Transpiration is independent of light. 2. It falls to zero in an absolutely moist atmosphere. 3. It is a function of the hygrometric condition of the air, and may be expressed with sufficient accuracy by the equation $E = a(F - f) \pm c$; where a is a coefficient varying for each plant, but invariable for plants in the same series of experiments; f the tension of the aqueous vapour existing at the time in the air; c a positive or negative constant. 4. When the transpiration of a plant is more active in the sun than in the shade, this depends (*a*) on the rays of heat, which always accompany the rays of light, and warm the tissues; and (*b*) on the activity of assimilation of the leaves in the light.

The yellowing of leaves is often due to the transpiration being checked. The disease of the vine known as "folletage," is due to the leaves withering and dying in consequence of excessive transpiration.

Transpiration-current in Woody Plants.†—J. Dufour continues the discussion on this subject, adducing fresh arguments in favour of Sachs's theory of imbibition; the currents also being assisted by filtration from cell to cell, especially through the agency of pitted vessels. Experiments are described carried on for the purpose of proving that the transpiration-current can only take place through the walls of the wood.

To these arguments R. Hartig replies,‡ maintaining that the passage of water through the wood does not ordinarily take place

* Ann. Sci. Nat. (Bot.), xvi. (1883) pp. 231–79.

† Dufour, J., 'Ueber den Transpirationsstrom in Holzpflanzen,' 1883. See Bot. Ztg., xli. (1883) p. 843.

‡ Hartig, R., 'Die Gasdrucktheorie u. die Sachssche Imbibitions-theorie,' Berlin, 1883. See ibid., p. 844.

through the cell-walls, but by filtration from cell to cell; although the former may occur in special circumstances, as, for example, when all the fluid water has been removed from the wood by transpiration.

Origin and Morphology of Chlorophyll-corpuscles and Allied Bodies.*—F. O. Bower gives a useful summary and discussion of the results of recent researches on this subject, especially those of Schimper, Meyer, and Schmitz which have already been noted here.

Under the heading of "the Trophoplasts" A. Meyer also gives † a summary of the results of the recent work on Chlorophyll-corpuscles.

Spectrum of Chlorophyll.‡—A. Tschirch continues his researches on "pure chlorophyll," the term which he applies to the product obtained by the reduction of chlorophyllan by means of powdered zinc. In the so-called "solid chlorophyll," obtained by evaporating pure chlorophyll in a glass vessel he notices a small displacement of the absorption-bands of the spectrum towards the red as compared with an alcoholic solution; and the same phenomenon is presented by chlorophyll dissolved and hardened in paraffin. In the solid chlorophyll of the leaf there is a much greater displacement in the same direction. This results, in the author's opinion, from the chlorophyll-grain being a mixture of two substances, pure chlorophyll and xanthophyll. A useful synonymy is appended of the terms employed by different writers in describing the various members of the chlorophyll group.

Portion of the Spectrum that decomposes Carbon Dioxide.§—C. Timirjaseff maintains that a solution of chlorophyll is not, as held by Wiesner and others, decomposed most quickly by the yellow, but by the red rays. The decomposition of carbon dioxide, as well as the transformation of chlorophyll, is caused by one and the same group of rays absorbed by the pigment. The green group of rays is not absorbed at all by weak solutions of chlorophyll.

Chlorophyll in Cuscuta.||—The parasitic *Cuscutæ* have hitherto been described as entirely destitute of chlorophyll. F. Temne, however, finds distinct indications of its presence by *C. europæa*. This was established by an evident green tinge, either of the whole protoplasm or of separate granules, especially in the inflorescence; by the spectrum of chlorophyll obtained in an alcoholic extract; and by direct evidence of the evolution of carbonic acid.

Work performed by Chlorophyll.¶—From a series of experiments, C. Timirjaseff deduces the result that, where there is energetic decom-

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 237–54 (1 pl.).

† Biol. Centrabl., iv. (1884) pp. 97–113.

‡ Ber. Deutsch. Bot. Gesell., i. (1883) pp. 462–71 (1 pl.); and ibid., Generalvers. in Freiburg., xvii.–xxii.

§ Arbeit. St. Petersb. Naturf. Gesell., xiii. (1883) p. 10 (Russian). See Bot. Centralbl., xvii. (1884) p. 101.

|| Ber. Deutsch. Bot. Gesell., i. (1883) pp. 485–6.

¶ Arbeit. St. Petersb. Naturf. Gesell., xiii. (1883) p. 9 (Russian). See Bot. Centralbl., xvii. (1884) p. 100.

position of carbon dioxide, 20 per cent., and, under specially favourable circumstances, as much as 40 per cent., of the entire solar energy is utilized by the chlorophyll, the proportion thus used up being very much larger than has been assumed by Pfeffer and Pringsheim.

Sphærocrystals.*—A. Hansen has examined the structure of crystals in a number of plants. Those found in the cells of several species of *Euphorbia* agree in general with the ordinary form, and consist of calcium phosphate; as also do those of *Mesembryanthemum* and of *Marattia cicutæfolia* and *Angiopteris evecta*. Those of *Cocculus laurifolius* and of *Capsella*, on the other hand, do not consist of any phosphate, but are apparently organic in their nature.

The author asserts that sphærocrystals do not grow, either by apposition or in any other way. They appear in the cell-contents in the form of drops, which gradually harden into solid bodies. They are invested by a pellicle; and their striking stratification does not result from their mode of growth, but from a differentiation during hardening.

The conclusions of the author were confirmed by observing the behaviour of artificial sphærocrystals made of calcium phosphate and calcium carbonate.

Sphærocrystals of Paspalum elegans.†—According to J. Borodin, if sections of the leaf of *Paspalum elegans* are moistened with alcohol, and the latter allowed to evaporate under the cover-glass, peculiar yellow sphærocrystals make their appearance, which shine brightly in polarized light. They are easily soluble in hot, less easily in cold water, rapidly in dilute hydrochloric acid, and especially in weak potash-lye, colouring it an intense yellow. When carefully warmed, they melt into homogeneous intensely yellow, strongly but not doubly refractive balls, still soluble in water. The substance which affords these sphærocrystals is very peculiarly distributed in the plant. It occurs only in the lamina of the leaves, the leaf-sheaths and stems being quite free from it. It is especially abundant in the apical part of the leaf. The distribution of potassium nitrate is exactly the reverse.

Although these properties resemble to a certain extent those of leucin in the dahlia, yet careful experiments show that the substance which yields these sphærocrystals is not leucin. But under special circumstances leucin is found in the leaf of *Paspalum elegans*.

Calcium Oxalate in Bark.‡—From observations made on the deposits of calcium oxalate in the bark of a considerable number of trees, S. Rauner is led to adopt the ordinary view that this substance is an excretory product, and not a reserve food-material. He found that they did not disappear from the bark as the new shoots were put out, but were constantly present at all times of the year.

* SB. Phys.-Med. Gesell. Würzburg, 1883, pp. 20–2.

† Arbeit. St. Petersb. Naturf. Gesell., xiii. (1883) pp. 47–60 (Russian). See Bot. Centralbl., xvii. (1884) p. 102.

‡ Arbeit. St. Petersb. Naturf. Gesell., xiii. (1883) pp. 24–33 (Russian). See Bot. Centralbl., xvii. (1884) p. 101.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Stigmariæ.*—Professor Harker has made the following determination of the species of *Stigmaria* found by E. Wethered in the Durham coal-beds. The microspores strikingly resemble those of *Isoetes*, especially when gently crushed. The triradiate markings of the fossil spores were almost exactly like the flattened three radiating lines which mark the upper hemisphere of the microspores of *Isoetes lacustris*. He suggests for the carboniferous plant the generic title *Isoetoides*.

In the discussion which followed the reading of this paper, Mr. W. Carruthers and Mr. W. Boyd Dawkins did not agree with the author in identifying these spores necessarily with the form allied to *Isoetes*. Neither true woody tissue nor sporangia are to be found in coal, although macrospores and microspores abound. Coal is composed of two principal elements, carbon proper and a fossil resin; the blazing property of coal is due to the latter, which is composed mainly, but not entirely, of fossil spores.

Muscineæ.

Cephalozia.†—In addition to the characters hitherto employed for distinguishing the families and genera of Hepaticæ, R. Spruce considers the following as of value:—(1) The origin of the branches, which are either all ventral, as in *Cephalozia*, *Calypogeia*, &c., or all lateral, as in *Lejeunia*, *Radula*, &c. (in *Frullania* and *Scapania* all are exactly axillary; in *Lejeunia* and *Radula* infra-axillary, nearer the outer base of the leaf). (2) The origin of the angles of the perianth, which originate either from the marginal coalescence of nearly flat leaves, as in *Lophocolea*, *Plagiochila*, &c., or from the wedge-shaped leaves, as in *Cephalozia*, *Scapania*, &c. (3) The structure of the wall of the capsule. (4) The number of sexual organs, especially of the male, which is very constant in many genera.

Then follows an exhaustive diagnosis of the genus *Cephalozia*, of its subgenera, and of most of its species. The most important generic characters are:—Prothallium filiform; branches of ventral origin; leaves flat or curved inwards, never reflexed; perigonial leaves always with only a single male organ; female inflorescence capitular, lateral, with its leaves in three rows; perianth free, triangular-wedge-shaped, the third edge always ventral; cap free; wall of capsule with semicircular fibres; elaters bi-spiral.

The genus is divided into eight subgenera, and a large number of species are described. The first two subgenera, each comprising only a single species, are thallose, the rest foliose. Several genera nearly allied to *Cephalozia* are also described, making up the author's tribe Trigonantheæ.

* Abstr. Proc. Geol. Soc. London, March 5, 1884.

† Spruce, R., 'On Cephalozia, a genus of Hepaticæ.' Malton, 1882. See Bot. Centralbl., xv. (1883) p. 300.

The author considers the separation of the Jungermannieæ Geocalyceæ as a distinct group to be unsound, each group having one or more "marsupial" (geocalycal) genera. The passage between above-ground and underground perianths occurs in those genera the perichætium of which is more or less united into a fleshy cup which may swell and form a rooting protuberance; further development downwards leads to a pendent sac. Thus *Acrobolbus* is a direct derivative from those species of *Nardia*, like *N. Breidleri*, the rooting projecting involucre of which is the forerunner of the pendent pocket of *A. Wilsoni*; the vegetative organs of both are similar.

The following are the characteristics of the three proposed primary groups of Hepaticæ:—(1) *Hypocoleæ*, with free involucre; (2) *Epicoleæ*, perianth and involucre coalescent; (3) *Marsupiocoleæ*, with sac-like fructification. The genera of Jungermannieæ can be classed under these three groups, thus:—(1) *Leioscyphus* and *Jungermannia*; (2) *Southbya* and *Nardia*; (3) *Lindigina* and *Acrobolbus*.

Fungi.

Lamellæ of the Agaricini.*—H. Heese has paid special attention to the structure of the lamellæ of the Agaricini, with a view of obtaining for them characters for the classification of the genera.

The structure of the trama may be classified under five heads, as follows:—

1. Trama homomorphous, with parallel threads of cells.
2. Trama homomorphous, with curved hyphæ.
3. Trama heteromorphous, elongated; with usually ribbon-shaped cells at the sides, vesicular cells in the middle.
4. Trama heteromorphous; usually with vesicular and ribbon-shaped cells intermixed (*Russula*, *Lactarius*).
5. Trama heteromorphous; elongated cells in the middle, round cells at the side (*Coprinus*).

These different forms run into one another.

When fully developed the hymenium is composed of four kinds of cells: (1) long pointed cells, cystidia; (2) short pointed cells, paraphyses; (3) short cells, rounded at the end, sterile basidia; and (4) cells like the last, but bearing spores, fertile basidia. Of these the last kind are always present; any of the three others may be wanting. Fleshy fungi rarely have paraphyses or cystidia; the latter are found chiefly in small membranous species. The regular occurrence of paraphyses is characteristic of *Coprinus*. The basidia may be classed under three heads: (1) narrow, occurring only with white-spored genera; (2) short; (3) long.

Fungi with homomorphous trama and ribbon-shaped interwoven hyphæ usually have narrow basidia, as in *Cantharellus* and *Clitocybe*. These series are connected on one side with *Mycena* with heteromorphous trama, on the other side with *Tricholoma* with parallel cells. In proportion as heteromorphism increases, a change may be seen

* Heese, H., 'Die Anatomie der Lamelle, u. ihre Bedeutung für die Systematik der Agaricineen,' 43 pp., Berlin, 1883. See Bot. Centralbl., xvii. (1884) p. 68.

from the basidial form of *Mycena*, through *Galera* and *Psathyra*, to *Coprinus*. The third group, with long basidia, can also, with the exception of *Lactarius* and *Russula*, be arranged in a series of relationship, the highest forms of which are *Amanita* and *Volvaria*.

With reference to the formation of sterigmata and the abstriction of spores, Heese dissents from the view that the same basidium may produce spores several times. He adduces several instances of dual sterigmata.

The cystidia may be used for the distinction of species to a much greater extent than the basidia, in relation to their position, size, and form. They may be fusiform, pear-shaped, and pointed at the end, capitulate, or hair-like. The writer is unable to determine their function.

The colour of the spores is characteristic; they should be observed both dry and moist, as they frequently change their form when moistened. The size of the spores has no relation to the size of the fungus, but only to that of the basidia. In the white-spored subgenera, the spores have a tendency to be rounded and shorter; light brown spores are mostly ovoid, dark brown spores ellipsoidal; black spores are always ellipsoidal.

Formation of Gum in Trees.*—Sir James Paget draws attention to some remarkable investigations made by Dr. W. Beyerinck† in connection with the formation of gum in trees. Dr. Beyerinck found that in the peach, apricot, plum, cherry, or other trees bearing stone-fruits, the formation of gum may be caused by inserting a portion of the gum under the edge of a wound through the bark. The observation that heated or long-boiled pieces of gum would not produce this effect, and that wounds made in the bark of the tree did not produce gum unless a portion was first introduced into it, led him to suspect that the formation of gum was due to the presence of bacteria or other living organisms. On microscopical investigation he found that only those pieces of gum containing spores of a highly organized fungus, belonging to the *Ascomycetes*, had the power of conveying the gum-disease or gummosis, and that these spores, inserted by themselves under the bark, produced the same pathological changes as did the pieces of gum. The fungus has been examined by Professor Oudermans, who has ascertained it to be a new species, and has named it *Coryneum Beyerinckii*. Its chief characters consist in the fact that it has a cushion-like stroma, composed of a bright brown parenchyma, on which stand numerous conidia having colourless, unicellular and very slender stems, about as long as themselves. The conidia are small, cask-shaped, about one-third of a millimetre in length, and usually divided by slightly constricting septa into four cells, of which the two terminal are longer than the two middle ones. From these cells germinal filaments may proceed, from which are developed brown, thick-walled, and many-celled mycelia. The first symptom of the gum-disease is the develop-

* Bull. Torrey Bot. Club, xi. (1884) pp. 33-4 from 'Medical Times.'

† Arch. Néerl. Sci. Exact. et Nat., xix. (1884) pp. 43-102 (2 pls.).

ment of a beautiful red colour around the wound due to the formation of a red pigment in one or more of the layers of the cells of the bark. Dr. Beyerinck believes that the fungus produces a fluid of the nature of a ferment, which penetrates the adjacent structures, since the disease extends beyond the parts in which any trace of the fungus can be detected. This ferment he believes to act on the cell-walls, starch-granules, and other constituents of the cells, transforming them into gum, and even changing into gum the *Coryneum* itself. The influence of this fluid is also exerted in the cambium, causing the formation of morbid parenchyma, the cells being cubical or polyhedral, thin-walled and rich in protoplasm, which is in its turn transformed into gum. It is further stated that "a similar disease produces gum arabic, gum tragacanth, and probably many resins and gum resins." Gum tragacanth is known to be produced by the pith as well as the bark of the stem, and to ooze out from the pith when the stem is cut; and if it be indeed due to a disease it would seem as if the disease infects the whole plant. Gum, moreover, may be found in the uninjured husk of the almond, and it seems at first sight more probable that the irritation caused by a fungoid parasite should cause a greater flow of the natural product, just as the irritation caused by an insect causes the development of galls.

Attraction of Insects by Phallus and Coprinus.*—E. Ráthay and B. Haas have examined the structure of the fructification of *Phallus impudicus*, with a view to determine the peculiarities in its construction which attract flies and other insects to it. This is effected partly by the odour and partly by the taste. They find the fluid which results from the deliquescence of the gleba to contain abundance of sugar; and visiting this they observed as many as fourteen species of insect, most of which also visit the nectar of flowers or feed on honeydew.

The same phenomenon is exhibited by a number of other species of Phalloideæ; and the explanation suggested is that the insects are useful to the fungi in disseminating the spores, which are set free by the deliquescence of the gleba.

The pileus of species of *Coprinus* and of some other species of Agaricini also exude sugar.

With regard to the exact chemical nature of the substance formed, the authors state that it consists in all these cases, in addition to dextrose, of another sugar which also belongs to the same class, and is probably trehalose. In *Phallus impudicus* there are no less than three substances which reduce alkaline solution of copper, viz. dextrose, levulose, and a substance intermediate between dextrose and gum. In *Coprinus deliquescens* the only one of these substances present is dextrose.

Development of Ascomycetes.†—After some further details of the points in the development of the Ascomycetes already alluded to, E. Eidam describes two other remarkable species.

* SB. K. Akad. Wiss. Wien, lxxxvii. (1883) pp. 18–44.

† Cohn's Beitr. Biol. Pflanzen, iii. (1883) pp. 377–433 (5 pls.). Cf. this Journal, *ante*, p. 94.

Helicosporangium parasiticum has been found especially on carrots. The mycelium branches copiously, the ends of the branches coiling like a watch-spring, a second spiral often springing from the stalk of the first, and becoming closely united with it in growth. The spirals become septated, and a central cell is separated, which increases considerably in size, becomes brownish red and densely filled with protoplasm, while the cortical cells are nearly empty, the central cell only germinating. The fungus produces also conidia.

Papulispora aspergilliformis is found on all kinds of decaying substances, such as stems, seeds, fruits, tubers, &c., forming a delicate white coating, which is soon covered with the brownish red clusters of spores. The mode of reproduction is by conidia resembling those of *Aspergillus*; but the fungus also produces very peculiar reproductive bodies, which are called bulbils by the author. It also produces chlamydospores.

Fungi Parasitic on Forest-trees.*—In continuation of previous investigations, E. Rostrup gives the following account of the parasitic fungi most destructive to forest-trees in Denmark.

Melampsora salicina. The author confirms the statement of Nielsen that the species of *Melampsora* found upon willows belong to the heterœcious Uredineæ, and that *Cœoma Ribesei* and *Euonymi* are their æcidial forms, while *C. Mercurialis* is the æcidial form of *M. Tremulæ*.

Peridermium Pini corticola, the vesicular æcidial form of *Coleosporium Senecionis*, has been of late years very destructive to *Pinus Strobus* in Denmark, completely destroying plantations from five to twenty years old. Since the æcidial form cannot propagate itself from tree to tree, while *Coleosporium* will maintain itself from year to year, the complete destruction of *Senecio sylvaticus* would be an effective way of eradicating the pest.

Cœoma pinitorquum often makes its appearance in large quantities on young plantations of various species of pine on the heaths of Jutland. *C. Laricis* has also found its way into Denmark, attacking the European and American larches since 1881.

Agaricus melleus sometimes destroys as much as 25 per cent. of the young pines in the Jutland plantations, rhizomorphs more than 11 feet long having been dug out of the ground; they attack and completely destroy felled trunks of oak or ash lying on the ground. Rostrup gives a list of twenty-four species of tree which this destructive parasite attacks.

In older plantations of conifers, still greater injury results from the attacks of *Trametes radiciperda*, which also occasionally seizes upon young trees.

Polyporus fomentarius is a true parasite, the mycelium of which permeates the entire duramen of beech-trees, attacking them when quite healthy. *P. betulinus* is also injurious to birch-trees; and *P. nigricans* is found in a half-fossil condition on the trunks of *Betula alba* buried in turf-mosses.

* Müller's Tidsskr. for Skovbrug., vi. (1883) pp. 199–300 (17 woodcuts). See Bot. Centralbl., xv. (1883) p. 147.

Thelephora laciniata is injurious to conifers from one to two years old, attacking especially *Pinus montana* and *Picea excelsa*.

Corticium comedens often attacks and kills young oaks and alders.

Of the Gymnoasci which form the "witch-brooms," *Exoascus* is especially described on various species of *Prunus*, *E. Carpini* on the hornbeam, and *Taphrina betulina* n. sp. on the birch. The colourless branched mycelium of the last species penetrates the branches and leaves, forming on the under side of the latter a mealy coating composed of the asci (about 45–55 μ long and 20 μ broad; in which are numerous ovate or elongated spores, about 5–7 μ long and 3–4 μ broad.

Peziza Willkommi has attacked a large number of young trees in a larch plantation. A few inches above the ground the bark assumes a red colour, and is covered with numerous whitish warts, the spermogonia of this fungus, containing a quantity of extremely small elliptical and slightly curved spermatia. The apothecia are developed somewhat later, a little higher on the stem. Beneath the coating of spermogonia the cambium-layer is entirely destroyed.

Lophodermium pinastri, which is exceedingly destructive to the Danish pine-woods, is treated at length, and is shown to be the cause of the disease known in Denmark as "Schütte." The leaves of trees from one to two years old are permeated by the colourless, branched and unseptated mycelium, causing them to turn brown. The spermogonia appear at the same time in great numbers on the cotyledons and primary leaves of the main stem, as black elongated, or slightly curved lines. They are filled with numerous rod-shaped spermatia, 6–8 μ long and about 1 μ broad. They always precede the formation of perithecia. It is most destructive to *Pinus austriaca*.

Another species, *Lophodermium brachysporum* n. sp., attacks *Pinus Strobus*. The perithecia are smaller than in the last species, and are placed in a single row on the under side of the leaves, often while they are still green. The asci are 100 μ long and 20 μ broad; the spores 20–25 μ long and 4 μ broad, and are surrounded by a gelatinous envelope. On *P. austriaca* is also found another species, *L. gilvum* n. sp., with very small oval pale-yellow perithecia, inclosing paraphyses 80–85 μ long, and asci 75–80 μ long and 10–12 μ broad, each of which contains eight long filiform spores.

Hypoderma sulcigenum n. sp. is an ascomycete, producing on *Pinus sylvestris* and *montana* a similar appearance to that of *Lophodermium pinastri*. It appears locally on the leaves, producing brown spots and streaks; the perithecia are black and linear, from 1–5 lines long, and open by a longitudinal crevice. They inclose filiform paraphyses and club-shaped asci 75–85 μ long and 12 μ broad, each containing four club-shaped spores, 30–40 μ long and 4 μ broad, at the thickest part, inclosed in a gelatinous envelope which is coloured a beautiful bright green by iodine. The mycelium, which permeates the leaves, is colourless, much branched, and unseptated. It is probably identical with Link's *Hypodermium sulcigenum*.

Hysterographium Fraxini is destructive to ash-trees from 6 to 10 feet high. Fawn-coloured depressed spots appear on the stem,

consisting of a colourless branched mycelium which penetrates the bast and cambium to the outermost layer of wood; on this mycelium are the pycnidia, which burst through the bark, and contain the colourless stylospores, 32–38 μ long, and about 11 μ broad. Shortly afterwards the perithecia appear on the same spots.

Nectria ditissima causes injury in oak and beech plantations from fifteen to twenty years old, and on apple-trees in gardens. *Phytophthora Fagi* has made its appearance on beech-trees. *Fusicladium ramulorum* has appeared on the young shoots of several species of willow and poplar, turning the leaves brown or black. The black spots on the leaves and branches are covered with an olive-green coating, which forms dendriform fissures, resembling those of *F. dendriticum*. The conidia are bright greenish yellow, bilocular, and of a peculiar form like that of the sole of a shoe, 18–20 μ long and 6–7 μ broad.

Puccinia graminis on Mahonia Aquifolium.*—C. B. Plowright has determined that an æcidium found on the berries of *Mahonia Aquifolium* gives rise, when the spores are sown on the leaves of wheat, to *Puccinia graminis*. This will account for the frequency of the wheat mildew in districts where the berberry is unknown; the *Mahonia* being widely cultivated in gardens and shrubberies, and as a cover for game. The same writer † has also determined the dock æcidium, which is common on *Rumex Hydrolapathum*, *obtusifolius*, *crispus*, and *conglomeratus*, to be the æcidiospore of *Puccinia Phragmitis*. On the other hand, the æcidium of *Rumex acetosa* is not connected with either *Puccinia Phragmitis* or *magnusiana*.

Polystigma rubrum.‡—W. B. Grove gives some account of *Polystigma rubrum*, Pers., based upon the recent investigations of A. B. Frank § and C. Eisch‖. It usually makes its appearance shortly before midsummer on the leaves of *Prunus domestica*, *P. spinosa*, and *P. insititia*. Its whole life-history is probably now known as Mr. Grove shows. The only point left in doubt is the mode by which the ascospores are conveyed from the ground to the young plum leaves.

New Synchytrium.¶—Under the name *Synchytrium pilificum*, F. Thomas describes a new species parasitic on *Potentilla Tormentilla*. It produces tufts of hairs on the stems, flower-stalks, leaves, sepals, and petals of the host, most frequently on the upper side of the leaves. They proceed from a wart, 0·36–0·39 mm. in diameter, and rising 0·11–0·27 mm. above the surface of the leaf; their number being usually between 20 and 35. The base of the wart is of a yellowish green or reddish violet colour. They do not seem to be very injurious, as, even when the petals are attacked, the flowers produce normal fruits. In the centre of each wart is a large brown cell, the

* Proc. Roy. Soc., xxxvi. (1883) pp. 1–3.
† Ibid., pp. 47–50.
‡ Quart. Journ. Micr. Sci., xxiv. (1884) pp. 328–34.
§ See this Journal, iii. (1883) p. 685.
‖ Ibid., p. 247.
¶ Ber. Deutsch. Bot. Gesell., i. (1883) pp. 494–8.

resting-spore of the *Synchytrium*, inclosed in and entirely filling up the nutrient cell. It is of a shortly elliptical or spheroidal shape, from 0·14–0·126 mm. in its largest diameter, and inclosed in a double wall. These develope and form swarm-spores in the spring in the same way as other species of *Synchytrium;* but further details are wanted. The trichomes of the æcidium are unicellular and thin-walled, and when old coil hygroscopically.

Pathogenous Mucorini, and the Mycosis of Rabbits produced by them.*—L. Lichtheim has found two species of Mucorini which cause pathogenous phenomena when introduced into the blood of rabbits. One of these made its appearance normally in white bread when placed in the breeding oven, in the form of a dense white silky flock, soon entirely covered by *Aspergillus*. This was propagated separately on strips of nutrient gelatine spread on glass plates. If the temperature of the chamber was not too high, the spores swelled up on the third day and put out a germinating filament on one side; on the third or fourth day these had grown into a copiously branched unseptated mycelium, which gradually completely overspread the nutrient substance. On the third or fourth day aerial branches appeared, the formation of sporangia commencing very soon at their apex, the other portion turning back after the manner of the stolons of *Mucor stolonifer*. The sporangiophores are usually simple, rarely dichotomously branched; opposite to them rhizoids are formed; the sporangia are black, smooth, and globular. The spores are nearly globular, strongly refractive, and inclosed in a single membrane.

The second species was less common, and is distinguished from all known Mucorini by its very small size. It appeared in a gelatine-culture of infusion of bread, and was propagated in the same way as the first. The mycelium is loose and crinkled; the sporangia extremely small and colourless. It spread very slowly over the nutrient substance, forming only distant streaks. From the delicate unseptated mycelium there rise long slender sporangiophores, on which are placed six or eight very small almost transparent sporangia. The sporangia are seated in a small cup-shaped swelling of the sporangiophore, and have somewhat the form of a pear. The spores are nearly globular, and strongly refractive.

In neither species were zygospores observed. Professor Cohn has named and described them as follows:—

Mucor rhizopodoformis.—Mycelium at first snow-white; filaments colourless, unseptated; brownish branches of the mycelium ascend as stolons, then bend, and sink down again on to the substratum; at the points of contact the mycelium puts out downwards short-branched brownish rhizoids, sporangiophores upwards. Sporangiophores simple, collected into tufts of two or more, unbranched, 120–125 μ high. Sporangia globular, seated on the apex of the sporangiophore, black when ripe, with smooth opaque membrane, which is soluble in water, without leaving behind any granular deposit; diameter 66 μ. Column

* Zeitschr. f. Klin. Medicin, vii. (1883) (3 pls.). See Bot. Centralbl., xvii. (1884) p. 138.

brownish after the absorption of the wall of the sporangium, wall swollen at the summit; sporangiophore separated from the column by a flat broad apophysis. Spores colourless, mostly globular, smooth, very minute, 5–6 μ in diameter. Several characters, besides its pathogenous properties, distinguish this species from *M. stolonifer*.

Mucor corymbifer.—Mycelium snow-white, afterwards light grey; filaments often very stout, 15 μ in diameter, unseptated, dichotomously branched; membrane and protoplasm colourless. Sporangiophores not erect, branched in an umbellate manner, bearing at the apex one or more (up to twelve) sporangia with longer or shorter stalks; other smaller sporangia being arranged in a raceme below the terminal umbel. Sporangia colourless even when ripe, pear-shaped, rounded at the end, passing gradually into the sporangiophore, varying greatly in size, the largest 70 μ, the next in the umbel 45–60 μ, and the smallest detached sporangia 10–20 μ in diameter; membrane colourless, transparent, quite smooth; the colourless mass of spores seen through the wall of the ripe sporangium; the column appears only after the absorption of the wall of the sporangium and dispersion of the spores. Spores colourless, minute, elliptical, 3 μ long by 2 μ broad. This species is also distinguished by several very striking characters independent of its pathogenous properties.

If the spores of these two species of *Mucor* are sown in any quantity in the blood of rabbits, a severe disease is caused, which is always fatal. The two species act in very nearly the same way, but the *Mucor* mycosis differs considerably from that of *Aspergillus*. The localization is also different; the *Mucor* entered chiefly the kidneys and the lymphatic apparatus of the intestinal canal, seldom the medulla of the bones, and only very rarely the liver; never the transverse muscles. In the brain neither *Mucor* nor *Aspergillus* was found.

Micrococci of Pneumonia.*—C. Friedländer has examined the micrococci contained in the alveolar exudation, and in the fluid of the lymph passages of the lungs, in cases of acute genuine pneumonia. Their presence was subsequently determined in the pneumonial fluid taken from the living patient. They were found in the greatest numbers in the pleuritic and pericardial exudations, the turbidity of these fluids often arising from enormous quantities of the micrococci. All or the greater number of these micrococci are surrounded by a more or less broad layer resembling an envelope or capsule, coloured light blue or red by gentian-violet or fuchsin respectively, and usually sharply defined externally. Sometimes each micrococcus is surrounded by an envelope of this kind of the same shape; sometimes two or three are inclosed in the same envelope; but the micrococci of pneumonia are never collected into zoogloea colonies. These envelopes are soluble in water and dilute alkalies, but insoluble in acids, and may therefore consist essentially of mucin or some similar substance.

* Fortschr. d. Medicin, i. (1883) pp. 715–33 (1 pl.). See Bot. Centralbl., xvii. (1884) p. 50.

The micrococci are best detected by placing the cover-glass with the dried-up fluid, coloured by aniline-water and gentian-violet solution, in a watch-glass with alcohol for half a minute, when the matrix rapidly loses its colour, the envelopes and micrococci much more slowly. The preparation may then be placed in a watch-glass with distilled water, examined in water, and afterwards preserved in Canada balsam or dammar lac. The envelopes are also coloured by eosin, especially by a weak solution acting for twenty-four hours; osmic acid differentiates them sharply, but without blackening them. These envelopes appear to be a highly characteristic peculiarity of the micrococci of pneumonia, never failing in acute genuine cases. They probably belong to the acme of that disease, not being found after the sixth day.

If developed by Koch's process on serum of blood and afterwards on gelatine, with addition of infusion of flesh, peptone, and sodium chloride, the micrococci have on serum of blood the form of a greyish pellicle on the surface, and an opaque cylinder in the interior of the serum. The cultures on gelatine were especially characteristic, and were propagated for eight generations. They resembled a nail with hemispherical head, and consisted of densely crowded micrococci, usually of elliptical form, but with no envelope. They were also cultivated on potato.

Experiments were also made in inoculating the pneumonia-micrococci in animals, by injection into the right lung. With rabbits no success was obtained; while mice always died in from 18 to 28 hours. In the cavities of the pleura, partly in the fluid, partly in the lymphoid cells, were masses of micrococci, with all the characters of those of pneumonia, including the envelope. They were also found in the lungs and blood. With dogs and porpoises no result was obtained in some cases, while others were successful. Experiments were also made with mice by inhaling; when some only were infected.

The size of the micrococci and development of the envelopes differ considerably with men and other animals. Those of mice were, on the average, larger than those of man; those of porpoises were smaller, but with broader envelopes; those of dogs were scarcely larger than those of man, and the envelope comparatively narrow. The mode of preparation also has an influence on the size of the micrococci.

Bacteria of the Cattle Distemper.*—The bacterium of the cattle-distemper has been hitherto known almost exclusively in the bacillus condition, not making its appearance in the blood till some ten hours before the death of the animal. F. Roloff has examined the blood in the early stages of the disease, and also those organs, especially the spleen and the lymphatic glands, in which the bacilli are first seen. In all these he found a large number of small round shining bodies or micrococci. The infection of other animals with blood containing these cocci, produced in them the ordinary distemper with its bacilli, showing that the two are stages of development of the same organism.

* Arch. Wiss. u. Prakt. Thierheilkunde, ix. (1883). See Bot. Centralbl., xvii. (1884) p. 112.

Passage of Charbon-bacteria into the milk of animals infected with Charbon.*—Chambrelent and A. Moussons have made the following experiments to determine whether the milk of a female in lactation affected with charbon contains the microbium of the infection. A cobaye, which had up to that time suckled its young, was inoculated with the charbon-virus. It died the next day, and a drop of blood taken from the ventricles of the heart was found to contain an immense quantity of bacteria. A drop of milk was taken from the mamillary gland by means of a sterilized tube, and placed in a Pasteur's "ballon" containing infusion of beef. At this time the milk presented a perfectly normal appearance, and showed no evidence of bacteria, although there were abundance in the blood. Four "ballons" treated in this way were left in the stove for two days; two were then quite limpid, one appeared to contain impurities; the fourth presented some flocci, and gave the appearance of a charbonized culture. It contained bacteria and interwoven filaments, but only in small numbers. A young cobaye was inoculated with this culture by means of a sterilized tube. It died in two days and its blood was found to contain bacteria. The rest of the culture, left in the stove, had in four days more assumed completely the characteristic appearance of charbon-cultures. A cobaye inoculated with it died the next day.

In a second experiment the milk was removed before the death of the animal. A young cobaye in lactation was inoculated with charbon-virus; the next day it was still alive. Milk was removed from it in the same way as before; four Pasteur's "ballons" were inoculated with it and placed in a stove. After four days one remained quite limpid; two had assumed the characteristic appearance of charbon-cultures; the fourth appeared to contain some foreign ferment. The two charbonized cultures contained great quantities of the characteristic filaments. Two cobayes inoculated with the fluid died the next day, presenting the characteristic lesions of charbon.

In a third experiment a large rabbit in lactation was inoculated with the same virus, which did not kill it. The milk of this rabbit displayed no bacteria, and the blood only a very few. Inoculation with the milk produced no signs of charbon-bacteria, and only one out of two with the blood.

The experiments show conclusively that bacteria are found in the milk of animals infected with charbon while they are still alive; but their number is enormously smaller than in the blood.

Comparative Poisonous Action of Metals on Bacteria.†—C. Richet has experimented on this subject, and gives a table of his results. The liquid was sea-water, neutralized urine, and commercial peptone, and the particular metal was added in gradually increasing quantity, in the form of chloride, until no bacteria were developed after forty-eight hours at 16°–20° C.

* Comptes Rendus, xcvii. (1883) pp. 1142-5.

† Ibid., pp. 1004-6. See Journ. Chem. Soc.—Abstr., xlvi. (1884) pp. 351-2.

The amount of each metal which will kill fish is always much less than that required to prevent the development of bacteria. The marked poisonous action of ammonium, lithium, and potassium on fish and all animals is in striking contrast to the slight effect which these metals exert on plants and bacteria. Poisons may be divided into two classes, viz. general poisons, of which mercury is the most potent, which even in small quantities have a deleterious action on both plants and animals; and special poisons, such as potassium and ammonium salts, and the alkaloids, which are injurious only to animals, and exert little or no poisonous action on plants. The difference is probably due to the fact that poisons of the second class act only on nerve-cells, whereas those of the first class act on all cells. Possibly the action of ammonium and potassium salts may serve to distinguish between plants and animals in the lower forms of life.

Micro-organisms in Soils.*—From examinations of a large number of samples, R. Koch found that the superficial layers of soil were very rich in germs of bacteria, particularly in bacilli. Micrococci were only found in places which had not been cleansed from decaying matter; the latter perished on heating the samples, but the bacilli did not, being mostly in the condition of spores, and it appears probable that they are introduced by means of manures and household offal.

The quantity of micro-organisms diminishes very rapidly with increase of depth, so that at the distance of one metre from the surface the earth is very free from them. P. Miquel attempts to estimate the number present in one gr. of soil, taken from a depth of 0·20 metre from the surface, and found in three samples: from Montsouris, 700,000 organisms; Gennevilliers, manured with liquid sewage, 870,000; Gennevilliers not so treated, 900,000.

The office of these minute organisms appears to be of great importance in the transformation of substances to forms suitable for plant-food.

Bacteria and Microscopical Algæ on the Surface of Coins in Currency.—Prof. P. F. Reinsch writes us as follows:—"Accidentally induced to examine microscopically the surface of a small silver coin, I made the observation of the presence of numerous *Bacteria* and microscopic unicellular algæ living in the incrustations and sediments which have been produced through constant use. I examined coins of various nations and of various value, and found my first observation perfectly confirmed. All silver and copper coins, several years in currency, show this curious vegetation of organisms of the lowest rank. It is observed best on coins twenty to thirty years old.

To observe this life, a small quantity of the sediment adhering to the prominences and in the cavities of the surface of the coin is scratched off with the top of a knife and put in a drop of distilled water on a slide, spread out in the water and immediately covered with a cover-glass.

Between the agglomerations of larger and smaller granules, scarcely dispersed fragments of fibres, and especially numerous granules of starch

* Bied. Centr., 1883, pp. 581–2. Cf. Journ. Chem. Soc.—Abstr., xlvi. (1884) p. 486.

(in the most cases granules of wheat), are observed. In a short time numerous mobile minute bodies are seen, the mobility of which seems at first to be the well-known molecular motion, but is soon turned into the most active bacteroid motion. By using a higher power (500 diam.) we observe in the agglomeration various forms of bacteroid life, very well recognizable both by their constant relations of size and shape, and by the mode of motion peculiar to the various bacteroid types. There are rod-shaped *Bacteria* with oscillating and spiral motion, and globular bacteria with the peculiar rocking-oscillating motion. Sometimes all these forms of bacteroid life are found on one and the same coin; in most cases there are found on one coin more especially globular *Bacteria*, on another coin more rod-shaped *Bacteria*. The globular forms make up in the case of all coins the principal constituent of bacteroid life in the incrustation. *Spirillum* is not found very often, but by searching after it, and dispersing the substance under the cover-glass it is sure to be found in a great many cases. Of *Bacillus*, four to six divided rods of 0·0055–0·0074 mm. in length are found on all silver, copper, and bronze coins. The automobile motion of the bacteroid bodies, lasting for many hours, is instantly stopped with one drop of a solution of iodine or of concentrated glycerine placed on the margin of the cover.

Of the unicellular algæ in the incrustations of nearly all the coins hitherto examined, I have distinguished till now two very distinct and constant types, the characteristics of which are so clear and constant, that they can be identified with known types of algæ and classified in the system of algæ. There is one most minute *Chroococcus* and one unicellular alga which I think very nearly allied to the Palmellaceæ. The slightly tinctured cells of this *Chroococcus* of 0·00925 mm. diam., form minute globular bodies, composed of 4, 8, to 12 cellules. These globular bodies are clustered together, forming minute irregular masses, 0·02 mm. diam. The Palmellaceous alga has many times larger, thick-walled cells; the contents of which are mostly intensely tinctured. The cells are found in all states of division from two to more. Of the Palmellaceæ *Pleurococcus* is the type, coming the nearest to this new alga. The cells in the undivided state are found 0·009–0·01 mm. diam. The thickness of the wall of the cells is equal nearly to 1/10 the transverse diameter of the cells. The cells in their many-divided state do not exhibit the same regular and symmetrical disposition of the daughter-cells as the typical *Pleurococcus* (*P. vulgaris*).

In addition to these organisms there are found in the incrustations of the coins (besides undeveloped fungoid hyphæ), spores of various Cryptogams of various size and shape, belonging to the Hyphomycetes and the Coniomycetes.

It may be concluded from the constancy of the characteristics and of the occurrence of these two unicellular organisms, that their occurrence is a spontaneous one, just as is the case with a large number of these organisms of the lowest state, concerning both living and dead matter; in other words that these organisms have to be considered not as accidentally adherent substances but as organisms,

which have their continual origin and seat in the incrustations of coins in currency. The discovery of the presence of these organic bodies (which, according to modern experiences, are generally recognized as important factors in the spread of epidemics) on objects so dispersed as coins, adds a new consideration in hygienic science. It seems also very probable that to the vital activity of these unicellular organisms, a share is due of the erosive process, perpetually going on on the surface of coins in currency.

The means for obviating the obnoxious influence of the organisms would simply consist in boiling the coins after a series of years of circulation, in a solution of caustic potash, and then cleaning the surface thoroughly from the incrustation."

The following is a description of the two new species:*—

Chroococcus monetarum. Cells minute, subglobose, angular, from 4 to 8 cells enveloped in a common mucilage and associated in small subglobose families. Diam. of cells 0·925 μ; diam. of families 0·46–0·56 μ.

Pleurococcus monetarum. Cells globose, with thick membrane, subtorulose (elevations 1/10 diam. of cell), undivided; from 2 to 8 cells associated in globose families; cell-contents brightly coloured. Diam. of cells 0·0074–0·011 mm.; diam. of families 0·011–0·0129 mm.

Rabies.†—L. Pasteur, with the assistance of MM. Chambrelent and Roux, has another communication on rabies. Inoculation has been effected either by applying the poison of rabies direct to the surface of the brain, or by injection into the blood. The former would appear to be a long and difficult operation, but we are assured that it may be well completed in twenty minutes, starting from the moment in which the animal was being subjected to chloroform.

Pasteur has already shown that the inoculation of the virus into the blood is most often accompanied by paralytic seizures without fury or barking, and that the first part to be affected is the spinal cord; and he has also already proved that the poison is to be found in the brain and spinal cord. He has since experimented with nerves and salivary glands, and he has been able to get poison effects with portions of the pneumogastric and sciatic nerves, as well as with the maxillary, parotid, and sublingual glands. It follows then that the whole of the nervous system is able to cultivate the rabic poison, and we find in this fact an explanation of the high degree of nervous excitement which is so often a characteristic of rabies. Poison placed in carefully sealed tubes is virulent after three weeks or a month, even when exposed to a summer temperature. The fluid of the central nervous system is sometimes, though not constantly poisonous: when limpid it is so, but not when distinctly opalescent. Cultivation experiments of the virus have not as yet been successful, but Pasteur is always able to distinguish the brain of a healthy from that of a rabid animal. Both, under the Microscope, exhibit an immense number of molecular granulations, but in the rabid brain they are finer and more numerous.

* Flora, lxvii. (1884) pp. 173–6.

† Comptes Rendus, xcviii. (1884) pp. 457–63.

He is inclined, therefore, to think that the microbe of rabies is infinitely small, a mere dot in shape, and not like a bacillus or a dumbbell-shaped micrococcus.

The only method known at present by which these granulations may be isolated from the other and nervous elements is the following:—Virus taken from the brain of an animal that has died of rabies is injected into the veins of a rabid animal at the moment when asphyxia commences. In a short time the normal nervous elements disappear from the blood in which only the just-mentioned minute granulations are now to be found. These may be stained by anilin dyes, but as the author is careful to point out, it is not yet definitely proved that these granulations are the microbes of rabies.

It has been found that while the trepanation-experiments are succeeded by desire to bite and "rabid barking"—furious rabies—injection experiments produce only paralytic rabies. If, however, exceedingly minute quantities of virus are injected, furious rabies ensues. On the other hand these minute quantities extend the period of incubation, and if the poison is diluted beyond a certain extent the inoculation has no effect. But these minute and inoffensive doses do not give protection against the effect of larger doses.

In rare cases the effects of the poison disappear to reappear with mortal result after some days. Entirely negative results have been obtained in reference to the pretended diminution of the poison by the influence of cold and by its passage from the mother to the fœtus.

Especial attention has been given to the very important question of the alteration of the character of the virus, and it has been found that the passage of the rabic virus through several species does more or less profoundly modify its virulence. Pasteur and his assistants now possess a virus which gives rabies to the rabbit in seven or eight days, and that with remarkable constancy; another virus has a similar effect on guinea-pigs.

Pasteur has already made known the curious fact that he has in his laboratory some dogs that are refractory to the virus of rabies, but he has not till now been able to say whether that was due to their natural constitution or not. He now finds that it is not so, but that he can by a system of inoculations of different kinds, make any number of dogs refractory; indeed he has now twenty-three. For the present he confines himself to this statement, but it is clearly one of great importance, as man only becomes rabid directly or indirectly from the bite of a dog. He concludes: "Could not human medicine profit by the long duration of the period of incubation to try and establish in this interval of time, before the appearance of the first symptoms of rabies, the refractory condition of subjects that have been bitten? Much, however, remains to be done before this hope can be realized."

Yeast-ferments.*—Continuing his researches on the ferment of beer, E. C. Hansen observes that there are in nature a large number

* Allg. Zeitschr. f. Bierbrauerei u. Malzfabrikat, 1883, p. 871. See Bot. Centralbl., xvii. (1884) p. 169. Cf. this Journal, iii. (1883) p. 252.

of fungi belonging to the most distinct groups which are capable of developing saccharomyces-like cells, by budding in nutrient solutions; but differing from that genus in not forming endogenous spores. Some of these fungi induce alcoholic fermentation, behaving in this respect like *Saccharomyces cerevisiæ*.

The author has made a careful examination of one of these unknown species. It propagates itself in beer-wort by budding, causing the higher fermentation, and showing in this respect a close relationship to *Saccharomyces ellipsoideus*. But under conditions where *S. cerevisiæ* would produce 6 vol. per cent. of alcohol, it produces scarcely 1·5 per cent. It also exhibits a great difference in its fermentive action, the chemical soluble ferment or invertin being entirely wanting, although it ferments saccharose as such. This establishes the fact frequently controverted, that saccharose can be directly fermented without previous immersion.

The fungus readily produces a perfect mycelium. Although its cells, when cultivated in beer-wort, altogether resemble typical *S. ellipsoideus* or *cerevisiæ*, they do not produce endogenous spores.

Action of Cold on Microbes.*—R. Pictet and E. Yung find that various organisms, such as bacilli, when subjected to a temperature of 70° C. for 108 hours, and to 130° for 20 hours, are not destroyed; others, such as *Torula* and the vaccine microbe, lost their power of producing fermentation.

Algæ.

Fertilization of Cutleria.†—E. de Janczewski has paid special attention to the development and mode of fertilization of *Cutleria adspersa*, growing at Antibes.

This species is strictly diœcious; but the male and female plants are often so intimately united at their base that it is practically impossible to separate them. They can only be distinguished by the different colours of their sori, orange in the male, very dark brown in the female plants. Each mature sporangium consists usually of 16 or sometimes of 32 cells, from each of which escapes a motile oosphere. This usually takes place early in the morning. The normal number of antherozoids produced in an antheridium is 128. The emission of antherozoids occurs at the same time as that of the oospheres; their period of motility does not exceed 12 hours at the outside. Their form and structure are precisely that of the Fucaceæ. Each of them has two vibratile cilia, and a bright orange granule. The motile oospheres bear a close resemblance to the zoospores of the Phæosporeæ, except that they are considerably larger. The whole of the oosphere is of a brown colour, except the anterior portion which constitutes a colourless beak. This beak bears at one side a slight swelling, to which are attached two vibratile cilia. The colourless protoplasm of the oosphere contains a number of brown chromoplastids, and of much smaller, colourless,

* Comptes Rendus, xcviii. (1884) pp. 747–9.
† Ann. Sci. Nat. (Bot.), xvi. (1883) pp. 210–26 (2 pls.).

highly refractive globules; there is no nucleus. Near the point of insertion of the vibratile cilia is a single large orange granule. The motility of the oospheres lasts as long as that of the antherozoids, and is equally affected by light.

As long as the oospheres are in motion, the antherozoids display no affinity for them; but as soon as the oospheres have lost their cilia and come to rest, the antherozoids are attracted to them. They move rapidly round them, finally come in contact with them, lose their cilia, and become absorbed into their substance. A single antherozoid is sufficient to impregnate an oosphere.

The fertilized oosphere contains the two orange granules derived from the male and female elements. It immediately becomes invested with a cell-wall, and begins to germinate the next day, dividing first of all into two cells, one of which is much larger than the other.

Zoospores which germinate without fecundation, resembling those of *Zanardinia*, are also probably present. They are found in unilocular zoosporangia, and resemble the motile oospheres except in their much smaller size.

Cutleria exhibits in its structure several important variations from the Fucaceæ. The antheridia are pluricellular in the former, unicellular in the latter. The oospheres of the Fucaceæ are immotile, and do not contain any orange granules; except in the latter point they resemble the oospheres of *Cutleria* after they have come to rest.

The nearest affinity of the Cutleriaceæ appears to be with the Ectocarpaceæ. *Ectocarpus Lebelii* and *secundus* possess antheridia which produce antherozoids precisely resembling those of the Cutleriaceæ and of the Fucaceæ, and equally incapable of independent germination. They also have plurilocular sporangia exactly like those of Cutleriaceæ. The plurilocular sporangia of other species of *Ectocarpus* and of the Phæosporeæ generally must be regarded as female organs, and the bodies which emerge from them not as true zoospores, but as motile oospheres homologous to those of Cutleriaceæ, which, in default of male organs, germinate without fecundation, offering an example of constant parthenogenesis. The same is also probably the case in the pelagic *Cutleria multifida*. The unisporous sporangia of *Tilopteris*, *Haplospora*, and *Scaphospora* are evidently homologous with the plurilocular sporangia of *Ectocarpus;* their oospheres appear, under certain conditions, to germinate parthenogenetically.

The occurrence of parthenogenesis normally in the greater number of Phæosporeæ, and exceptionally only in the Cutleriaceæ, must be regarded as placing this family at the head of the group.

Endoclonium polymorphum.*—Under this name a new parasitic alga is described by M. Franke. It has been observed only on *Lemna gibba*, on which it occurs in two forms, one endophytic in the air-cavities beneath the stomata on the upper side of the frond; the other epiphytic, on all parts of the host. The two forms are connected by an imperfect alternation of generations; but the same

* Cohn's Beitr. Biol. Pflanzen, iii. (1883) pp. 365–76 (1 pl.).

form may also repeat itself through a number of generations. The zoospores of the endophytic protococcus-like form germinate after coming to rest, on the surface of the *Lemna*, and give rise to the stigeoclonium-like epiphytic form. This produces macrozoospores, with four cilia, which continue to repeat the same form, and microzoospores, which sometimes, without conjugation, either enter the air-cavities beneath the stomata, and develope the endophytic form, or repeat the epiphytic form on the surface of the host: at other times they conjugate, and the zygozoospore also probably enters the air-cavities and gives rise to the endophytic form.

When cultivated in a moist atmosphere the cells of the epiphytic form increase in size and multiply rapidly, and, like the microzoospores and macrozoospores, may pass into a resting condition, their cell-wall thickening, but without any formation of jelly. The apical cells of the filaments finally put out long apical points destitute of chlorophyll.

Both kinds of zoospore have a red eye-spot, and are formed by repeated bipartition, with the exception of the macrospores, which are produced singly in the sporangia. The macrospores are 13·5 μ long and 10 μ broad, and provided with four cilia; the microspores are biciliated, and 7·5 μ long by 3·5 broad. The endophytic form produces zoospores of one kind only, resembling the microzoospores.

The parasite occurs especially on the white dead parts of the *Lemna*, where it produces dark green spots visible to the naked eye.

Godlewskia, a new Genus of Cryptophyceæ.*—E. de Janczewski has found, growing on *Batrachospermum* in a ditch near the botanic garden of Cracow, a new species and genus of algæ, to which he gives the name *Godlewskia aggregata*. It is distinguished at a glance from its host by its beautiful blue-green colour. Each individual consists of a basal flask-shaped cell or sterigma, and a number of smaller globular cells, borne in a row at its apex, conidia, formed by continued division of the sterigma. These conidia germinate directly, but do not separate easily from the parent sterigma, sometimes as many as two generations being found still attached to it, each basal conidium developing into a sterigma. *Godlewskia* must be assigned to the family Chamæsiphoneæ among Cryptophyceæ.

Sexuality in Zygnemaceæ.†—A. W. Bennett has investigated the reproduction of the Zygnemaceæ, with a view to the solution of the question:—Is it of a sexual character? De Bary, twenty-five years ago, and since then, Wittrock, have instanced what they have thought to be sexual differences between the conjugating cells, though most later writers rather ignore any essential physiological distinction. Mr. Bennett has directed his investigations chiefly to the genera *Spirogyra* and *Zygnema*, and from these he supports the inference of the above-mentioned authors. He finds there is an appreciable

* Ann. Sci. Nat. (Bot.), xvi. (1883) pp. 227–30 (1 pl.).
† Journ. Linn. Soc. (Bot.), xx. (1884) pp. 430–9.

difference of length and diameter in the conjugating cells, that deemed the female being the larger. The protoplasmic contents pass only in one direction, and the change first commences in the chlorophyll-bands of the supposed male cells, with accompanying contraction of the protoplasmic contents. The genera *Mesocarpus*, *Staurospermum*, and the doubtful form *Craterospermum*, on the whole substantiate the view above enunciated of sexuality.

Movements of the Oscillarieæ.*—In addition to the oscillatory movements of the Oscillarieæ, creeping and rotating movements of the protoplasm are also to be perceived, especially in those species where the cell-wall is thin and flexible, as *Oscillaria tenerrima* and *ærugineo-cærulea*. These have been more closely investigated by A. Hansgirg. The oscillating motion commences as soon as the filament has become fixed to a substratum by means of the mucilaginous substance excreted on the surface of the cell-wall. This extremely thin layer of mucilage often forms a hollow tube behind the creeping filament. It is not coloured brown by iodine like protoplasm, and takes only a passive, not an active part in the movement of the filament. The motive power which causes the gliding motion of the filament on a solid substratum resides in the protoplasmic contents of the cells, and is connected with osmotic currents.

In the protoplasm which had escaped from the broken end of a filament of *O. princeps*, the author observed a number of amœboid cells, from 9 to 12 μ in diameter, nearly spherical in form, and putting out colourless pseudopodia about twice the length of the central body, and to these he attributes the motile power of the protoplasm of the filament. The so-called "cilia" which proceed from the terminal cells of the filament of *O. ærugineo-cærulea*, do not participate in its motion except passively, and are, according to the author, independent parasitic organisms of the nature of *Leptothrix*.

In all the cells of the filaments of *Oscillaria*, the turgidity is unusually great, and the dividing septa experience great differences of pressure from variations in the tension. The cause of the oscillating motion appears to be that the protoplasm takes up water more rapidly, and consequently swells to a greater extent, than the enveloping sheath of mucilage. Several species can retain their vitality to an extraordinary extent, and for a long time after losing their water and becoming completely dried up.

A series of experiments made with a variety of substances led the author to the conclusion that the movements of the Oscillarieæ are caused mainly by the osmotic forces and forces of imbibition, which act on the protoplasmic contents of the cells, and not to any external layer of protoplasm. In those species where the filaments are inclosed in an osmotic mucilaginous sheath, in which they move alternately backwards and forwards, this takes place chiefly by osmotic processes in the protoplasmic contents of the cells, in consequence of which the turgidity becomes greater alternately in the

* Bot. Ztg., xli. (1883) pp. 831–43 (1 pl.).

cell of each end of the filament. In those species which have no such sheath, variations in the turgidity are also brought about by variations in the exosmotic and endosmotic phenomena of the cells.

Alveoli of Diatoms.*—A. Grunow considers that the perforation of the alveoli has been completely proved in diatoms from the Jutland cement-stone and from the London clay; but that this can only modify the previously adopted interpretation, since he considers that the diatoms from these localities have already begun to undergo dissolution—this being unquestionably the case in those from the London clay—in consequence of which the delicate closing membranes of the alveoli disappear first of all. He believes that whenever diatoms are accompanied by lime, and especially when iron pyrites is present, as is the case in these localities, alkaline reactions have been set up, which may have been very weak, but which always act more strongly on silica than even very strong acids. In valves treated with very strong acids the alveoli may sometimes be seen actually perforated; while others close by will still be closed. *Coscinodiscus oculus-iridis* and *C. Asteromphalus*—the former of which (in cement-stone) has open, and the latter unquestionably closed membranes—are so closely related to one another that no sharp line of demarcation can be drawn between them. The author has given a close examination to this group of diatoms from Franz-Josef Land; and believes that the alveoli are closed above and below by delicate membranes proceeding from the thickening-ring. In *Triceratium Favus* the upper one is sometimes furnished with small spines. He considers it very improbable that in nearly related forms there should be so great a diversity of structure as that between perforation and complete continuity of the valves.

MICROSCOPY.

a. Instruments, Accessories, &c.

Hensoldt's and Schmidt's Simplified Reading Microscopes.†—Dr. C. Bohn refers to the necessity for insuring that the divisions of the micrometer of these instruments ‡ shall be a simple fraction of the magnified image of the circle divisions. If the distance of the latter from the objective is altered by moving the objective or the Microscope, the power is no doubt changed, but the image no longer coincides with the micrometer scale. Shifting the scale alone is of no use, for the same reason. The only course is to alter the distance of the objective from the circle divisions and the distance of the micrometer scale simultaneously in a proper ratio, the conditions for which he discusses. A Ramsden eye-piece must be used.

* Bot. Centralbl., xvii. (1884) p. 67.
† Zeitschr. f. Instrumentenkunde, iii. (1884) pp. 87–8.
‡ See this Journal, ii. (1882) p. 548.

Geneva Company's Travelling Microscope.—This is a very ingeniously constructed instrument, shown set up in fig. 51, and as folded for travelling in fig. 52.

To fold it, the narrow curved support between the base and the uprights is turned back within the latter, a pin which fixes it in position (not shown) being first withdrawn from the base. The uprights are then brought down to meet the base, the body-tube, stage, and mirror being at the same time swung so as to be horizontal. The base consists of an open frame only, but is heavy enough to give complete steadiness.

Fig. 51.

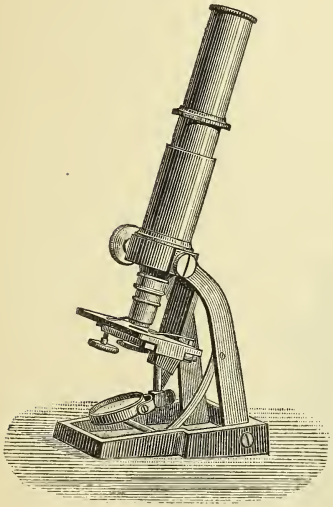
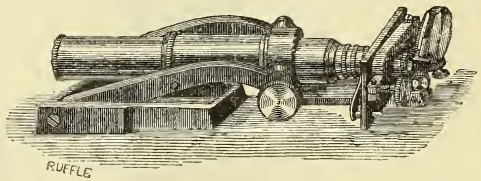


Fig. 52.



The milled head seen on the right of the body-tube clamps the socket of the latter between the uprights, so as to prevent it altering its inclination. The fine adjustment is effected by tilting the stage at one end by the screw beneath it.

When folded, the instrument measures $7\frac{1}{2} \times 3$ in. $\times 1\frac{3}{4}$ in.

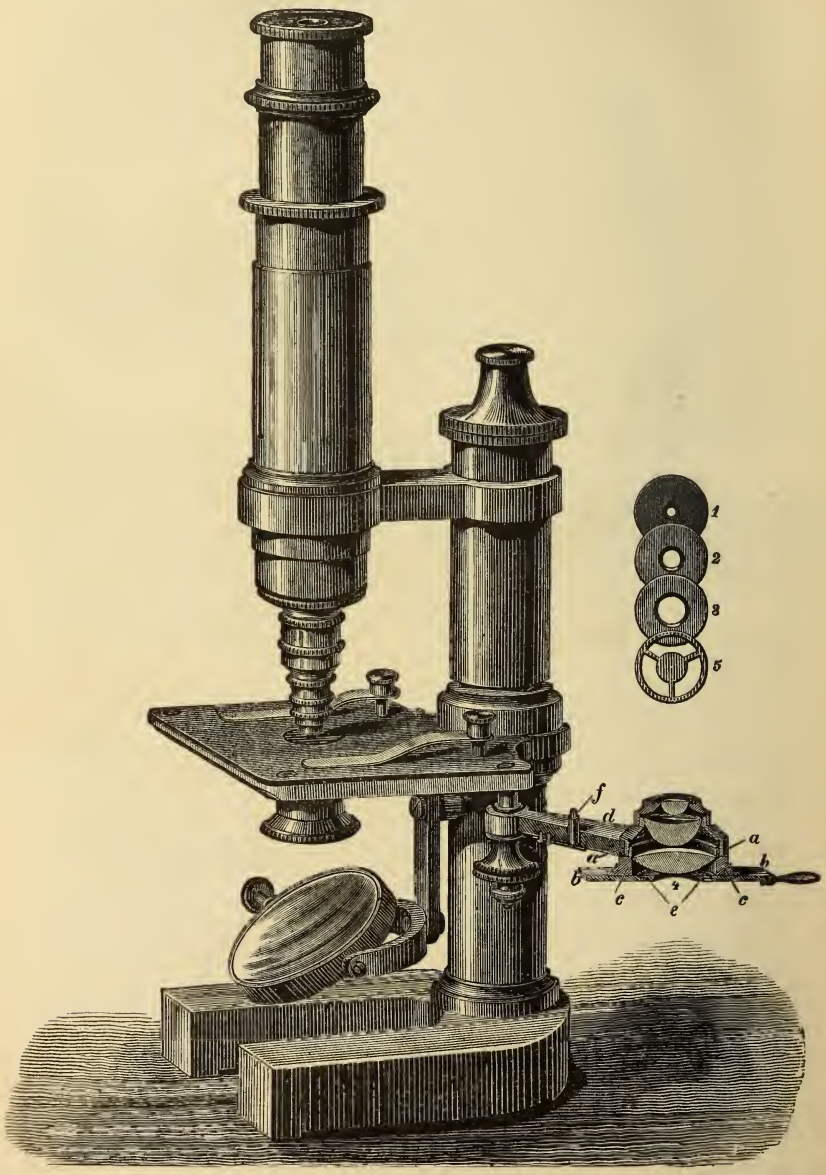
Reichert's Microscope with modified Abbe Condenser.—C. Reichert, of Vienna, with his medium stand (No. III.) supplies a modified form of Abbe condenser, shown in fig. 53, with which may be contrasted the original form by Zeiss (fig. 54).

The optical combination, consisting of three lenses with an aperture of 1·30 N.A., is screwed in a ring *a* attached to an arm *d*. This arm revolves on a pivot beneath the stage, so that it can be turned away from the stage, as shown in the figure. The fitting *c* of the lower lens has inner grooves to receive the diaphragm slide *b*, which can be drawn out entirely, for changing the five diaphragm-stops which drop into an aperture at *e*, or partially (to the right or left), so that the aperture may lie eccentrically to the optic axis for oblique illumination. A spring-pin falling in three holes marks the central or extreme lateral positions of the slide. The lenses with the diaphragm slide can be rotated in the ring, so that all azimuths of obliquity can be obtained. The pin *f* fits into a hole beneath the stage when the condenser is centered.

A slide beneath the stage for the ordinary cylinder diaphragms can be used when required on the condenser being turned aside.

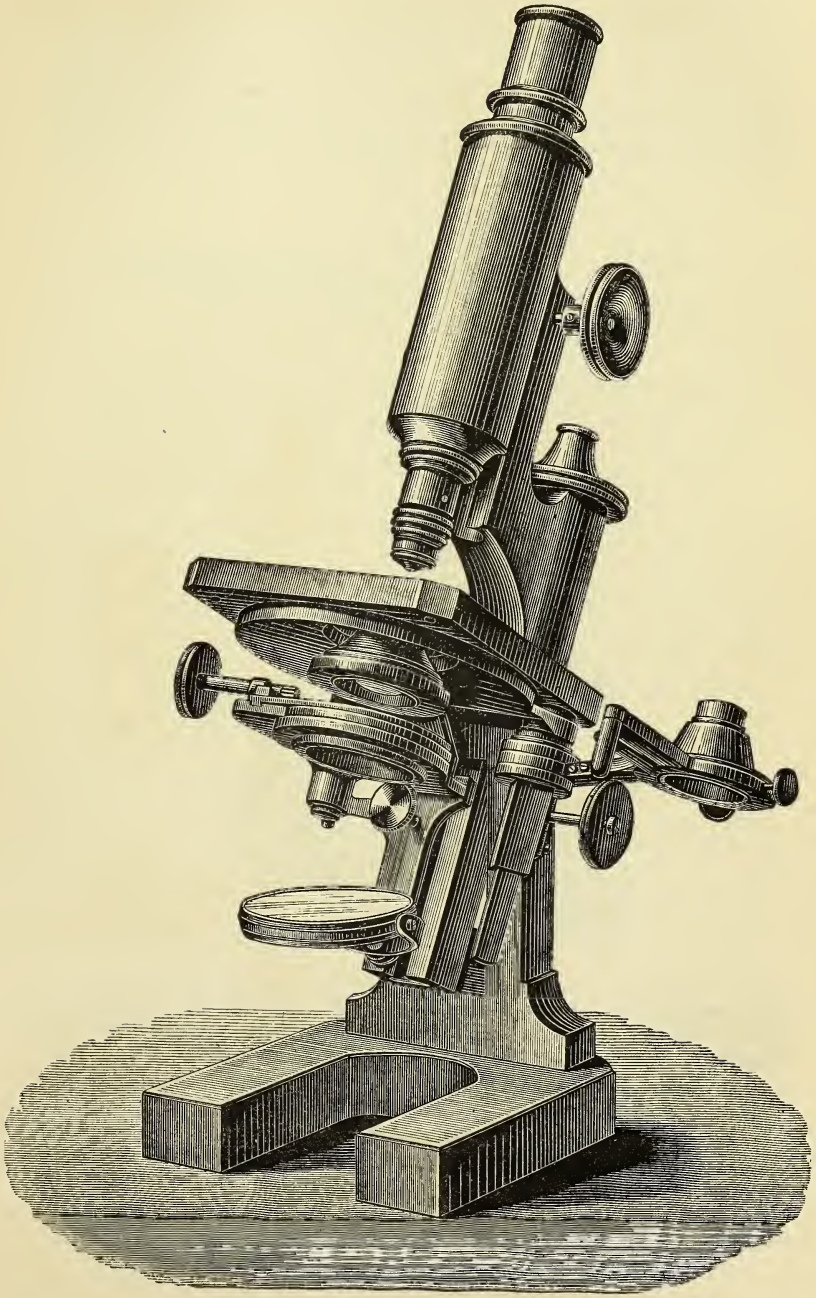
This apparatus seems to supply effectively the want which has long been felt for an adaptation of the Abbe condenser to the smaller

FIG. 53.



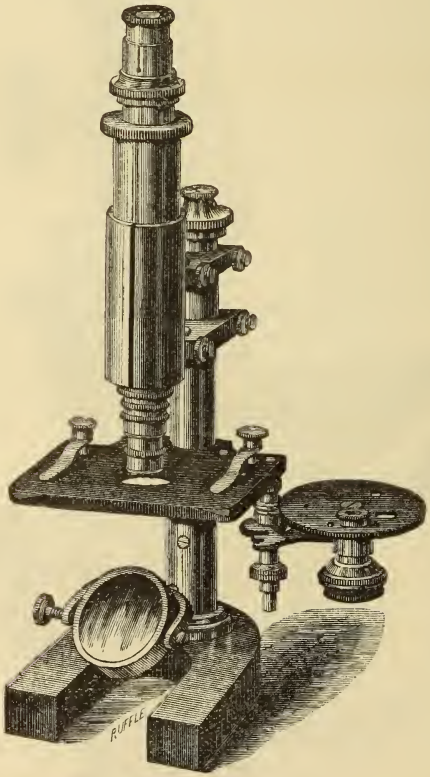
stands, though some of the advantages of the original form must necessarily be lost in such a case.

FIG. 54.



Reichert's Polarization Microscope.—This (fig. 55) is an inexpensive form of stand by C. Reichert, the chief peculiarity of which is that the wheel of diaphragms with five apertures rotates at the end of a horizontal arm, which, as with the condenser in the preceding form, swings on a pivot away from the stage, as shown in the figure. The diaphragm-plate is raised above the arm on a vertical axis, so that the tube attached to the largest aperture to hold the polarizer

FIG. 55.



may not prevent the complete rotation of the plate.* A notched projection on the arm falls against a second spindle beneath the stage when the apertures of the diaphragm-plate are central. The tube which holds the polarizer has a rotating fitting, and carries the polarizer with it.

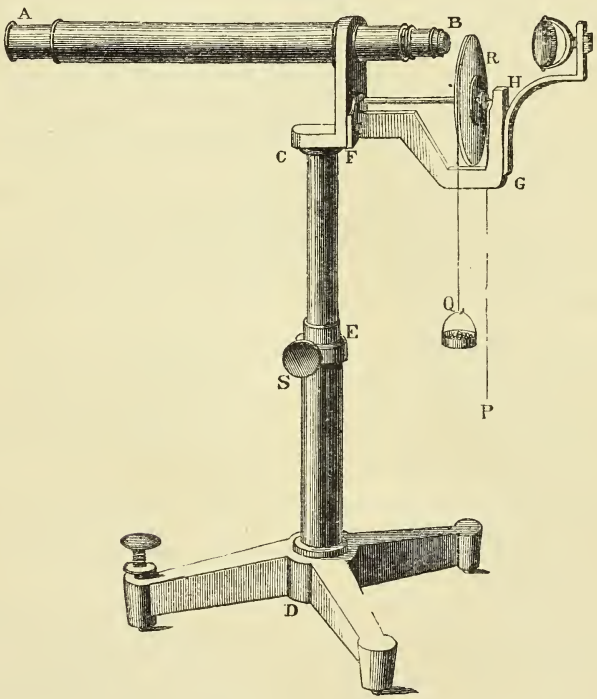
The analyser fits over the eye-piece without any attachment, which would seem to be undesirable, even though the Microscope can only be used in an upright position.

* When the polarizer is in place the plate cannot rotate completely, but no rotation is then required.

Reinke's Microscope for observing the Growth of Plants.*—J. Reinke, amongst other apparatus for observing the growth of plants, devised the instrument shown in fig. 56.

A tripod D supports a hollow pillar S in which slides a second pillar C E which can be raised to a height of 32 cm. from the table and is fixed with a clamp screw. To the latter pillar is attached a horizontal Microscope A focusing by the eye-piece and magnifying about 100 times. In front of the objective B is a glass wheel R

Fig. 56.



6 cm. in diameter with a grooved edge which runs very easily on two fine steel points let in the bent arm F G shown in the figure. A mirror on a second arm H illuminates the field of view.

A thread P passes over the groove in the wheel, the end of which is attached to the plant under examination, and at the other is a weight Q to keep the thread stretched. The circumference of the wheel for 10 cm. is graduated in half millimetres, and each millimetre is numbered. In the body-tube of the Microscope is a micrometer scale with 50 divisions. This is to be adjusted so that the 0 and 50 of

* Bot. Ztg., xxxiv. (1876), pp. 65–9, 91–5, 105–43, 145–60, 169–71 (2 pls.).

the scale exactly coincide with two consecutive divisions of the wheel. The half millimetres of the wheel can then be read to 1/50ths (= 0·01 mm.).

As the plant grows the wheel revolves, and the extent of the revolution is read on the wheel and scale by the aid of the Microscope. If the weight reaches the table, the movable pillar can be drawn out, and when the divisions on the 10 cm. of the wheel are passed over it can be brought back to 0 again by gently raising the weight.

Tetlow's Toilet-bottle Microscope.*—D. Tetlow has patented the following instrument, the specification of which we give verbatim without any attempt at an abstract, venturing only to emphasize one paragraph by italics of our own. The figures are also facsimile.

"To all whom it may concern: Be it known that I Daniel Tetlow, of the city and county of Philadelphia, and State of Pennsylvania, have invented a new and useful Improvement in Microscopes, which improvement is fully set forth in the following specification and accompanying drawings, in which—

Fig. 57 is a perspective view of a Microscope embodying my invention with central vertical sections thereof in line $x\,x$.

My invention consists of a Microscope having a body of the form of a bottle and the eye-piece removably fitted to the neck thereof, the construction, operation, and advantages being hereinafter set forth.

Referring to the drawings, A represents the body of a Microscope, the same being essentially of the form of a glass bottle having a closed bottom which is integral with the body; and B represents the eye-piece, consisting of the lens or glass C and metallic cap or holder D, the lens being properly set in the holder, and the latter removably fitted on the neck of the bottle.

E represents a base on which the bottle is stood, the same being formed of metal and receiving the bottom of the bottle, said bottom being shouldered, so as to properly set in the base and provide a neat joint for the parts.

While I have described the holder D and base E as metallic, sheet metal being preferred, it is evident that they may be formed of any suitable material and the base may be part of the glass.

The eye-piece is removed and an object to be examined placed in the bottle. The eye-piece is then restored, and the object may then be viewed through the lens C, as in Microscopes.

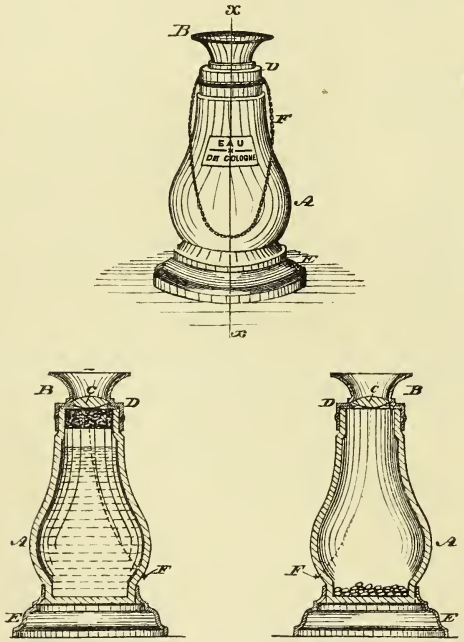
The body, being of the form of a bottle, has the following advantages: The object is not liable to be lost or displaced. It may be seen through the wall of the body and comparisons readily made as to its natural and magnified conditions and remain in the body for further examination, as the bottle provides an inclosure, the access to which being the mouth of the bottle, and this is covered by the lens C.

Another object of the invention is to employ the body A, *primarily,*

* Specification forming part of U.S.A. Letters Patent No. 287,978, dated November 6, 1883. Application filed August 24, 1883.

as a receptacle for some material or substance, such as perfumery. When the body is filled, it is corked and the eye-piece fitted to the neck, an attractive and convenient toilet-bottle thus being produced. The cork is concealed by said eye-piece, so that unauthorized persons will experience some difficulty in abstracting the perfumery. When the

Fig. 57.



perfumery is exhausted, the cork is thrown away and the service of the Microscope begins, said service being similar to that hereinbefore stated.

To the eye-piece is secured a chain, F, whereby the device may be readily carried, whether as a Microscope or toilet-bottle.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

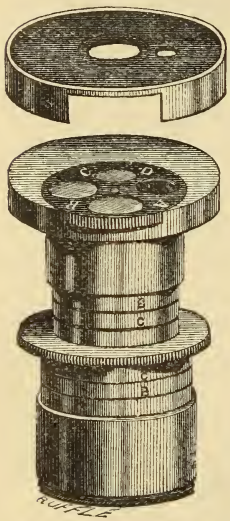
1. A glass bottle having a closed bottom integral with the body thereof and an open mouth, in combination with an eye-piece closing said mouth, formed of a lens and holder therefor, said mouth being adapted to contain a cork, substantially as and for the purpose set forth.

2. A bottle provided with a removable eye-piece and a base and chain, substantially as and for the purpose set forth."

Griffith's Multiple Eye-piece.—Mr. E. H. Griffith sends us the eye-piece (fig. 58) which he has devised.

A disk at the top of the eye-piece, with projecting milled edge, carries different eye-lenses which by rotation are brought successively into the optic axis. An aperture in the cap shows by a letter which lens is in place.

Fig. 58.



The upper tube to which the eye-glass disk is attached can be drawn out as shown in the figure, and the lower one, in which the field-lens is set, can be similarly drawn out.

Rings marked B and C show the proper position for each power, and when entirely closed, the eye-piece is of the proper length for a D eye-piece.

It was intended by the inventor to have a slit with stops for regulating the length of the eye-piece, and that a revolving diaphragm-disk should also be included, but these have not yet been added.

As to the utility of the eye-piece, it may be pointed out that whilst it would be very convenient to be able to obtain different eye-piece powers by simply rotating a disk, yet most of the advantage is lost by the necessity of withdrawing the eye-piece from the tube to alter its length—a process which would occupy as long a time as would be required to insert a different eye-piece. Moreover, it is optically impracticable to make use of the same field-lens for B, C, and D eye-pieces.

Francotte's Camera Lucida.*—P. Francotte thinks that Beale's camera lucida has a capital defect; the image is formed on the reflector too close to the eye-piece. The consequence is that the whole field is not visible at one time to the eye; whilst, for instance, the centre can be seen, the periphery is invisible; and in order to see all parts of the field, it is necessary to move the eye. Besides this, the short space left free between the eye-piece and the glass is very inconvenient.

To obviate this he replaces the eye-piece by a single lens, giving an image which is reflected by an inclined glass plate or a mirror. The inclination of the reflecting surface may vary between 40° and 50°, according to the point of the table upon which the image is to be projected. The image is erect, and the whole field is included.

The apparatus can be easily and very cheaply constructed. An ordinary lens (3 to 6 times) in a tube of cardboard is used as the eye-piece. The tube is cut obliquely, so that, on the elliptical section, a thin plate of glass or a mirror may be applied. On the upper surface an opening is made exactly over the place where the image is reflected.

By adopting the same principle and replacing the large prism of

* Bull. Soc. Belg. Micr., x. (1884) pp. 77–9.

Oberhäuser's camera by a mirror, the eye-piece by a single lens, and the small prism by a reflecting glass plate or a mirror, a convenient instrument is obtained which will not necessitate the inclination of the Microscope.

Rogers's New Eye-piece Micrometer.*—"Professor W. A. Rogers, of Harvard Observatory, has again laid microscopists under obligation by making an eye-piece micrometer for high oculars. It is a cover-glass of proper size to fit above the diaphragm of a 1/2 in. or 3/8 in. ocular, ruled in a scale with the fifth and tenth lines longer, and so fine as to need the magnifying power of the eye-lenses to separate the lines well. The high-power ocular separates also the striæ of diatoms, or other minute subdivisions of objects, and the scale enables one to count them with a readiness and ease which has not before been possible. It is a simple and inexpensive thing, that takes the place of the most expensive spider-web micrometers."

Geneva Co.'s Nose-piece Adapters.—Thury Adapters.—Prof. M. Thury takes exception to the remark at p. 284 that these adapters do not "differ in principle from the nose-pieces of Nachet and Vérick."

The first adapter was, he says, made in October 1863 after his designs for Count Castracane, and another in 1865 for Prof. E. Claparède. A Microscope exhibited by the Geneva Co. at the Paris Exhibition in 1867 was fitted with a similar adapter and was accompanied by a written description. At the 1878 Exhibition the modified movable form was exhibited. M. Nachet, who adopted the fixed form in 1877, "loyally termed it the 'Pince-Thury.'" It was after the 1878 Exhibition that the movable form came to be made by others.

Prof. Thury's apparatus was evidently therefore the precursor of all such contrivances.

Selection of a Series of Objectives.—Several writers have published their views on this subject, differing (with the exception of Dr. Carpenter) more or less from those put forward by Prof. Abbe in his paper on the "Relation of Aperture and Power."

Dr. G. E. Blackham† selects "as a set of powers sufficient for all the work of any microscopist the following:—

One 4 in. objective of 0·10 N.A. = 12° air angle nearly.
One 1 in. objective of 0·26 N.A. = 30° air angle nearly.
One 1/6 in. objective of 0·94 N.A. = 140° air angle nearly.
One 1/8 in. objective of 1·42 N.A.

The first two to be dry-working objectives without cover correction, the third to be dry-working with cover correction, and the fourth to be a homogeneous-immersion objective with cover correction, and all to be of the highest possible grade of workmanship. The stand . . . to be furnished with six eye-pieces, viz. 2 in., 1 in., and 3/4 in. Huyghenian, and 1/2, 1/3, and 1/4 in. solid. The following table

* Amer. Mon. Micr. Journ., v. (1884) p. 52.
† Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 33-41, 227-31.

shows the application of these powers to all grades of work, from that which is ordinarily done with a pocket lens to the extreme limits of microscopical vision :—

No. of lines to 1 in.	N. A. required to resolve.	Equivalent angular aperture.	Amplifying power needed to give apparent size of 100 to 1 in. at 10 in.	Amplifying power actually used.	How obtained.	
					Objective.	Eye-piece.
100	Less than 0·10	Less than 10° air	None	None	Naked eye	Naked eye
500	Less than 0·10	Less than 10° air	5	12½	4 in. of 0·10 N.A.	2 in.
5,000	Less than 0·10	Less than 10° air	50	50	1 in. of 0·26 N.A.	2 in.
10,000	0·11	12° 38′ air	100	100	..	1 in.
20,000	0·21	24° 16′ „	200	200	..	1/2 in.
30,000	0·32	37° 20′ „	300	300	1/6 in. of 0·94 N.A.	2 in.
40,000	0·41	48° 26′ „	400	600	..	1 in.
50,000	0·52	62° 40′ „	500	600	..	1 in.
60,000	0·63	78° 08′ „	600	600	..	1 in.
70,000	0·73	93° 48′ „	700	800	..	3/4 in.
80,000	0·84	104° 17′ „	800	800	..	3/4 in.
90,000	0·94	140° 16′ „	900	1200	..	1/2 in.
96,000	1·00	180° air, 82° 17′ homogeneous imm. fluid	960	1066	1/8 in. of 1·42 N.A.	3/4 in.
100,000	1·04	86° 21′ „	1000	1066	..	3/4 in.
110,000	1·15	About 98° „	1100	1600	..	1/2 in.
120,000	1·25	About 110° „	1200	1600	..	1/2 in.
130,000	1·35	About 125° „	1300	1600	..	1/2 in.
136,888	1·42	About 138° „	1368	1600	..	1/2 in.

. . . It has not been my purpose to lay down any single set of objectives as the only proper one, but to indicate the principles on which selection should be made, and the relation of aperture to amplifying power, and to show that there is at present no good theoretical reason for the use of objectives of greater amplifying power than the 1/8 in."

Dr. Blackham, it will be seen, advocates the use of eye-pieces as high as 1/4 in. which is largely in excess of Prof. Abbe's figures, which do not go beyond an amplification of 15 times.*

Mr. J. D. Cox believes† " Dr. Blackham has the verdict of experience with him when he says four or five lenses with a proper number of eye-pieces will cover the whole range of microscopical examination. In such a number of lenses you may get all the necessary combination of the three qualities of angle, power, and working distance which you may need. Different investigators may choose different series, but no one need have a greater number in the series. Economy is to be considered in deciding whether we shall choose one or another lens; but this is also consistent with the state-

* See this Journal, iii. (1883) p. 808.

† Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 229–30.

ment that all the elements, including economy, may be combined in such a small series. The lowest glass may be anything from a 1½ in. to a 3 in. If of an angle of 20° to 25° it will have plenty of working distance and penetration. The next glass should be of 40° angle, or very near it, as this is the maximum normal angle for binocular vision of opaque objects. Its working distance should be enough to allow the use of dissecting-needles under it, and the easy illumination of dry opaque objects. These conditions are found in good glasses ranging from 1 in. to 1/2 in. objectives. The third glass should also be a dry glass, having working distance enough to accommodate work with the animalcule-cages and compressors, and upon rough histological material. Its angle should be from 100° upwards, to as wide an angle as is consistent with the necessary working distance. These conditions are found in glasses ranging from 4/10 in. objectives to 1/6 in. Beyond the three lenses thus generally described, a single immersion lens of widest possible angle seems to give all the advantages that can be attained in the present condition of the art of making objectives.

In the third and fourth of the series, the angle should be the widest consistent with the other conditions specially named, and this is the only demand of the practical microscopist in which, as it seems to me, the phrase 'wide angle' can have any appropriate place."

Dr. J. Edwards Smith * says that he has practically, for the past four years, confined himself to the use of four object-glasses, namely, a 1 in. or 2/3 in. of 45° or 50°, a 1/2 in. of 38°, a 1/6 in. immersion, balsam angle ranging from, say 87° to 95°, according to the position of its collar, and a 1/10 in. immersion having a constant angle of 100°. Of the last two glasses, the 1/6 in. has a working distance of 1/50 of an inch. The 1/10 in. will work readily through covers 1/100 of an inch thick. A large amount of his work is on urinary deposits. For the examination of malignant growths and for minute pathology generally, a dry 1/4 in. of 100° is in reserve.

Mr. E. M. Nelson's† view is to give the beginner a 1½ in. and a 2/3 in.; later on a 1/6 in. may be added, and as a higher power a 1/12 in. immersion of 1·43 N.A. "For all working purposes the battery would then be complete, and the microscopist equipped to repeat any results hitherto obtained. As luxuries, a 3 in., 1/3 in., and 1/25 in. might be got. It sometimes happened that the high initial magnifying power of the 1/25 in. enabled the observer to find some hitherto unknown object, or portion of an object, more easily than with the 1/12 in.; but when once found its details of structure would be better made out with the 1/12 in. So far it had not been possible to construct a 1/25 in. as perfectly as a 1/12 in., nor with so high an aperture; hence it would rarely bear any eye-piece beyond the lowest. The 1/12 in., however, with proper manipulation, would bear the 1 in. eye-piece, and then reveal structure that could not be made out with 1/25's, as hitherto constructed.

* 'How to see with the Microscope,' 1880, pp. 202, 203, and 206.
† Engl. Mech., xxxix. (1884) p. 48.

"Half-inch objectives had been made with apertures of 80°. Some authorities had declared that 40° was the highest aperture that could be usefully employed with that focal length. He had obtained one of the best examples of the 1/2 in. of 80°, and had made a careful series of trials with it. He had applied diaphragms above the back combination to cut down the aperture to 60° and 40° respectively, and the results might be briefly told. Taking the proboscis of the blow-fly and viewing it with the 1/2 in. diaphragmed down to 40° aperture, and arranging the illumination in the most favourable manner, he noted every detail of the picture, the sharpness and blackness of the points of the bristles, the transparency and clearness and general precision of the image; then removing the diaphragm behind the lens, he increased the aperture to 60°, and he found the image improved in every way. Increasing the aperture to the fullest extent, 80°, gave no advance upon the quality of image seen with 60° up to the 1 in. eye-piece; for this reason he concluded that 60° was the really useful aperture for a 1/2 in., and gave as much resolving power as the eye could well sustain with that combined power. No doubt the extra 20° would give the lens a higher resolving power with a stronger eye-piece, but he thought that might be better obtained with a lens of shorter focal length."

Mr. Nelson gives * the following table of apertures for object-glasses (with 1 in. eye-piece on a 10 in. tube), and says that "if ideal perfection is to be reached, the values given in the above table must be aimed at."

In.		N.A.		°
3	..	·08,	air angle	10
2	..	·12,	„	15
1½	..	·17,	„	20
1	..	·26,	„	30
2/3	..	·39,	„	46
1/2	..	·52,	„	63
4/10	..	·65,	„	81
1/4	..	1·04,	„ water angle	103
1/5	..	1·3,	crown glass angle	117
1/6	..	1·56, which has yet to be constructed.		

It will be seen that there is a wide divergence between Mr. Nelson's and Prof. Abbe's figures. For instance, for N.A. 0·65 Prof. Abbe suggests an objective of 1/8 in. and Mr. Nelson a 4/10 in.

Lastly, we may give Dr. W. B. Carpenter's views as expressed in his latest publication on the subject.†

"The 1/8 in. is (according to the writer's experience, which is confirmed by the theoretical deductions of Prof. Abbe) the lowest objective in which resolving power should be made the primary qualification,—the 1/6, 1/5, 1/4, and 4/10 in. being specially suited to kinds of biological work in which this is far less important than focal depth and dioptric precision. This view is strengthened by the very important consideration that the resolving power given by

* Engl. Mech., xxxviii. (1883) pp. 367-8.

† 'Encyclopædia Britannica,' 9th ed., xvi. (1883) pp. 269-70.

wide aperture cannot be utilized, except by a method of illumination that causes light to pass through the object at an obliquity corresponding to that at which the most divergent rays enter the objective. Now, although in the case of objects whose markings are only superficial such may not be productive of false appearances (though even this is scarcely conceivable), it must have that effect when the object is thick enough to have an internal structure; and the experience of all biological observers who have carried out the most delicate and difficult investigations is in accord, not only as to the advantage of direct illumination, but as to the deceptiveness of the appearances given by oblique, and the consequent danger of error in any inferences drawn from the latter. Thus, for example, the admirable researches of Strasburger, Fleming, Klein, and others upon the changes which take place in cell-nuclei during their subdivision can only be followed and verified (as the writer can personally testify) by examination of these objects under axial illumination, with objectives of an angle so moderate as to possess focal depth enough to follow the wonderful differentiation of component parts brought out by staining processes through their whole thickness.

The most perfect objectives for the ordinary purposes of scientific research, therefore, will be obviously those which combine exact definition and flatness of field with the widest aperture that can be given without an inconvenient reduction of working distance and loss of the degree of focal depth suitable to the work on which they are respectively to be employed. These last attributes are especially needed in the study of living and moving objects; and in the case of these, dry objectives are decidedly preferable to immersion, since the shifting of the slide which is requisite to enable the movement of the object to be followed is very apt to produce disarrangement of the interposed drop. And, owing to the solvent power which the essential oils employed for homogeneous immersion have for the ordinary cements and varnishes, such care is necessary in the use of objectives constructed to work with them, as can only be given when the observer desires to make a very minute and critical examination of a securely mounted object."

A table is then given which in addition to the magnifying-powers of objectives with the A and B eye-pieces also "specifies the angle of aperture which, in the writer's judgment, is most suitable for each. He has the satisfaction of finding that his opinions on this latter point, which are based on long experience in the microscopic study of a wider range of animal and vegetable objects than has fallen within the purview of most of his contemporaries, are in accordance with the conclusions drawn by Professor Abbe from his profound investigations into the theory of microscopic vision, which have been carried into practical accomplishment in the excellent productions of Mr. Zeiss." An extract from the table will be found on the next page.

"For ordinary biological work, the 1/8, 1/10, and 1/12 objectives, with angles of from 100° to 200°, will be found to answer extremely well if constructed on the water-immersion system."

Focal Length.	Angular Aperture.	Focal Length.	Angular Aperture.
in.	°	in.	°
4	9	1/4	50–80
3	12	1/5	95
2	15	1/6	110
1½	20	1/8	140
1	30	1/10	150
2/3	40	1/12	160
1/2	45	1/16	170
4/10	70		

"It must be understood that there is no intention in these remarks to undervalue the efforts which have been perseveringly made by the ablest constructors of microscopic objectives in the direction of enlargement of aperture. For these efforts, besides increasing the resolving-power of the instrument, have done the great service of producing a vast improvement in the quality of those objectives of moderate aperture which are most valuable to the scientific biologist; and the microscopist who wishes his *armamentum* to be complete will provide himself with objectives of those different qualities as well as different powers which shall best suit his particular requirements."

"High-angled" Objectives.†—Dr. J. Edwards Smith "prefers to regard as 'high-angled,' any, and all glasses, without reference to their focal lengths, which are endowed with the widest apertures obtainable. If this be accepted, then it will occur that a 1 in. of 50° should be classed as a high-angled objective, and similarly a 2 in. of 25°. And, again, it would also then occur that a 1/6 in. of 130°, which fifteen years ago ranked as a wide, would now be classed as a glass of medium power."

Zeiss's A* Variable Objective and "Optical Tube-Length."—The demonstration of the important influence of "optical tube-length" on the magnifying power of the Microscope explains what has hitherto seemed a curious anomaly in the action of this objective.

It will be remembered that it has a considerable range of power according as its two lenses are "closed" (when they are 44 mm. apart) or "open" (when they are at a distance of 52 mm.), the closing and opening being effected by rotating the collar on the objective.

In the closed position the equivalent focal length of the objective is 54·1 mm., and in the open 39·7 mm., or a ratio of approximately 4 : 3. The power of the Microscope is however increased not in the ratio of 3 : 4 only, but of 3 : 5·28.

The explanation of this difference is found in the fact that Δ, or the optical tube-length, varies considerably according to the position of the lenses of the objective. When they are closed the posterior focal plane is 153·6 mm. from the back lens of the objective, but when open 125·7 mm. only. Δ is therefore (with a tube-length of 10 in. or 250 mm. from the back lens of the objective to the anterior focal plane of the ocular) 250 − 153·6 = 96·4 mm., *or* 250 − 125·7 = 124·3 mm.

† 'How to see with the Microscope,' 1880, p. 104. Cf. also p. 146.

In the formula, therefore, for the magnifying power of the Microscope as a whole

$$N = \frac{250\ \Delta}{f\phi}$$

(f and ϕ being the focal lengths of the objective and ocular respectively), N is in the one case 17·8 and in the other 31·3, assuming ϕ to be 25 mm.

Those who are interested in optical formulæ may like to have before them the method by which (1) the focal length of the objective and (2) the distances of its posterior focal plane are determined, according to the improved methods of Prof. Abbe, of which we hope to give a more detailed account later.

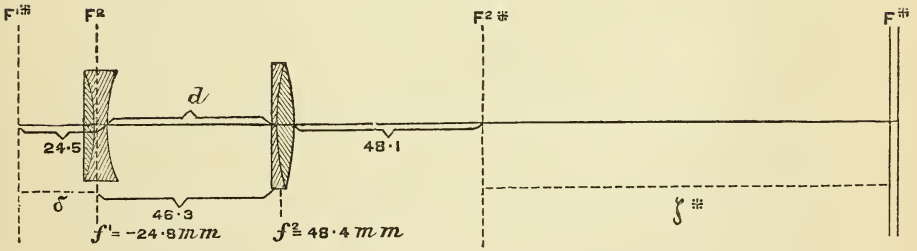
(1) To determine the focal length f of the combination, we require to know only the focal lengths f_1 and f_2 of the two lenses, and the position of their anterior and posterior focal planes, whence we derive f according to the formula

$$f = -\frac{f_1 f_2}{\delta}$$

(δ being the distance of the posterior focal plane of the first lens † from the anterior focal plane of the second lens).

Thus suppose in fig. 59 that we have given $f_1 = -24{\cdot}8$ mm. and

FIG. 59.



$f_2 = 48{\cdot}4$ mm., we require only to determine δ to solve the equation.

We can determine δ from the distances (supposed to be given) of the focal planes from the respective lenses, the distance of the posterior focal plane of the first lens $F_1^* = 24{\cdot}5$ mm. and that of the anterior focal plane of the second lens $F_2 = 46{\cdot}3$ mm. For the diagram shows that if from the total distance between F_1^* and the front of the second lens (which is made up of the variable distance between the lenses d and the quantity 24·5), we deduct the distance 46·3 mm. of the focal plane F_2 from the second lens we shall have the distance δ.

† The first lens being a plano-concave the *posterior* focal plane (i. e. which relates to the posterior medium, or to the image) is in *front* of the lens, and not, as with convex lenses, at the back.

Thus, according as the lenses are closed or open ($d = 44$ mm. or 52 mm.),

$$\delta = 44 + 24{\cdot}5 - 46{\cdot}3 = 22{\cdot}2$$
$$= 52 + 24{\cdot}5 - 46{\cdot}3 = 30{\cdot}2.$$

Having thus found δ, f is also found, as it is

$$\frac{24{\cdot}8 \times 48{\cdot}4}{22{\cdot}2} = 54{\cdot}1,$$

or

$$\frac{24{\cdot}8 \times 48{\cdot}4}{30{\cdot}2} = 39{\cdot}7.$$

(2) The second step is to find the distance of the posterior focal plane F* of the combination, which being deducted from 10 in. gave us Δ.

This distance, as the diagram shows, is made up of two quantities, one being the distance of the posterior focal plane F_2* of the second lens, which is supposed to be given, and $= 48{\cdot}1$ mm., and the other, an unknown quantity, which we will call ζ*. This unknown quantity may be determined from the known quantities of f_2 and δ by the formula

$$\zeta^* = \frac{(f_2)^2}{\delta}.$$

It is therefore

$$\frac{(48{\cdot}4)^2}{22{\cdot}2} = 105{\cdot}5,$$

or

$$\frac{(48{\cdot}4)^2}{30{\cdot}2} = 77{\cdot}6,$$

according as the lenses are open or closed.

Adding these values of ζ* to $48{\cdot}1$ we get the figures given above as the distance of the posterior focal plane from the back lens, i. e. $153{\cdot}6$ or $125{\cdot}7$.

The focal length of the objective and the distance of its posterior focal plane are thus very readily found, without elaborate calculations, by simply knowing the focal lengths and the position of the focal planes of the separate lenses, data which can be obtained very simply and without the necessity of knowing anything about the formulæ on which the objective is constructed or the refractive index of the glass of which its lenses are made. We hope, as we have said, to return to this subject hereafter and in more detail.

Queen's Spot-lens Mounting.†—In order to overcome as far as possible the difficulty J. W. Queen and Co. have felt in fitting the spot-lens to instruments of various patterns (some with movable substage and some with fixed tube, the latter at varying distances from the upper surface of the stage), they have devised the following mount:—

The tube A (figs. 61 and 62) is made of standard size to fit the

† Micr. Bulletin, i. (1884) p. 11 (3 figs.).

usual English and American substage or accessory tubes. The tube B carries a third tube C (blackened inside), sliding easily within it. Securely mounted in the latter tube is the spot-lens, which thus may be accurately focused upon the object; and when once adjusted for any stand, there is no occasion to alter it. If the small tubes be only 1/2 in. or 5/8 in. in length, the focusing range is a long one.

Fig. 60.

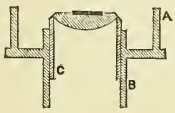


Fig. 61.

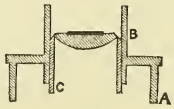


Fig. 62.

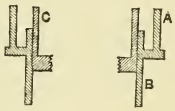


Fig. 60 shows the instrument as fitted to a Microscope which has the fixed tube beneath the stage. By reversing, as shown in fig. 61, the same mount may be used equally well in the movable substage of larger instruments.

They have also applied the same device to the usual substage Society-screw adapter, for carrying achromatic condenser or objective used as such (fig. 62).

The inside diameter of the tube C in this case is made $1\frac{1}{8}$ in., which will exclude very few objectives. It may, of course, be used, as the other, either in Microscopes with fixed stage tubes, or with movable substage.

Paraboloid as an Illuminator for Homogeneous-Immersion Objectives.*—A. J. Moore attempts "to make two comparatively inexpensive pieces of apparatus take the place and do the work of any first-class wide-angled immersion condenser. These accessories are the ordinary parabola and the hemispherical lens."

Ordinarily the former is a dark-ground illuminator, but when the aperture of the objective exceeds that of the parabola, the effect is simply that of a dry condenser, in which the central rays are stopped out. But even at its best the light cannot traverse the slide at a greater angle than 41° from the axis; and it is rarely, if ever, even so great as this. Now, if the light reflected by the parabola could be converted into a glass (or balsam) angle without altering its angular direction, it would be amply sufficient to give light to the objective at the widest balsam angle now used in the best homogeneous-immersion objectives. This may be done by using, under the slide, a hemispherical lens,† whose radius is less than that of the concavity of the parabola, making optical contact by the immersion fluid. This is to be accurately centered and the parabola brought up so close that the hemispherical lens will occupy the concavity. When properly adjusted, it will be obvious that those rays which are transmitted by the parabola impinge normally to the surface of the hemispherical

* 'The Microscope,' iv. (1884) pp. 27–30 (1 fig.).

† This was described and figured by Mr. F. H. Wenham, Trans. Micr. Soc. Lond., iv. (1856) pp. 57–8 (1 fig.).—Ed.

lens, and hence are not refracted; that is, they traverse the same path in the lens that they had upon the parabola. The effect, then, is that of the wide-angled immersion condenser with the central rays stopped out.

Although this may be very desirable for some objects, it is not generally so, and it becomes necessary to limit the direction from which the light comes. This may be very easily accomplished by the use of a cardboard diaphragm. This may be made by cutting a circle of blackened cardboard, the diameter of the inside of the mounting of the parabola, so that when pushed home against the glass surface the circle will be held friction-tight. By cutting small holes in this card the light may be regulated; and it should be kept well in mind that when the holes are cut in the outer edge of the card, the light, although oblique, will be more nearly central than when admitted to the reflecting surface through a hole nearer the centre; but should the hole be too near the centre of the card the light will not be transmitted at all, owing to the fact that it will strike the top of the concavity of the parabola. A good guide to go by is a circle upon the card whose diameter is the same as that of the top of the concavity. The most of the oblique light may then be obtained by cutting the holes near this line. Holes may be cut at various angles to each other, to effect the resolution of the various sets of lines by which some objects are marked.

The author adds: "The chief objection to this method of illumination is, that central light cannot be obtained; but this, of itself, is of no particular account, as the parabola may be removed from the substage when it is desired. As to the performance of this arrangement, I can speak in the highest terms; the resolution of the diatoms of Möller's balsamed plate being easily accomplished; and when the full operation of the parabola was used, the dots of No. 18 showed better than I have ever seen them by any other method of illumination."

Fig. 63.

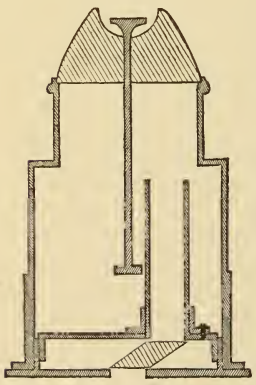


Fig. 64.

Paraboloid for Rotating Illumination in Azimuth.—We have a paraboloid with an arrangement shown in section in fig. 63. The bottom of the fitting is closed by a brass box in which is a rhomboidal prism, the lower face of which is over an oblong slot in the centre of the lower plate of the box, while the upper face is towards the side of the upper plate, and just beneath the outer zone of the paraboloid. Over the upper face is a tube $1\frac{1}{2}$ in. high (the horizontal section of which is shown in fig. 64). Axial rays are, by means of the prism, made to fall on a part of the outer zone of the paraboloid, and by rotating the box can be brought into any azimuth of the latter.

Horizontal Position of the Microscope.*—Mr. H. J. Slack considers that the usual position of a Microscope with a tube slanting a little and the head leaning forward to look down it, is all very well for a short examination of any object, but not at all desirable for continuous work. A better plan is to get a carpenter to make a light stool 2 ft. long and 14 in. wide, standing on four legs, the length of which should be determined by that of the Microscope it is intended to use and the height at which the observer sits. His own stool is 7 in. high, and when placed on an ordinary table brings a full-sized Microscope with its tube in a horizontal position at a convenient height for the eye of an observer sitting in an ordinary chair. The late Mr. Lobb, who was skilful in exhibiting troublesome objects, always used his Microscope in this position; but as far as Mr. Slack knows, it is seldom adopted. When the instrument is in position as described, the substage mirror should be turned out of the way, and the lamp placed so that its flame is exactly opposite the axis of the instrument, and can be seen in the middle of the field on looking through it. If the objects to be watched are large enough for a low power, the light may be softened by placing under the slide a piece of foreign post paper saturated with spermaceti. For high powers, an achromatic condenser is desirable, and one of the smallest central stops is usually the most useful for displaying fine cilia, or delicate whips, as well as for lighting up without glare the interior of various creatures. If all is arranged properly, the manners and customs of infusoria may be watched for hours without more fatigue than reading a well-printed book. A tenth part of the time spent with the head leaning forward in the usual way is far more exhausting.

Flögel's Dark Box.—Dr. J. H. L. Flögel some fourteen years ago devised the dark box, shown in fig. 65, to put over the Microscope and shut out all extraneous light. It is open behind and has an aperture in front to admit light to the mirror. From back to front it measures 20–25 cm., and in width 60–80 cm.; its height depends upon the stand to be used.† He now adds a few words in the interest of those microscopists who may wish to have similar boxes made. ‡

The principal thing is the right position of the aperture by which the light is admitted; its upper edge must lie exactly at the level of the stage—not lower, in order that the full light from the window may be used; and not higher, in order that light may not fall from above on the stage, which would do away with most of the advantages of the box. The Microscope is put as far as possible in the box, so that the edge of the stage touches it, and, in order that there may be sufficient room for the head of the observer in this position, the anterior portion of the box is bowed out. On the right and left of the

* 'Knowledge,' v. (1884) pp. 109–10.

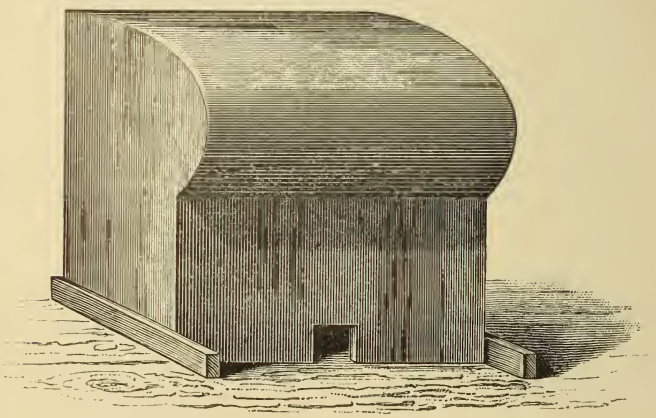
† Dr. L. Dippel considers this plan preferable to a darkened room with an opening in the shutter to admit light. The contrast between the illuminated field and the dark room is too great. The pupil of the eye is now enlarging and now contracting, and injurious results must inevitably follow. 'Das Mikroskop,' 1882, pp. 751–2 (1 fig.).

‡ Zool. Anzeig., vi. (1883) pp. 566–7.

Microscope there should be enough room for the hands to move comfortably and to be able to draw.

The action of the dark box is that it strengthens the retina wonderfully in the perception of the finest details. This takes place in two ways. First, in the ordinary mode of observing with the

Fig. 65.



Microscope, the eye of the observer is so much disturbed by the light from the illuminated eye-piece setting, and the surrounding objects, that many microscopists are accustomed to shade the eye with the hollowed hand as a remedy in delicate observation. This is obviated in the most perfect manner by the dark box. In the next place, it is by no means a matter of indifference whether strong or weak light-impressions are simultaneously received by the other open eye, which is at rest. Every more intense light-impression prejudices the sight of the other eye more than is commonly supposed. Into the dark box, however, only a faint illumination can enter from the light of the room behind it, especially when the table is black.

Feussner's Polarizing Prism.*—Dr. K. Feussner gives a detailed description of the polarizing prism lately devised by him, which presents several points of novelty, and for which certain advantages are claimed. The paper also contains an account, although not an exhaustive one, of the various polarizing prisms which have from time to time been constructed by means of different combinations of Iceland spar.

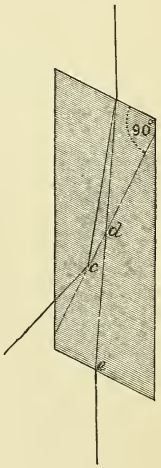
I. *Older Forms of Polarizing Prisms.*—In comparing the various forms of polarizing prisms, the main points which need attention are:—the angular extent of the field of view; the direction of the

* Zeitschr. f. Instrumentenk., iv. (1884) pp. 42–50 (8 figs.). See P. R. Sleeman in 'Nature,' xxix. (1884) pp. 514–7 (8 figs.).

emergent polarized ray, whether it is shifted to one side of or remains symmetrical to the long axis of the prism; the proportion which the length of the prism bears to its breadth; and, lastly, the position of the terminal faces, whether perpendicular or inclined to the long axis. These requirements are fulfilled in different degrees by the following methods of construction.

1. *The Nicol Prism.**—This (fig. 66), as is well known, is constructed from a rhombohedron of Iceland spar, the length of which must be fully three times as great as the width. The end faces are cut off in such a manner that the angle of 72° which they originally form with the lateral edge of the rhombohedron, is reduced to 68°. The prism is then cut in two in a plane perpendicular to the new end surfaces, the section being carried obliquely from one obtuse corner of the prism to the other, in the direction of its length. The surfaces of this section, after having been carefully polished, are cemented together again by means of Canada balsam. A ray of light, on entering the prism, is separated by the double refraction of the calc-spar into an ordinary and an extraordinary ray: the former undergoes total reflection at the layer of balsam at an incidence which allows the extraordinary ray to be transmitted; the latter, therefore, passes through unchanged. This principle of obtaining a single polarized ray by means of total reflection of the other is common to all the forms of prism now to be described.

Fig. 66.



Dr. Feussner gives a mathematical analysis of the paths taken by the two polarized rays within the Nicol prism, and finds that the emergent extraordinary ray can include an angular field of 29°, but that this extreme value holds good only for rays incident upon that portion of the end surface which is near to the obtuse corner, and that from thence it gradually decreases until the field includes an angle of only about half the previous amount. He finds, moreover, that, although of course the ray emerges parallel to its direction of incidence, yet that the zone of polarized light is shifted to one side of the central line. Also that the great length of the Nicol—3·28 times its breadth—is not only an inconvenience, but, owing to the large pieces of spar thus required for its construction, prisms of any but small size become very expensive. To this it may be added that there is a considerable loss of light by reflection from the first surface, owing to its inclined position in regard to the long axis of the prism.

It is with the view of obviating these defects that the modifications represented in figs. 67 to 71 have been devised.

* Edin. New Phil. Journal, vi. (1828) p. 83.

2. *The Shortened Nicol Prism* (fig. 67).—This arrangement of the Nicol prism is constructed by Steeg and Reuter of Homburg v. d. H. For the sake of facility of manufacture, the end surfaces are cleavage planes, and the oblique cut, instead of being perpendicular, makes with these an angle of about 84°. By this alteration the prism becomes shorter, and is now only 2·83 times its breadth; but if Canada balsam is still used as the cement, the field will occupy a very unsymmetrical position in regard to the long axis. If balsam of copaiba is made use of, the index of refraction of which is 1·50, a symmetrical field of about 24° will be obtained. A prism of this kind has also been designed by B. Hasert, of Eisenach,* but its performance appears to be inferior to the above.

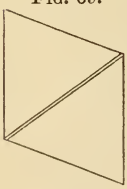
Fig. 67.

3. *The Nicol Prism with Perpendicular Ends* (fig. 68).—The terminal surfaces in this prism are perpendicular to the long axis, and the sectional cut makes with them an angle of about 75°. The length of the prism is 3·75 times its breadth, and if the cement has an index of refraction of 1·525, the field is symmetrically disposed, and includes an angle of 27°. Prisms of this kind have been manufactured by Steeg, C. D. Ahrens, and others.

Fig. 68.

4. *The Foucault Prism* † (fig. 69).—This construction differs from all those hitherto mentioned, in that a film of air is employed between the two cut surfaces as the totally reflecting medium instead of a layer of cement. The two halves of the prism are kept in position, without touching each other, by means of the mounting. The length of the prism is in this way much reduced, and amounts to only 1·528 times its breadth. The end surfaces are cleavage planes, and the sectional cut makes with them an angle of 59°. The field, however, includes not more than about 8°, so that this prism can be used only in the case of nearly parallel rays; and in addition to this the pictures which may be seen through it are to some extent veiled and indistinct owing to repeated internal reflection.

Fig. 69.

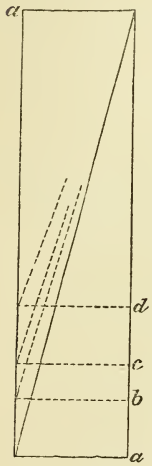


5. *The Hartnack Prism* † (fig. 70).—This form of prism was devised in 1866 by Hartnack and Prazmowski, and was described, vol. iii. (1883) p. 428. It is considered by Dr. Feussner to be the most perfect prism capable of being prepared from calc-spar. The ends of the prism are perpendicular to its length; the

* Pogg. Ann., cxiii. p. 189.
† Comptes Rendus, xlv. (1857) p. 238.
‡ Ann. Chem. et Physique, vii. (1866) p. 181.

section carried through it is in a plane perpendicular to the principal axis of the crystal. The cementing medium is linseed oil, the index of refraction of which is 1·485. The field of view afforded by this construction depends upon the cementing substance used, and also upon the inclination of the sectional cut in regard to the ends of the prism; it may vary from 20° to 41°. If the utmost extent of the field is not required, the prism may be shortened by lessening the angle of the section at the expense however of interfering with the symmetrical disposition of the field.

Fig. 70.



6. *The Glan Prism* * (fig. 71).—This is a modification of the Foucault, and in similar manner includes a film of air between the sectional surfaces. The end surfaces and also the cut carried through the prism are parallel to the principal axis of the calc-spar. The ends are normal to the length, and the field includes about 8°. This prism is very short, and may indeed be even shorter than it is broad. It is subject to the same defect as that mentioned in the case of the Foucault, although perhaps not quite to the same extent.†

Fig. 71.

II.—*Feussner's Prism* (figs. 72–3).—This prism differs very considerably from the preceding forms, and consists of a thin plate of a doubly refracting crystal cemented between two wedge-shaped pieces of glass, the terminal faces of which are normal to the length. The external form of the prism may thus be similar to the Hartnack, the calc-spar being replaced by glass. The indices of refraction of the glass and of the cementing medium should correspond with the greater index of refraction of the crystal, and the direction of greatest and least elasticity in the latter must stand in a plane perpendicular to the direction of the section. One of the advantages claimed for the new prism is that it dispenses with the large and valuable pieces of spar hitherto found necessary: a further advantage being that other crystalline substances may be used in this prism instead of calc-spar. The latter advantage, however, occurs only when the difference between the indices of refraction for the ordinary and extraordinary rays in the particular crystal made use of is greater than in calc-spar. When this is the case, the field becomes enlarged, and the length of the prism is reduced.

The substance which Dr. Feussner has employed as being most suitable for the separating crystal plate is nitrate of soda (*natron-salpeter*), in which the above-mentioned values are $\omega = 1{\cdot}587$ and

* Carl's 'Repertorium,' xvi. p. 570 and xvii. p. 195.

† Amongst others, the modifications of the Nicol prism which have recently been devised by Prof. S. P. Thompson (see this Journal, iii. (1883) p. 575), and by Mr. R. T. Glazebrook (Phil. Mag., 1883, p. 352), do not appear to have been known to Dr. Feussner.

$\epsilon = 1{\cdot}336$. It crystallizes in similar form to calcite, and in both cases thin plates obtained by cleavage may be used.

As the cementing substance for the nitrate of soda, a mixture of gum dammar with monobromonaphthalene was used, which afforded an index of refraction of 1·58. In the case of thin plates of calcite, a solid cementing substance of sufficiently high refractive power was not available, and a fluid medium was therefore employed. For this purpose the whole prism was inclosed in a short glass tube with air-tight ends, which was filled with monobromonaphthalene. In an experimental prism a mixture of balsam of tolu was made use of, giving a cement with an index of refraction of 1·62, but the low refractive power* resulted in very considerable reduction of the field. The extent and disposition of the field may be varied by altering the inclination at which the crystal lamina is inserted (fig. 72), and thereby reducing the length of the prism, as in the case of the Hartnack.

Fig. 72.

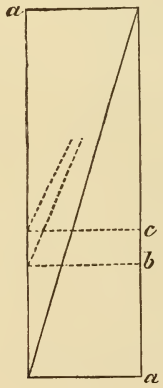
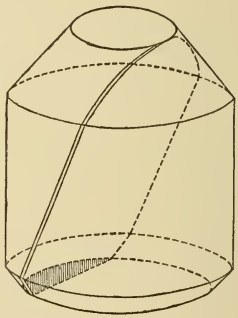


Fig. 73.



In order to obviate the effects of reflection from the internal side surfaces of the prism, the wedge-shaped blocks of glass of which it is built up may be made much broader than would otherwise be necessary; the edges of this extra width are cut obliquely, and suitably blackened.

The accompanying diagram (fig. 73) represents a prism of cylindrical external form constructed in this manner, the lower surface being that of the incident light. In this the field amounts to 30°, and the breadth is about double the length.

Dr. Feussner remarks that a prism similar in some respects to his new arrangement was devised in 1869 by M. Jamin,† who used a thin plate of calc-spar inclosed in a cell filled with bisulphide of

* i. e. low as against 1·6585 the greater index of the calc-spar.

† Comptes Rendus, lxviii. (1869) p. 221.

carbon; and also by Dr. Zenker, who replaced the liquid in M. Jamin's construction by wedges of flint glass.

The following tabular view of different forms of polarizing prisms is taken from the conclusion of Dr. Feussner's paper:—

	Field.	Inclination of section in regard to long axis.	Ratio of length to clear width.	Fig.
	°	°		
I. The Old Polarizing Prisms.				
1. Nicol's prism	29	22	3·28	66
2. Shortened Nicol prism.				
a. Cemented with Canada balsam	13	25	2·83	67
b. „ „ copaiba „	24	25	2·83	67
3. Nicol with perpendicular ends.				
a. With Canada balsam	20	15	3·73	68
b. With cement of index of refraction of 1·525	27	15	3·73	68
4. Foucalt's prism	8	40	1·528	69
5. Hartnack's prism.				
a. Original form	35	15·9	3·51	70 *a b*
b. With largest field	41·9	13·9	4·04	70 *a a*
c. With field of 30°	30	17·4	3·19	70 *a c*
d. With field of 20°	20	20·3	2·70	70 *a d*
6. Glan's prism	7·9	50·3	0·831	71
II. Feussner's Polarizing Prism.				
1. With calc-spar: largest field	44	13·2	4·26	70 *a a*
2. „ „ field of 30°	30	17·4	3·19	70 *a c*
3. „ „ field of 20°	20	20·3	2·70	70 *a d*
4. With nitrate of soda: largest field	54	16·7	3·53	72 *a a*
5. „ „ „ field of 30°	30	24	2·25	72 *ab* & 73
6. „ „ „ field of 20°	20	27	1·96	72 *a c*

As an analysing prism of about 6 mm. clear width, and 13·5 mm. long, the new prism is stated by its inventor to be of the most essential service, and it would certainly appear that the arrangement is rather better adapted for small prisms than for those of considerable size. Any means by which a beam of polarized light of large diameter—say 3 to 3½ in.—could be obtained with all the convenience of a Nicol would be a real advance, for spar of sufficient size and purity for such a purpose has become so scarce, and therefore so valuable, that large prisms are difficult to procure at all. So far as an analyser is concerned, the experience of Mr. P. R. Sleeman would lead to the opinion that improvements are to be looked for rather in the way of the discovery of an artificial crystal which absorbs one of the polarized rays than by further modifications depending upon total reflection. The researches of Dr. Herapath on iodosulphate of quinine * are in this direction; but crystals of

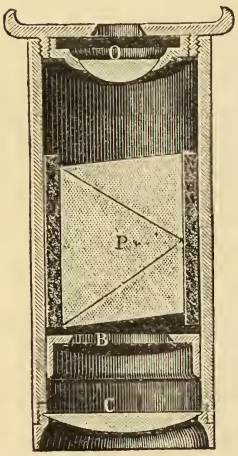
* Phil. Mag., 1852, p. 161, and 1853, p. 346.

the so-called herapathite require great manipulative skill for their production. If these could be readily obtained of sufficient size, they would be invaluable as analysers.

This opinion is supported by the existence of an inconvenience which attends every form of analysing prism. It is frequently, and especially in projecting apparatus, required to be placed at the focus of a system of lenses, so that the rays may cross in the interior of the prism. This is an unfavourable position for a prismatic analyser, and in the case of a powerful beam of light, such as that from the electric arc, the crossing of the rays within the prism is not unattended with danger to the cementing substance, and to the surfaces in contact with it.

Abbe's Analysing Eye-piece.—This (fig. 74), devised by Prof. Abbe, consists of a Huyghenian eye-piece with a doubly refracting prism P (a calc-spar prism achromatized by two suitable glass prisms) inserted between the eye-lens O and field-lens C, and over the diaphragm at B. The rays polarized parallel to the refracting edge pass through the prisms without deviation, whilst those polarized at right angles are strongly deflected, and are stopped off by a diaphragm over the eye-lens. The field of view remains undiminished.

Fig. 74.



Measurement of the Curvature of Lenses.*—With very small lenses the spherometer cannot be used, and Prof. R. B. Clifton's method is based on the Newton's rings formed between the lens and a plane surface, or a curved surface of known radius. From the wave-length of the light employed in observing and the diameter of a ring the radius of curvature can be determined. He places the lens on a plane or curved surface under a Microscope, and lights it by the sodium flame —wave-length 5892×10^{-7}—measures the approximate diameters of two rings a distance apart (in practice the tenth and twentieth rings are found convenient), takes the difference of their squares, and divides it by the wave-length and the number of rings in the gap between to find the radius of the lens. The formula is :—

$$\rho^1 m \lambda = (x^2{}_{m+n} - x^2{}_n)$$

where x_{m+n} and x_n are the diameters of the nth and $(m+n)$th rings ; λ is the wave-length of the light, and ρ^1 the radius of curvature of the lens. The method with proper care gives accurate results. Prof. Clifton has also used it to determine the refractive index of liquids in

* 'Nature,' xxix. (1883) p. 143.

small quantities; Mr. Richardson having found it for water = 1·3335 by this method, which is usually correct to two places of decimals. It can also be used to determine if the lens is uniformly curved and spherical.

New Microscopical Journals. — Two new Journals have made their appearance. The first is the quarterly 'Zeitschrift für wissenschaftliche Mikroskopie und für mikroskopische Technik,' published at Brunswick, and edited by Drs. L. Dippel, M. Flesch, A. Wichmann, and W. J. Behrens. It embraces "Microscopy" in its widest sense, and includes original articles, abstracts and reviews, and a bibliography of microscopical literature. It may be recommended to all microscopists who read German. The other is the bi-monthly 'Microscopical Bulletin,' published by Queen and Co., of Philadelphia, which, though unpretentious, gives useful information on microscopical subjects.

Bausch, E.—A new Condenser. [*Post.*] *The Microscope*, IV. (1884) pp. 105–6.

„ „ Eye-pieces and Objectives.
[General explanations.] *The Microscope*, IV. (1884) pp. 107–12.

Bausch and Lomb Optical Co.'s Improved "Investigator" Stand.
[Cf. I. (1881) p. 100. Mirror and substage now swing independently, position of body-rack changed, &c.]
Amer. Mon. Micr. Journ., V. (1884) p. 84 (1 fig.).

Bohn, C.—Ueber die Berichtigung des vereinfachten Ablese-Mikroskopes für Theilungen. (On the rectification of the simplified reading Microscopes for graduations. [*Supra*, p. 436.]
Zeitschr. f. Instrumentenk., IV. (1884) pp. 87–8.

Bond, G. M.—Standards of Length and their Subdivision.
[Describes the Saxton Yard-dividing Comparator, the Rogers-Bond Universal Comparator, and a Comparator made by the Ballon Manufacturing Company for Professor Anthony.]
Journ. Franklin Institute, CXVII. (1884) pp. 281–95, 357–67 (5 figs.).

Bradbury, W.—The Achromatic Object-glass. XXXII.–V.
Engl. Mech., XXXIX. (1884) pp. 93–4, 159–60, 246–7, 272 (6 figs.).

"Calculus."—Polarizer for the Microscope.
[Simple contrivance to fit on tail-piece.]
Engl. Mech., XXXIX. (1884) p. 215 (1 fig.).

Congdon, E. A.—Microscopy one hundred and fifty years ago.
[Notes on 'Baker on the Microscope,' 1740.]
The Microscope, IV. (1884) pp. 74–6.

D., E. T.—Graphic Microscopy.
IV. Pollen of Mallow. V. Peristome of *Fumaria hygrometrica*.
Sci.-Gossip, 1884, pp. 73–4 (1 pl.), 97–8 (1 pl.).

Davis, G. E.—[Leitz's] Oil-immersion Objectives.
Micr. News, IV. (1884) pp. 131–2.

„ „ Evenings with the Microscope. I.
[Measuring magnifying power of objectives and eye-pieces, and testing corrections of objectives.]
Micr. News, IV. (1884) pp. 132–5.

„ „ Microscopy. *Sci. Monthly*, I. (1883) p. 26.

Flesch, M.—Welche Aussichten bietet die Einführung des elektrischen Lichtes in die Mikroskopie? (What prospect does the introduction of the electric light afford in Microscopy?) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 175–81.

Hansen, E. C.—Ueber das Zählen mikroskopischer Gegenstände in der Botanik. (On the counting of microscopic objects in Botany.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 191–210 (6 figs.).

Hazlewood, F. T.—A home-made revolving Table. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) p. 94.

Hitchcock, R.—Neglected Opportunities.
[Exhortation to investigate the microscopic life of the country.]
Amer. Mon. Micr. Journ., V. (1884) pp. 95–6.

„ „ A New Microscopical Society.
[Sarcastic comment on the announcement of the establishment of the Ladies' Microscopical Society at San Francisco having been first sent to England. "Trusting the members will learn that, although they may look to foreign lands for styles and methods of personal adornment, when they come to such a serious subject as microscopy, their wants can be as well met and their fame as well appreciated in their own country."]
Amer. Mon. Micr. Journ., V. (1884) p. 97.

Jadanza, N.—Sui sistemi diottrici compositi. (On compound dioptric systems.)
Atti R. Accad. Sci. Torino, XIX. (1883) pp. 99–117.

Jung, H.—Ueber ein neues Compressorium. (On a new Compressor.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 248–50 (2 figs.).

Lancaster, W. J.—Lantern Microscope.
[Directions for making. "You may make a lantern Microscope in half a dozen different ways, and the method to work upon will depend entirely upon the illumination you have. You state in query that you have the lime-light; you could not have anything better. Fit up your Microscope in any form you like, and for object-lenses get three sets of lenses, A, two 1½ in. focus, both plano, one 1/2 in., the other 3/4 in. diameter; B, two lenses both 1 in. focus, one 3/8 in. diameter, the other 5/8 in. diameter; C, two lenses 3/4 in. focus, one 1/4 in., the other 1/2 in. diameter; and D, two lenses 1/2 in. focus, one 3/16 in., the other 3/8 in. diameter. Mount them in separate tubes in each case, both convex surfaces together, at the following distances apart:—A 1 in., B 2/3 in., C 1/2 in., D 5/16 in.; then a stop must be placed in front of each of the smallest lenses, the larger lens going towards object. The sizes of stops and their distances from small lenses are as follows:—A, 1/8 in. diameter, 1/2 in. in front; B, 3/32 in., 5/16 in.; C., 1/12 in., 3/16 in.; D, 1/16 in., 1/8 in."]
Engl. Mech., XXXIX. (1884) p. 152.

Lommel, E.—Spectroskop mit phosphorescirendem Ocular. (Spectroscope with phosphorescent eye-piece.) [*Post.*]
SB. K. Akad. Wiss. München, 1883, p. 408.

Magnifying Powers, Table of, with Note. *Micr. Bulletin*, I. (1884) p. 23.

McCalla, A.—The "Congress" Nose-piece.
[Reply to Mr. Bulloch, *ante*, p. 300, with woodcuts of his original design.]
Amer. Mon. Micr. Journ., V. (1884) pp. 64–5 (3 figs.), 78–9.
The Microscope, IV. (1884) pp. 101–2.

Mercer, F. W.—A New Photomicrographic Camera. [*Post.*]
Photography (Chicago), I. (1884) pp. 9–10 (1 fig.).

Mitchell, G. O.—A Focusing Glass for Photo-micrography. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) p. 80 (1 fig.).

Nelson, E. M.—On the selection and use of Microscopical Apparatus.
[*Ante*, p. 302, repeated here to give the following note:—(1) The Ross is decidedly to be preferred to the Jackson form, mainly on the ground of

the superiority of the long lever fine-adjustment over any other. (2) No Microscope is worthy to be called a scientific instrument unless it has a centering substage. (3) Choice and Aperture of Objectives, *supra*, p. 447. (4) Eye-pieces. (5) Daylight, artificial light, and incandescence lamp, *supra*, p. 447. (6) Condensers (Powell's the most effective for powers beyond 1/4). (7) Paraboloids, Lieberkuhns (*post*), Vertical Illuminator, and Micrometers. (8) Polarization. (9) Diffraction and the difficulties of interpretation with objects requiring high magnification.]

Engl. Mech., XXXIX. (1884) p. 48.

Noe, L. H.—Homogeneous immersion.

["It seems to me that to make a lens which shall work through different thicknesses of cover-glass equally well and without adjustment, the immersion medium should correspond with the cover-glass, so that the combined thickness of glass and immersion fluid would always be the same (although the thickness of each varied) for an object in contact with the under side of the cover."]

Amer. Mon. Micr. Journ., V. (1884) p. 79.

"Not an Optician."—Theory of the Achromatic Object-glass.

[Comments on O. V.'s articles.]

Eng. Mech., XXXIX. (1884) p. 210.

"Orderic Vital."—The Dialyte and Plate Glass.

Engl. Mech., XXXIX. (1884) p. 215.

Orth, J.—Cursus der normalen Histologie zur Einführung in den Gebrauch des Mikroskopes sowie in das practische Studium der Gewerbelehre. (Course of normal Histology as an introduction to the use of the Microscope as well as to the practical study of Histology.) 3rd ed., xii. and 340 pp., 108 figs. 8vo, Berlin, 1884.

Peaucellier.—Note sur la déformation des images réfractées et sur l'aplanatisme d'un système de lentilles. (Note on the distortion of refracted images and on the aplanatism of a system of lenses.)

Mém. Soc. Sci. Bordeaux, V. (1883) pp. 327–34 (1 pl.).

Peragallo, H.—Histoire sommaire du Microscope composé et de ses récents perfectionnements. (Compendious history of the compound Microscope and its recent improvements.) 8vo, Toulouse, 1883.

Plehn, F.—Apparat zur Prüfung der Brennweite des Auges oder anderer optischer Systeme. (Apparatus for testing the focal length of the eye or other optical systems.)

Title only of German Patent, Cl. 42, No. 1894, Feb. 1884.

"Prismatique."—Plate Glass for Optical Purposes.

Engl. Mech., XXXIX. (1884) pp. 191–2, 281.

Proctor, R. A.—Review of Poulsen and Trelease's 'Botanical Micro-chemistry,' in which the invention of the achromatic microscope-objective is attributed to J. J. Lister in 1829! *Knowledge*, V. (1884) p. 231.

Puscher & Wiederhold.—Cementing Brass on Glass.

[Puscher recommends a resin soap for this purpose, made by boiling 1 part of caustic soda, 3 parts of colophonium (resin) in 5 parts of water and kneading into it half the quantity of plaster of Paris. This cement is useful for fastening the brass tops on glass lamps, as it is very strong, is not acted upon by petroleum, bears heat very well, and hardens in one-half or three-quarters of an hour. By substituting zinc white, white lead, or air-slaked lime for plaster of Paris, it hardens more slowly. Water only attacks the surface of this cement. Wiederhold recommends, for the same purpose, a fusible metal composed of 4 parts of lead, 2 parts tin, and 2½ parts bismuth, which melts at 212° Fahr. The melted metal is poured into the capsule, the glass pressed into it and then allowed to cool slowly in a warm place.]

Polyt. Notizblatt. See *Engl. Mech.*, XXXIX. (1884) p. 119.

Reichert, C.—Anleitung zum Gebrauche des Mikroskops. (Introduction to the use of the Microscope.) 14 pp. (2 figs.), 8vo, Wien, 1883.

Scott, G. B.—Polarizer for the Microscope.

[Analyser mounted in a tube on a swivel just over the nose-piece so that it can be "pushed over to one side out of the way by a lever" when not in use. Polarizer also mounted on a short arm beneath the stage. Microscopes with narrow tubes must have a recess into which the analyser can go.]

Engl. Mech., XXXIX. (1884) p. 173 (2 figs.).

Stein, T.—Die Verwendung des elektrischen Glühlichtes zu mikroskopischen Untersuchungen und mikrophotographischen Darstellungen. (The application of the electric incandescence light for microscopical investigations and photomicrography.) [*Post.*]

Zeitschr. f. Wiss. Mikr., I. (1884) pp. 161–74 (7 figs.).

Stowell, C. H.—Our third Annual Soirée. *The Microscope*, IV. (1884) pp. 63–4.

,, ,, An Editor's Life.

[Letter from a microscopist who "finds the working of the Microscope very pleasant employment for the evening of life."]

The Microscope, IV. (1884) p. 105.

Swammerdam, John, Sketch of his Life and Researches.

Journ. of Sci., VI. (1884) pp. 198–206.

Tait, P. G.—Light. viii. and 276 pp. and 49 figs. [Microscope, pp. 113–6.] 8vo, Edinburgh, 1884.

Vogel, J.—Das Mikroskop und die wissenschaftliche Methode der mikroskopischen Untersuchung in ihrer verschiedener Anwendung. 4th ed. By O. Zacharias. Lfg. 1. Leipzig, 1884.

Wanschaff, J.—Ueber eine neue Methode zur Anfertigung sehr langer Mikrometer-schrauben. (On a new method of constructing very long micrometer screws. [*Post.*]

Zeitschr. f. Instrumentenk., IV. (1884) pp. 166–9.

Ward, R. H.—An Eye-shade for Monocular Microscopes. [*Post.*]

Amer. Mon. Micr. Journ., V. (1884) pp. 82–3 (1 fig.).

Wassell, H. A.—Plate Glass for Optical Purposes.

Engl. Mech., XXXIX. (1884) pp. 170–1.

Wiederhold.—See Puscher.

Zacharias, O.—See Vogel, J.

β. Collecting, Mounting and Examining Objects, &c.

Dissection of Aphides.*—G. B. Buckton says that "in the dissection of Aphides much assistance may be often got by a selection of liquids. Some of these are best suited for the purpose of hardening the tissues, so that they may bear separation and tearing asunder without their destruction. Others are used for colouring the transparent organs, so as to make them more visible. These organs of Aphides are so delicate that pure water will in a great measure destroy them. In such cases a weak solution of common salt, or very dilute glycerine, or sugar and water, or albumen and water, all of which should nearly approach the density of the juices of the insect, will be found a considerable help.

Some Aphides are so large, so full of liquid, and so charged with oil-globules that some treatment is necessary to reduce their bulk, and to allow of a sufficiently thin stratum of balsam for mounting.

In such cases the Aphides may be placed in spirits of turpentine, and just raised to the boiling-point in a small test-tube. After soaking in the turpentine for a few hours, all the oil-globules will be removed,

* 'Monograph of the British Aphides,' iv. (1883) pp. 193–5.

and the insect by this treatment will have become transparent, and the aqueous parts will not then chill the balsam.

To prepare Aphides for dissection, liquids may be divided into those used for hardening the tissues and those employed for colouring the same. For hardening, a digestion for several hours in weak alcohol will be of advantage. The alcohol must not be too strong, or the albuminous portions will be coagulated and become too opaque.

Weak acetic acid will render some portions tough, and the same action is also well effected by a weak solution of phosphoric or of nitric acid.

The action of ordinary ether upon Aphides is not well understood. Their bodies are speedily destroyed by plunging them into the liquid. At the same time a considerable stream of air-bubbles contained in the tracheæ is expelled, and of such a volume as would lead to the supposition that much of this air must be in some state of solution in the body-juices.

The reaction of weak potash has been before noted. As a rule, the germinal matter resists its action for a considerable time. Simultaneously this reagent usually stains it a bright gamboge yellow. In some genera (notably *Sachuus* and *Dryobius*) potash deepens very markedly the violet dye natural to these Aphides. In other cases I have found potash to evoke the violet shade from specimens otherwise colourless. This dye is fugitive, and if discharged by an acid, cannot be again recovered by the action of an alkali. Soda and ammonia also bring out this colour.

Advantage may be taken of the fact that there is a certain order in which the tissues resist the intrusion of a foreign matter such as a dye. Thus the germinal and most vitally endowed organs reject dyeing by carmine, logwood, and such coal-colours as magenta; whilst the portions in process of exfoliation and decay absorb it the most readily. For such purposes, weak alcohol may be made slightly alkaline by ammonia, and tinged with a little carmine or cochineal solution. Dilute chromic acid both tinges the tissues yellow and renders them tough. Solutions of osmic acid also may be used with advantage, and, in short, the usual reagents employed for conducting minute anatomy may be taken with due circumspection and tenderness.

For labelling specimens, paste will be found much more adherent than gum. The former may be preserved for some months in a well-closed bottle, if a little aqueous solution of corrosive sublimate be stirred into it."

Transmission, Preservation, and Mounting of Aphides.*—G. B. Buckton gives the results of his experience as to the best mode of transmitting living Aphides, and also the best method for killing and preserving such-like insects for future examination.

As to transmission, the chief thing to be guarded against is desiccation, and no plan seems to be so successful as their inclosure in ordinary quills stopped by plugs of cork or pellets of beeswax. The substance of the quill is sufficiently porous to prevent mildew on the

* 'Monograph of the British Aphides,' iv. (1883) pp. 188–93.

one hand and a rapid evaporation on the other. In this way small insects may be sent through the post, and in a far better condition than can be secured in any tin boxes, even though they be filled with leaves. If a slip of some succulent leaf be rolled round each quill, to retain moisture, a bundle will conveniently pass through the post.

For preservation (other than on a slide) the best plan is to drop the insects into small flattened glass tubes partially filled with a suitable liquid, then draw the tube to a fine point, break the end off, and warm the empty space (or, better, expel the air by a pump), and the tube can be entirely filled with liquid, and then sealed with the blowpipe.

For mounting microscopically, five or a dozen spots of fluid Canada balsam should be dotted on a slide from the head of a pin, and by means of a hair pencil as many living insects transferred to them. "The specimens at once adhere, and if the spots are small the insects spread out their limbs naturally, with a view to escape. They may be fixed on their backs or otherwise, according to the views desired.

A very thin glass cover, or, if very high magnifying powers are wanted, a small disk of clear mica, is laid over the insects, and then one or more drops of the fluid balsam are delivered from a glass rod at one of the sides of these covers. The balsam runs slowly under by capillarity, and it drives all the air before it, the small weight of the cover assisting it to spread, until the whole area is filled. No pressure is to be used, or the elastic bodies of the Aphides will change shape; and besides this, the juices will be forced through the cornicles and pores. If the balsam is thick, a very gentle heat, hardly exceeding that of the cheek, may be applied, but as a rule the temperature of a room is better than that which exceeds it. The insects die immediately they are cut off from air, and in almost every case their position will be good for examination. To spread the wings of a small insect, the above-mentioned small dots may be made in a row. The belly of the specimen is applied to the middle spot, and by a bristle one wing may be applied to the dot on the one side, and the other wing to the third dot. The cover is then placed as before, and when the balsam runs in it will not disturb the position of the spread wings.

It will be noticed that very soon after live insects have been mounted in a resinous substance that will not mix with water, a white cloudiness forms around each specimen. This is caused by the watery juices of the insect, which 'chill' the medium and make it opaque.

This cloudiness, however, entirely disappears after perhaps a month, the moisture being carried slowly outwards. The same is to be said of stray air-bubbles. The oxygen of the air unites with the balsam, and thus hardens it; but what combination is effected with the nitrogen is not so clear. However, air-bubbles in balsam disappear in time, provided the former is not in too hard a condition.

In cases when the above small pressure is undesirable, small circles, cut by round punches of different sizes out of very thin sheet

lead, will be found more convenient to insert between the glass slip and its cover than circles of card, which are sometimes recommended. The thin sheet lead from the Chinese tea-chests is very suitable for punching, and as it is not porous like card, it yields no air-bubbles by heat.

D. Von Schlechtendal has* described a method by which it would appear that all the characters of form and colour (?) may be preserved in Aphides and other insects. The method consists of a rapid death and drying of the insect by means of a current of heated air. The *Aphis*, previously attached to some suitable support, is suddenly and momentarily subjected to the heat of a spirit or other flame, by which it is immediately killed and caused to retain its natural position. Several examples are then carefully roasted in a current of hot air, such as that passing through an inclined glass tube duly made hot, or dried on a sheet of paper moved over a heated metal plate.

When dry, the specimens are mounted on card by attachment with gum tragacanth; or, as Mr. T. W. Douglas suggests, more conveniently on mica, called 'talc,' in the shops, which, as it is incombustible, is well suited for a support both before and after drying.

This method is vouched for as good by Drs. Giebel, Taschenburg, Mayr, and Rudow.

I have not tried this roasting process, but it must require some address to prevent the shrivelling of wings in such delicately-formed insects, and to provide against the bursting action of the boiling juices.

A more complete history of the process than the foregoing was given by Mr. Douglas in 1878.†

M. Lichtenstein has many times been good enough to forward in letters to me preparations of Aphides which have been secured between two films of mica. The insects, he explains, are immersed in a solution of resin in turpentine, 'a natural amber,' and, when all are in due position, the mica films are placed over apertures in card, and then gummed papers, similarly perforated, are pressed upon them. This arrangement secures all in their places.

Methods and operations in science, like events in history, repeat themselves. Fifty years ago films of mica were used to cover objects for the Microscope, and before the manufacture of the thin glass now so commonly used, it admirably answered its purpose. Under deep magnifying powers, such as 1/12 in., it will be found even now of great service. The mineral may be split by the lancet into films much thinner than glass can be blown in a flat state. Small unscratched pieces may be selected which are perfectly transparent, and their cost is quite trifling.

On account of the high refracting power of Canada balsam, the colours of recently-immersed Aphides show themselves very brightly; and it sometimes happens that tints, quite lost through irradiation or glance on the surfaces, become distinct by treatment with this resin.

The bright colours and markings of some species are due to the

* Entomol. Nachrich., iv. p. 155.

† Entomol. Mon. Mag., xv. p. 164.

hue of the internal juices of the insects. These cannot be preserved by balsam, but it is otherwise with the pigments which stain the somewhat horny coverings of the thorax and abdomen. These colours are persistent."

Breckenfeld's Method of Mounting Hydræ.*—A. H. Breckenfeld describes the following process as accomplishing the desired end more perfectly than any other published.

Have in readiness a slide upon which a well-dried cell of sufficient depth has been turned. Then, from a gathering of *Hydra*, transfer a sufficient number of individuals (the more fully developed the better) very carefully, by means of a camel's hair brush or a pipette, to a drop of water spread near the end of a plain glass slide, and place the latter upon a table in such a way that the end with the drop projects about two inches over the edge. This is easily done by placing a weight upon the opposite end. After allowing the slide to remain perfectly undisturbed for three or four minutes, hold a lighted coal-oil lamp so that the top of its chimney is very near the slide, but a trifle above it. The *Hydræ* will then appear brightly illuminated, and it can easily be determined by the unaided eye whether or not their tentacles are fully extended. If they are, quickly move the lamp directly under the drop, with the top of the chimney about an inch beneath the slide, and hold it in that position for about 3–5 seconds, the exact time depending principally upon the intensity of the heat. Then quickly remove the slide and place it upon a slab of marble or metal. When cool, pour the drop containing the zoophytes into the prepared cell on the slide which has been held in readiness, add a drop or two of a suitable preservative fluid, arrange the animals, if necessary, by means of a needle or camel's hair brush (using very great care, however, as the tentacles will be destroyed by the least rough handling), cover with thin glass, and finish as in the case of any fluid mount.

This "hot water" process seems to succeed peculiarly well with the brown *Hydra* (*H. vulgaris*).

Cell-sap Crystals.†—Crystals of the colouring material present in the petals and other portions of plants are by no means common or, as a rule, easy to obtain; and G. Pim thinks it may therefore interest some to know that the rich violet-coloured cell-sap in the flower of *Justicia speciosa*, a common and easily-grown stove-plant, crystallizes very easily into minute slender prisms. To obtain them it is only necessary to mount a fragment of the flower-stamen for choice, in dilute glycerine jelly, not too hot, without any previous treatment; after a few hours the colouring material collects into a few cells, in the form of the crystals above mentioned, forming a very pretty and interesting object for a 1/4 in. objective.

Staining for Microscopic Purposes.‡—H. Gierke contributes a paper on this subject. In the first part, after an excellent introduc-

* Amer. Mon. Micr. Journ., v. (1884) pp. 49–50.

† Journ. of Bot., xxii. (1884) p. 124.

‡ Zeitschr. f. Wiss. Mikroskopie, i. (1884) pp. 62–100. See Bot. Centralbl., xviii. (1884) p. 52.

tion, the writer gives an historical review of the application of microchemical methods of staining, giving special attention to the carmine-pigments. The earliest experiments on microscopic staining with carmine for the purpose of a ready differentiation of tissues were made by Goeppert and Cohn. More extended investigations on the capability of the various elements of vegetable tissues to fix carmine shortly followed by R. Hartig. In animal histology, carmine staining was first employed by Gerlach (1858). Further contributions to its application were made especially by Maschke, Thiersch, Beale, Rollen, Gwancher, Hoyer, Czokor, Ranvier, and others. Reference is further made to the cultivation of cochineal, and to the most convenient methods of obtaining carmine for technological purposes, and its application as a staining material in the form of ammonium carminate, and carmine acetate. The author convinced himself by experiments that old preparations of ammonium carminate, which contain a certain quantity of ammonium carbonate, stain better than fresh solutions. Finally, a shorter reference is made to the aniline-dyes, hæmatoxylin, indigo-carmine, and picro-carmine.

The second part includes a chronological and tabular account of the literature of the subject, especially with regard to the following staining materials:—(1) carmine; (2) hæmatoxylin; (3) ammonium molybdate; (4) alizarin and purpurin; (5) alcanna and lakmus; (6) sodium indigo-sulphate (indigo-carmine).

Mode of announcing new Methods of Reaction and Staining.* —E. Giltay calls attention to the fact that the publication of new methods of reaction is often made without sufficient precision for others to be able readily to form a judgment on their applicability for the special purpose. In the description of the application of a reagent, at least one mode of preparing it ought to be accurately described, such expressions as "somewhat," "a little," "a short time," and such like, should be avoided, and replaced by exact statements of weight and time. In the case of little known substances, the chemical formula—intelligible in all languages—should be appended. The descriptions of colours should be as correct as possible, with reference to all influencing circumstances, and should be based on some definite colour-scale, such as that of Chevreul's 'Des Couleurs.'

Pure Carminic Acid for Staining.†—G. Dimmock has often wondered why naturalists use carmine solutions in which water, with some caustic or destructive material added, is the principal solvent. Carmine of commerce, it is true, is not readily soluble, even in water, until ammonia, borax, or some other aid to solution is added; but carminic acid, the basis of the colouring matter of carmine, has long been stated in the leading chemical dictionaries and handbooks to be readily soluble in water and in alcohol. Watts (Dict. Chem., 1872, 1st suppl., p. 413) says of carminic acid:—"This acid forms a purple

* Zeitschr. f. Wiss. Mikroskopie, i. (1884) pp. 101–2.
† Amer. Natural, xviii. (1884) pp. 324-7.

mass, fusible and soluble in all proportions in water and in alcohol. Sulphuric and hydrochloric acid dissolve it without alteration. It bears a heat of 136° C. without decomposition." Earlier still Watts (Dict. Chem., i. 1863, p. 804) says:—"The fine red pigment known in commerce as carmine is prepared by treating a solution of cochineal with cream of tartar, alum, or acid oxalate of potassium. The fatty and albuminous matters then coagulate and carry down the colouring matter with them." Now in preparing most carmine solutions this precipitation takes place, and the carmine, having greater cohesive (not chemical) affinity for impurities of animal origin than for alcohol, its solution is not readily accomplished by that medium, nor indeed by water. In preparing carmine solution for histological purposes by some of the published recipes, more than one-half of the colouring matter of the carmine is lost in the refuse left upon the filter paper.

There are two ways commonly in use for preparing carminic acid. The first mode is that of De la Rue, which Watts (Dict. Chem., i. 1863, p. 804) gives as follows:—"To separate carminic acid, cochineal is exhausted with boiling water; the extract is precipitated by subacetate of lead slightly acidulated, care being taken not to add the lead-solution in excess; the precipitate is washed with distilled water till the wash-water no longer gives a precipitate with a solution of mercuric chloride, then decomposed by sulphuretted hydrogen; the filtrate is evaporated to a syrupy consistence and dried over the water-bath; and the dark purple product thus obtained is treated with alcohol, which extracts the carminic acid." The second mode is that of C. Schaller and is given by Watts (Dict. Chem., 1st suppl., 1872, p. 413) as follows:—"Schaller prepares this acid by precipitating the aqueous extract of cochineal with neutral lead acetate slightly acidulated with acetic acid; decomposing the washed precipitate with sulphuric acid; again precipitating the filtrate with lead acetate, and decomposing the precipitate with hydrogen sulphide. The filtered solution is evaporated to dryness; the residue dissolved in absolute alcohol; the crystalline nodules of carminic acid obtained on leaving this solution to evaporate are freed from a yellow substance by washing with cold water, which dissolves only the carminic acid; and the residue left on evaporating the aqueous solution is recrystallized from absolute alcohol or from ether."

Schaller's mode of preparation gives purer carminic acid than De la Rue's, but either kind is sufficiently pure for histological purposes. The precipitation by lead acetate and the dissolving in alcohol free the carminic acid from animal impurities, and the consequence is a purer form of pigment than can be extracted by any process hitherto employed for the preparation of carmine for histological purposes.

It is unnecessary to explain to naturalists the advantages of alcoholic solutions of carmine over aqueous ones. The alcoholic solution colours preparations much quicker than the aqueous solution does; for colouring sections, the author employs a solution of 0·25 gr. carminic acid to 100 gr. of 80 per cent. alcohol, and leaves sections in the

solution from two to five minutes. A solution of equal carmine strength but in absolute alcohol can be employed; it has, however, no special advantages, since with the 80 per cent. alcoholic solution the sections can be washed directly in absolute alcohol, and then put into oil of cloves or turpentine. Colouring in the piece before sectioning never takes as long with alcoholic carminic acid as it does with ordinary carmine solutions, and if it did take long the strong alcohol would preserve the tissue from maceration. In colouring pieces of mollusca, or of other equally slimy animals, the slime should be removed beforehand, or the staining will be unsatisfactory, because the slime congealing in the alcohol takes up the colouring matter, forming an almost impervious coloured layer on the outside and leaving the inside of the piece nearly uncoloured.

Some preparations coloured in alcoholic carminic acid and then put up in glycerine lost their colour in a few months, the colour seeming to be entirely diffused in the glycerine, while similar preparations mounted in Canada balsam retained their colour perfectly. The author does not know if this fading would occur with preparations coloured with alcoholic ammonic carminate, or even if this diffusion was not due to some impurity of the glycerine (of the purity of which he was doubtful); time to test this matter further failed.

An alcoholic ammonic carminate, or ammonia carmine, can be prepared, at a moment's notice, from alcoholic carminic acid, by adding ammonia drop by drop, and stirring until the entire solution changes from its bright red to purple red. By this mode pure alcoholic ammonic carminate can be produced with no excess of ammonia, and at any time. As the carminic acid can be preserved dry without decomposition, and dissolves quickly in alcohol, one can carry the ingredients of a carmine solution in the vest pocket without inconvenience.

In making and using alcoholic carminic acid pure alcohol and distilled water give the best results, because a portion of the carminic acid is converted to carminates by the salts of impure water. In making alcoholic ammonic carminate this precaution is not as necessary, because the colour of the carminates produced by the impurities of the water is so nearly like that of ammonic carminate.

Alcoholic carminic acid may be used, as Grenacher's carmine solution is used, to colour sections from which the colour is to be afterwards partly extracted by very dilute hydrochloric acid, leaving nuclei red. Another way to use carmine solutions, which is especially applicable to alcoholic carminic acid, is to precipitate the carmine in the tissues by some salt, the carminate of the base of which gives a desired coloration. For example, specimens hardened for a moment under the cover-glass with an alcoholic solution of corrosive sublimate (mercuric chloride) and, after washing with alcohol, coloured in alcoholic carminic acid, take a fine colour of mercuric carminate. So, too, specimens coloured in alcoholic carminic acid can be changed by a few moments' treatment with a very dilute alcoholic solution of lead acetate or cobalt nitrate to a beautiful purple. Sometimes salts in the

tissues of the animals change portions of the carminic acid to purple carminates, giving a double coloration without further treatment.

Picric acid added to alcoholic carminic acid in extremely small quantities (best in a dilute alcoholic solution, testing the solution on specimens after each addition) makes a double alcoholic colouring fluid (a so-called picro-carmine). The author has been unable thus far to determine the proportion of picric acid required for this solution, having in every case added an excess. All different kinds of carmine solutions can be made from carminic acid with the advantage of having always uniform strength, of being definite mixtures, and of not spoiling as readily as those made directly from cochineal.

Incompatible reagents with carminic acid are, of course, all alkaline solutions and nearly all metallic salts; with ammonic carminate, are naturally all acids; with all carmine solutions, are bromine and chlorine.

Hoyer's Picro-Carmine, Carmine Solution, and Carmine Powder and Paste.*—Hoyer proposed † an improved picro-carmine made by dissolving his carmine powder in a concentrated solution of neutral picrate of ammonia. P. Francotte points out that picrate of ammonia is a substance which it is not possible to have constantly at hand, and he has therefore modified Hoyer's preparation in the following manner:—Dissolve 1 gr. of carmine in from 5 to 7 c.cm. of concentrated ammonia, diluted with the same amount of water; in 50 c.cm. of distilled water dissolve (warm) 1/2 gr. of picric acid; mix the two solutions and dilute so as to make 100 c.cm. Then add to the liquid thus obtained 1 gr. of chloral hydrate. If any free ammonia remains, gently warm in a water-bath to drive away the excess, or allow the alkali to volatilize by exposing the liquid to the open air. This solution lasts a long time without changing.

M. Francotte also supplements Prof. Hoyer's description of his process for obtaining carmine solution. ‡ The latter directs chloral hydrate to be added to the neutral liquid to keep it, but does not state the quantity to be used. M. Francotte forms a carmine solution of 10 c.cm. by the addition of distilled water, to which is added 1 gr. of chloral hydrate.

If a paste is required instead of a powder, Prof. Hoyer directs it to be made with alcohol, glycerine, and chloral, but does not give the quantities. M. Francotte uses to 1 gr. of carmine, 2 c.cm. of alcohol, 2 c.cm. of glycerine, and 1 gr. of chloral.

Dry Injection-masses.—Prof. H. Fol writes that the red gelatine vermicelli mentioned at p. 312 (carmine emulsions) should be pressed out into slightly acidulated water (1 part acetic acid to 1000 parts water). The carmine will otherwise be washed out.

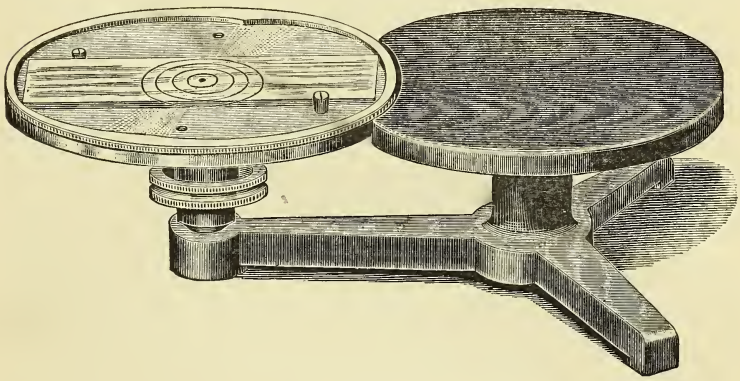
Imbedding Diatoms.§—R. Hitchcock suggests a plan for imbedding diatoms from fresh gatherings. It is to prepare an artificial

* Bull. Soc. Belg. Micr., x. (1884) pp. 75–7.
† See this Journal, iii. (1883) p. 142.
‡ Ibid., p. 141.
§ Amer. Mon. Micr. Journ., v. (1884) pp. 54–5.

calcareous rock from a mixture of finely-ground lime and clay, making a kind of hydraulic cement, with which the diatoms may be mingled. When this hardens, the sections may be cut, and isolated by treatment with diluted hydrochloric acid. The large *Pinnularia* is a good species to begin with.

Zentmayer's New Centering Turn-table.*—The turn-table represented in fig. 75 is the invention of Mr. J. Zentmayer. The plan of centering the slide is, it is claimed, quite original and perfect in its

Fig. 75.



results. The slide is placed so that its edges are in contact with the two pins projecting from the face of the plate. A ring with an oval inner edge is fitted to the periphery of the disk, in such a way that by turning it the slide is grasped at the diagonally opposite corners by the inner edge of the ring, and is thus centered longitudinally. The two pins centre it the other way. The ring may be easily removed, and spring clips substituted when desirable.

Phosphorus Mounts.—It was recently stated † that diatoms mounted in phosphorus solution cannot be kept for any time. This is not so. Mr. J. W. Stephenson has slides mounted several years ago (one in 1873), which are as good now as at first. All that is necessary is to avoid long exposure to daylight which turns the diatoms an opaque red.

Styrax.—On testing this medium (as supplied by Allen and Hanbury) with the refractometer, its refractive index is found to be 1·585 very nearly. It has so much colour that it is difficult to determine the third decimal with accuracy.

If we take the index of diatomaceous silex to be 1·43, and of Canada balsam 1·52, it is seen that styrax gives a marked increase of visibility over balsam, for while balsam is only 9, styrax is more than 15.

* Amer. Mon. Micr. Journ., v. (1884) p. 23 (1 fig.).
† Engl. Mech., xxxix. (1884) p. 149.

A. C. Cole * considers gum-styrax to be a "*perfect* substitute for balsam," that it "yields the best possible results," and that it "may be considered absolutely permanent and unalterable." The styrax solution is "even easier to work with than balsam, and air-bubbles are not produced in it by the application of heat."

Smith's New Mounting Media.†—Prof. H. L. Smith has been experimenting with various substances to find satisfactory media of high refractive index for the mounting of diatoms, &c. The desiderata at which he has aimed are: 1st, high refractive index; 2nd, a substance to be used in a fluid or semi-fluid state in the process of mounting; 3rd, the property of hardening on the slide, so as to make a permanent mount; and, 4th, a proper cement, to protect it from decomposition if the material is in danger from that cause by reason of exposure to the air or to immersion fluids.

Professor Smith is now assured that he has succeeded in his efforts, and has produced two media, both of combinations entirely new and heretofore unnoticed in chemistry. He has also devised a cement for rings upon the slides to protect the media, which is also new, and makes attractive mounts.

His first medium is a transparent, colourless substance, in the form of a thick fluid, which hardens by heat applied in the same way as in mounting in balsam. The heat expels the fluid part of the mixture, and leaves a solid which is a permanent mount, and requiring no more care in subsequent handling or packing of slides than balsam. The index of refraction of this medium when solidified is 2·00.

The second medium is a yellow-tinted, thick fluid, similar in handling to the last, and to be used and treated in the same manner, but having an index of 2·25 ± when solidified. A perceptible brownish-yellow tint remains in this medium, similar to that of pretty old balsam which has been a little overheated. This medium would naturally be used for special examinations of particularly difficult objects, and the colour is not enough to be objectionable, though the first medium, with its absolute transparency, would be preferred for more common use. Used in a fluid state, the denser medium has scarcely any colour, but its refractive index is of course lowered a little.

In either of them the resolution of *Amphipleura pellucida* is made with surprising ease and strength, and with light of very small obliquity compared with that which has been necessary in dry or balsam mounts. In short, it gives all the results which the high refractive index would lead us to expect, and with none of the objections for cabinet use which belong to the solution of phosphorus and other mixtures.

The cement for ringing is specially devised to avoid any danger of its attacking or decomposing the mounting medium.

The following is a copy ‡ of the report made to the State Microscopical Society of Illinois by a committee to whom were referred some slides of Diatomaceæ mounted in the new media.

* Methods of Micr. Research, Part x. (1884) p. lvii.
† Amer. Mon. Micr. Journ., v. (1884) p. 71.
‡ 'The Microscope,' iv. (1884) pp. 77–8.

"Your committee carefully examined the slides submitted to them, but gave special attention to the slides of *Amphipleura pellucida* mounted in a nearly white or colourless medium, whose refractive index is stated to be 2 —.

A new Bulloch Professional stand, with a 10-inch tube, was used. It was fitted with a condenser made on the Abbe pattern by Mr. Bulloch, the numerical aperture of which was stated by the maker to be 1·23. The condenser was used with a homogeneous-immersion fluid (cadmium chloride in glycerine). The illumination was furnished by a kerosine lamp with a flat wick turned edgewise toward the mirror, and the light was reflected through the condenser by the concave mirror.

The objectives used were, first, a dry 1/6 of Bausch and Lomb, said to be of 140° air angle, with a Beck No. 3 eye-piece, which gives a supra-amplification of 13·88. The angle of light from the condenser was as high as could be used by the objectives and fully illuminate the object, and with these appliances the lines showed with great distinctness.

We then used a homogeneous-immersion Zeiss 1/18, 1·28 N.A., with the following eye-pieces: Beck No. 1, supra-amplification 5; Beck No. 2, supra-amplification 8·33; Tolles 1 in., supra-amplification 10; Beck No. 3, supra-amplification 13·88; Tolles 1/2 in., supra-amplification 20·83. The illumination was the same, except that the angle of light was as oblique as the condenser could give. With all of these eye-pieces the *beads* showed very strongly.

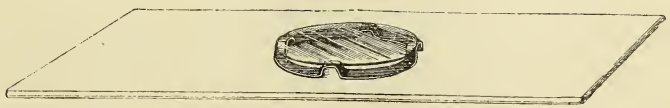
The slide mounted in a yellowish medium with a refractive index said to be 2·3, did not seem to present any marked superiority over the other.

Your committee would expect these media, particularly the colourless one, to be of great value if they keep well. Their advantage in the study of diatoms is obvious. We would also expect them to be even more useful in histology if preparations can be transferred to them without injury. They may also be of great service in the study of bacteria.

By the process of staining, now necessary in the study of these structures, they are shrivelled and perhaps changed in other ways, and we may hope to learn much more about them than is now known if they can be studied in these media in a more natural condition." (Signed by B. W. Thomas, Lester Curtis, H. A. Johnson, H. W. Fuller, and H. J. Detmers.)

Wilks's Cell.—Mr. E. Ward supplies cells for mounting without pressure in Canada balsam made on a plan suggested by Mr. Wilks and shown in fig. 76.

Fig. 76.



The cell is made of soft metal and, as will be seen from the figure, has four elevations alternating with depressions, the cover-glass

resting on the upper points of the curves. By leaving an excess of balsam round the cell and cover-glass, air-bubbles ultimately escape through the spaces, and loss by evaporation of essential oil in the balsam is provided for. If the cell is too deep for the object it can be pressed between two glass slips until shallow enough.

Closing Glycerine Cells.—Mr. W. M. Bale writes: "I see by one or two remarks in the Journal that some manipulators still find a difficulty in securely closing glycerine cells. I have found the following plan obviate all liability to leakage. Use a cell of firm material, such as glass or ebonite, and a cover-glass of larger size, so that when in position it projects outside the cell for 1/12 in. or 1/8 in. all round. Fill the cell and press down the cover-glass, forcing out the superfluous glycerine; then (if on examination under the Microscope the object is found to be properly displayed) put on a spring clip to keep the cover close down, and with a fine syringe wash away the whole of the glycerine which may have exuded from the cell. The space below the projecting margin of the cover-glass will now be filled with water instead of glycerine, and by applying a piece of blotting-paper the water may be absorbed; the slide must then be allowed to stand for a minute or two till the outside of the cell is quite dry, when a little tenacious fluid cement may be applied at the margin of the cover, and allowed to fill the circular space outside the cell. Unless an excess of cement be placed on the slide there will be no tendency whatever to 'run in,' provided that the cell be quite flat, so that the cover can come into close contact with it all round, and that it be deep enough for the object. I formerly recommended this plan for mounting in fluids which would evaporate,* and I since find that it is equally applicable to a dense medium like glycerine, provided that the latter be syringed away from the outside of the cell, as directed. I have young *Hippocampi* preserved in ebonite cells in this manner, but I may add that it is not uncommon to find ebonite cells more or less bent, and such are useless for the purpose, it being essential that the cover should fit closely to the cell, as otherwise the water used in washing would enter it."

Getschmann's Arranged Diatoms.—Whether diatoms ought or ought not to be "arranged" is a question which is more often answered in the negative, and in calling attention to the slides prepared by R. Getschmann of Berlin, we have no intention of objecting to the general verdict. We simply record the fact of the existence of the slides, and that they much surpass any of the previous efforts with which we are acquainted. With the diatoms are included Lepidoptera scales, Echinoderm spines, &c.

Classification of Slides.†—Dr. C. S. Minot suggests a scheme of arrangement of microscopical (and especially histological) slides based on embryology. The foundation of the system is primarily the germ-layers and then the order of development of the various organs.

* See this Journal, iii. (1880) p. 864.

† 'Science Record,' ii. (1884) p. 65.

The first division embraces the ectoderm and its derivatives. Here would be placed in order the skin, nerves, glands, teeth, membranes, bones, and organs of sense, and all other organs derived from the outer germ-layer in as nearly as possible the order of their appearance in the embryo.

To the second division belong the endodermal structures, the lining of the alimentary tract, the liver, respiratory organs of vertebrates, endostyle of Tunicates and the thyroid and thymus glands, pancreas, spleen, and stomach.

The mesoblastic tissues may be divided into two great groups: the first, those of the mesenchyma, embraces the spicules of sponges and the skeleton of Echinoderms, smooth muscles, connective tissue, fat-cells, blood, blood-vessels, heart, lymphatics; and, lastly, cartilage and bone. To the other division, to which the term mesothelial tissues may be applied, belong the peritoneum of the vertebrates and its homologues in other groups, striated muscle, and its modification, electric organs, the segmental organs of the lower forms, and the excretory organs of the higher forms, sexual organs, then the stomodeum and its glands, and the proctodeum and its appendages.

The position of the mouth of vertebrates and its accessories is uncertain, as doubts exist whether it is comparable to a portion of the stomodeum of the lower forms or is a superadded feature.

In the case of compound organs the preparations should be placed with their most characteristic elements. Thus the liver should be placed with the hypoblastic tissues, the nerves and skin with the ectodermal, &c. In cases of series of sections of one animal, they of course should be kept together.

Dr. Dimmock adopts a different plan. Each of his slides is numbered in the order of preparation, and then two card catalogues are made, one by organs, the other systematic, each card referring by a number to the corresponding slide. On these cards can be entered full accounts of the specimen, its mode of preparation, the special features presented, &c., and thus with a slight additional amount of labour, the advantages of each system of arrangement may be obtained.

Blackham's Object-Boxes.*—Dr. G. E. Blackham takes the common rack-boxes for twenty-four slides, and putting on the cover, pastes a piece of stout twilled muslin on the back and lapping over on to the cover. This forms a hinge, and gives the boxes a uniform look. Each box is devoted to a special series or class of objects, and properly labelled, and stands up on end in a revolving book-case. The slides lie flat, and the whole collection is in reach from the working table, without getting out of the chair. For indexing each box Dr. Blackham, with an electric pen, makes a label covering the inner side of the cover, the name of each slide is written on this, on the line opposite the slide itself as it stands in the box. These boxes are cheap, convenient and portable, and are, he considers, preferable to the more elaborate and costly cabinets of drawers.

* Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 236–7.

Stillson's Object Cabinet.*—Dr. J. O. Stillson's cabinet consists of a number of trays made of thick pasteboard. They are 9 in. wide and 16 in. long. There are two rows of slides in each tray and 10 or 12 in each row according to the partitions, which can be removed or left in. The depth of the tray is equal to the thickness of the thickest slides, so that when they are in place, each lying flat, they fill the apartment. There is a lid to each tray, also made of pasteboard but stiffened, and made heavier by the addition of a strip of wood, such as is used in making cigar boxes. This strip extends all around the margin of the lid, and there is another across the middle the long way.

Two long openings are cut through the lid, about 2 in. wide, so that when the lid is closed it will press the slides down in their places firmly, but at the same time not touch the cover-glasses. High, dry and opaque mounts can be placed alongside of the thinnest balsam or diatoms, and when it is desired to look for a slide the whole tray can be surveyed with the eye at a glance, and the names of twenty or twenty-four specimens can be read without opening the tray. When the trays are all in the box, the lid holds them firmly in place suitable for shipping. He has borders for the labels printed on fancy coloured paper, and writes in pencil on the wrong side of the label such a history as he desires and pastes it on the slide. Then the name labels are cut with a circular No. 8 punch, and pasted on the border paper. There is plenty of room to write in front the English and Latin names, date and number; by turning the slide round one can read from the back through the glass the history and mode of preparation.

Pillsbury's (or Bradley's) and Cole's Mailing Cases. — This "mailing case," the design of J. H. Pillsbury, is intended to supply a demand for some safe and cheap means of packing one or more slides for sending through the post. The entire device comprises three differently shaped pieces of wood (tops, bottoms, and centres) so formed that two, three, or more may be put together as shown in

Fig. 77.

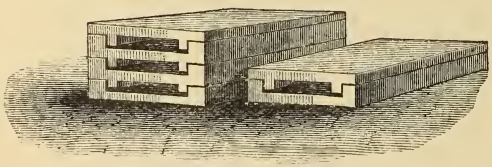


Fig. 78.

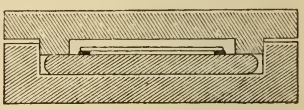


fig. 77. For one slide the top and bottom pieces are used, for two slides the centre pieces also, and so on to any convenient number.

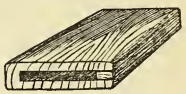
The cross section fig. 78 shows the relation of the parts of the case to the slide. The pinching of the wooden lips on the margin

* Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883.

of the glass outside the mounting serves to hold the slide securely in place, and to protect the mounting from possible injury.

Every dozen tops and bottoms is accompanied with twenty-four strips of gummed paper which may be used on the edges to secure the pieces before wrapping for mailing. If one slide is to be sent the strips may be gummed lengthwise on the edges. If centres are used for more slides the strips may be used to pass around on to top and bottom. The slight shrinking of the moistened paper in drying pinches the slide sufficiently to hold it securely.

Fig. 79.



A. C. Cole uses the boxes shown in fig. 79. They consist of a piece of wood $3\frac{1}{8}$ in. × $1\frac{5}{8}$ in. and 1/2 in. thick in which a coarse saw-cut has been made nearly through it as shown in the figure. The slide is placed in the groove thus formed with a little cotton wool and the open side is filled up with a strip of wood about 3/16 in. section.

Adams, J. M.—How to keep [send] living Infusoria.
[Dr. A. C. Stokes uses *Lemna* plants which keep the water sweet and supply oxygen while in transit.]
The Microscope, IV. (1884) p. 64.

B., W.—Microscopical. [Mounting Cuticle of Leaf.]
Engl. Mech., XXXIX. (1884) p. 132.

Behrens, W.—See Boecker, W. E.

Blochmann, F.—Ueber Einbettungsmethoden. (On imbedding methods.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 218–33 (2 figs.).

Boecker, W. E.—Ueber ein neues Mikrotom mit Gefriereinrichtung, automatischer Messerfuhrung und selbstthätiger Hebung des Objectes. (On a new Microtome with freezing apparatus, automatic knife-guide, and automatic raising of the object). [*Post.*]
Zeitschr. f. Instrumentenk., IV. (1884) pp. 125–7 (2 figs.).
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 244–8 (by W. Behrens).

Booth, M. A.—Mailing packages of Diatoms.
[Inquiring how to send small exchanges to foreign countries.]
Amer. Mon. Micr. Journ., V. (1884) p. 100.

Born, G.—Die Plattenmodellirmethode. (The method of modelling by [wax] plates.) [*Post.*]
Arch. f. Mikr. Anat., XXII. (1883) pp. 584–99.
Amer. Natural., XVIII. (1884) pp. 446–8.

Buchka, K.—Ueber Hæmatoxylin und Brasilin. (On Hæmatoxylin and Brasilin.)
Nachr. K. Gesell. Wiss. Göttingen, 1883, pp. 60–66.

Buckton, G. B.—Monograph of the British Aphides. Vol. iv. ix. and 228 pp. (27 pls.). 8vo, London, 1883.
[Contains "The preservation and mounting of Aphides for the Microscope," "The preservation of Aphides for the Museum," and "The dissection of Aphides." *Supra*, p. 466.]

Burrill's (T. J.) Staining fluid, directions for use of.
Micr. Bulletin, I. (1884) pp. 21–2.

Cattaneo, G.—Fissazione, Colorazione e Conservazione degli Infusorii. (Fixing, colouring, and preserving Infusoria.) *Concld.*
Bollett. Scientif., V. (1883) pp. 122–8.

Cleaning Slides and Covers—Letter by J. C. Lathrop. [See also *ante*, p. 323.]
Amer. Mon. Micr. Journ., V. (1884) p. 79.

Coale, R. D.—Preparation of the Ethyl Ether of Gallic Acid.
[Cf. III. (1883) p. 931.]
Amer. Mon. Micr. Journ., V. (1884) p. 82.

Cole, A. C.—Studies in Microscopical Science.
Vol. II. No. 15. Sec. I. No. 8. Adipose Tissue, pp. 29–32. Plate 8 × 250.
No. 16. Sec. II. No. 8. pp. 29–34. Epidermal Tissue. Plate 8. T. S. of aërial root of *Dendrobium* × 130.
No. 17. Sec. I. No. 9. Development of Bone, pp. 33–6. Plate 9. Ossification of Cartilage (Quain) × 300.
No. 18. Sec. II. No. 9. pp. 35–8. Vasicular Tissue. Plate 9. Bast, Sieve Tubes and Liber Cells.
" " Methods of Microscopical Research.
Part IX. pp. xlix.–lii. Mounting (*continued*). Description of Materials.
Part X. pp. liii.–vii. Mounting (*continued*). The Preparation of Diatomaceæ.
" " Popular Microscopical Studies. No. VII. A Grain of Wheat (*concluded*), pp. 25–8.—The Common Bulrush (*Typha*), pp. 29–31. Plate 7. T. S. of Stem, double stained, × 75.
No. VIII. The Intestine, pp. 33–7. Plate 8. T. S. Ileum of Cat injected × 50.

Collins' (C.) Series of 48 Fish Scales. *Micr. News*, IV. (1884) p. 109.

Cornil, —.—Sur le mode de conservation des pièces anatomiques destinées à être examinées au Microscope. (On the mode of preserving anatomical objects required to be examined with the Microscope.
[Brief note only of original paper. The best preserving liquid is 90 per cent. alcohol using a volume at least 20 times as great as that of the piece to be preserved, which should if possible be reduced to 1/2–1 cm. cube.]
Journ. de Micr., VIII. (1884) p. 189, from *Progrès Médical.*

Cox, J. D.—[Prof. H. L. Smith's] New Mounting Media. [*Supra*, p. 476.]
Amer. Mon. Micr. Journ., V. (1884) p. 71.

Coze and Simon, P.—Recherches de pathologie et de thérapeutique experimentales sur la Tuberculose. (Experimental pathological and therapeutical observations on Tuberculosis.)
[Contains I. Technique.]
Journ. de Microgr., VIII. (1884) pp. 235–9, from *Bull. Gén. de Thérapeutique.*

Creese, E. J. E.—An inexpensive Turn-table.
["A home-made turn-table which any one with ordinary knack can make for himself at the cost of a shilling."]
Journ. of Micr., III. (1884) pp. 106–7 (3 figs.).

Deby, J.—Notes diatomiques. (Notes on Diatoms).
[I. On MM. Prinz and Van Ermengem's work on the structure of the valves of diatoms (*post*). II. Discovery of *Terpsinoë musica* in Spain. III. Special slides of diatoms by Möller (*post*).]
Journ. de Microgr., VIII. (1884) pp. 228–31.

Dippel, L.—Die Anwendung des polarisirten Lichtes in der Pflanzenhistologie. (The use of polarized light in vegetable histology.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 210–7 (5 figs.).
" " Kalium-Quecksilberjodid als Quellungsmittel. (Biniodide of mercury and potassium as a swelling agent.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 251–3.

Durkee, R. P. H.—Mounting in balsam in cells. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) pp. 84–85.

Edinger, L.—Notiz, betreffend die Behandlung von Präparaten des Centralnervensystems, welche zur Projection mit dem Scioptikon dienen sollen. (Note on the treatment of preparations of the central nerve-system intended for projection with the Sciopticon.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 250–1.

Elsner, F.—Mikroskopische Atlas. Ein illustrirtes Sammelwerk zum Gebrauche für Gesundheitsbeamte, Apotheker, Drogisten, Kaufleute und Gebildete Laien. (Microscopical Atlas. An illustrated compendium for the use of officers of health, apothecaries, druggists, merchants, and well-informed laymen.) Part I. 9 pp. and 2 pls. of 27 photomicrographs. 4to, Halle, 1884.
[Contains Coffee and Coffee-surrogate. Tea and Tea-surrogate.]

FERGUS, S. T.—Double staining sections of Buds. *Micr. Bull.*, I. (1884) p. 18.

FLESCH, M.—Notiz über die Anwendung des Farbstoffes des Rothkols in der Histologie. (Note on the use of the colouring matter of the red cabbage in Histology.) [*Post.*]

Zeitschr. f. Wiss. Mikr., I. (1884) p. 253–4.

FRENZEL, J.—Ueber die Mitteldarmdrüse der Crustaceen.

[Contains "Methods of studying the so-called liver of the Crustacea." *Amer. Natural.*, XVIII. (1884) p. 556–7. *Post.*]

MT. Zool. Stat. Neapel, V. (1884) p. 51.

GAGE, S. H.—Notes on the use of the Freezing Microtome. [*Post.*]

Science Record, II. (1884) pp. 134–5.

GILTAY, E.—L'Hématoxyline comme réactif spécifique des membranes cellulosiques non lignifiées et non subérifiées. (Hæmatoxylin as a reagent for non-lignified and non-suberose cellulose membranes.) [*Post.*]

Arch. Néerl. Sci. Exact. et Nat., XVIII. (1883) pp. 437–52.

GRANT, F.—Microscopic Mounting. IX. Mounting Media. 1. Phosphorus and monobromide. 2. Advantages as to the absence of contraction and as to visibility. 3. Thin aqueous fluids. 4. Advantages of different media with respect to granulation. 5. Thick aqueous media: advantages as to staining and pressure.

[Sec. II. requires considerable correction. *Inter alia*, the refractive index of diatoms is put at "about 1·5," and balsam at 1·528, or a visibility of ·028! Diatoms are stated to be more visible in air than in phosphorus. The disadvantages of air-mounting are not referred to its inapplicability for fine markings, but to a "dulness or mist which gathers inside," &c.]

Engl. Mech., XXXIX. (1884) pp. 148–50.

GRAVIS, A.—Procédés techniques usités à la Station Zoologique de Naples en 1883. (Technical methods used at the Naples Zoological Station in 1883.)

[Summary of various methods previously published, and *post.*]

Bull. Soc. Belg. Micr., X. (1884) pp. 104–27, 132–3.

HAACKE, W.—Entwässerungsapparate für Macro- und Microscopische Präparation. (Dehydrating Apparatus for Macroscopic and Microscopic Preparations.) [*Post.*] *Zool. Anzeig.*, VII. (1884) pp. 252–6 (1 fig.).

HARTZELL.—A method of staining the Bacillus [of tubercle.] [*Post.*]

Amer. Mon. Micr. Journ., V. (1884) p. 76–7, from *Medical Times.*

HAZLEWOOD, F. T.—Blue Staining.

[The stain—described III. (1883) p. 733—"gives surprisingly fine results with micrococci, bacteria, bacilli, &c." Method of suspending the slides in the water.]

Amer. Mon. Micr. Journ., V. (1884) pp. 83–4.

HEITZMANN, C.—Mikroskopische Morphologie des Thierkörpers im gesunden und kranken Zustande. (Microscopical morphology of the animal body in health and disease.) xvi. and 876 pp. (380 figs.). 8vo, Wien, 1883. Also 8vo, New York, 1884.

HITCHCOCK, R.—Styrax and Liquidambar as substitutes for Canada Balsam.

[Recommendation of Styrax.]

Amer. Mon. Micr. Journ., V. (1884) pp. 69–71.

„ „ Crystals of Arsenic.

[Select a small tube about 1 in. in length, and fit it in a holder made of a thin strip of copper, brass, or other metal having a hole bored through it to receive the tube. Let the mouth of the tube project slightly above the metal, and support the latter in some convenient way over a spirit lamp. Place a small quantity of white arsenic in the tube, and apply heat slowly until a white powder begins to collect about the mouth. Then warm a glass slip, and hold it over the top of the tube until bright crystalline particles appear on its under surface. Then remove the lamp and let the tube cool.]

Amer. Mon. Micr. Journ., V. (1884) p. 71–2.

„ „ Cleaning Polycystina. „ „ „ „ pp. 72–3.

HITCHCOCK, R.—Microscopical Technic. III, IV. Mounting Objects Dry.
Amer. Mon. Micr. Journ., V. (1884) pp. 73–4, 91–4.

„ „ Spring Collections. „ „ „ „ pp. 77–8.

HOEHNEL, F. v.—Ueber eine Methode zur raschen Herstellung von brauchbaren Schliffpräparaten von harten organisirten Objecten. (On a method for the rapid preparation of useful sections of hard organized objects.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 234–7.

HOFFMANN, F. W.—Einfacher Einbettungsapparat. (Simple imbedding apparatus.) [*Post.*] *Zool. Anzeig.*, VII. (1884) pp. 230–2 (1 fig.).

HOLZNER, G.—Zur Geschichte der Tinctionen. (On the history of Staining.) [*Post.*] *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 254–6.

JACKSON, E. E.—How to Mount Casts.
[After allowing urine to settle, pour off and wash sediment repeatedly with clean water, the object being to get rid of the albumen. The white sediment consists of casts and epithelia. Have ready a solution of eosin, 5 grs. to 1 oz. (water 3, alcohol 1), pour it on sediment, allow to stand 30 minutes, then wash repeatedly as long as colour comes freely. Allow to settle, place a drop on cover, when dry enough to adhere, rinse off with alcohol to get rid of water; dry. Wet with spirits of turpentine and mount as usual in balsam.]
The Microscope, IV. (1884) pp. 78–9.

„ „ Mounting Desmids.
[A dip was put in a cell, the water absorbed by blotting-paper, then a drop of mixture of carbolated mucilage of gum arabic and solution of borax was put on the desmids and they were covered and ringed. It remains to be seen whether the medium has bleaching or shrinking properties.]
The Microscope, IV. (1884) p. 117.

KINGSLEY, J. S.—Microscopical Methods. II.
[Elementary instruction.] *Science Record*, II. (1884) pp. 124–7.

L., V. A.—To Harden Animal Tissues. *Sci.-Gossip*, 1884, p. 89.

LAGERHEIM, G.—Eine Präparirmethode für trockene mikroskopische Pflanzen. (A method for preparing dried microscopical plants.) [*Post.*]
Bot. Centralbl., XVIII. (1884) pp. 183–4.

LATHROP, J. C.—See Cleaning.

LINDT, O.—Ueber den mikrochemischen Nachweis von Brucin und Strychnin. (On the microchemical analysis of Brucine and Strychnine.)
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 237–40.

MEYER, H. V.—Fernere Mittheilung über die Kleisterinjection. (Further communication on paste injection.)
[Further experience of his modification of Pansch's method has proved its value. Remarks on the use of fuchsin and vermilion.]
Arch. f. Anat. u. Physiol.—Anat. Abtheil., 1883, pp. 277–8.

MICHAEL, A. D.—British Oribatidæ. Vol. i. xi. and 336 pp. (31 pls.). 8vo, London, 1884.
[Contains description of cells used for observing the development and immature stages, pp. 68–70 (glass rings made from thinnish 3/4 or 7/8 in. tubing and 3/8 in. deep). Collecting and preservation, pp. 99–109. Drawing, pp. 191–5. *Post.*]

MOELLER, J.—Das neue Patent-Schlittenmikrotom von C. Reichert. (The new patent sliding Microtome of C. Reichert.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 241–4 (1 fig.).

PIM, G.—Cell-sap Crystals.
[*Supra*, p. 470.] *Journ. of Bot.*, XXII. (1884) p. 124.

PRAY, T., junr.—Cotton-fibre and its structure.
[Refers to the "importance of examining cotton by the Microscope," and the "advantages which manufacturing corporations would gain by selecting their stock in this way."]
Science, III. (1884) p. 583 (*Proc. Soc. of Arts. Mass. Inst. of Technol.*, April 10).

RATABOUL, J.—Les Diatomées. Récolte et préparation. (The Diatomaceæ. Collection and preparation. *Contd.*)
Journ. de Microgr., VIII. (1884) pp. 115, 173–6, 231–4.

RINDFLEISCH.—Bacilli of Tubercle.
[They are best stained by fuchsin, soluble in alcohol but not in water. Two or three drops of a concentrated solution in 2–3 cm. of anilin-oil water are sufficient. The staining is especially good at 40° C. The bacilli are uniformly stained if a few drops of fuchsin are added to a mixture of equal parts of alcohol, water, and nitric acid.]
The Microscope, IV. (1884) p. 91.

SHARP, B.—On Semper's method of making dried preparations. [*Post.*]
Proc. Acad. Nat. Sci. Philad., 1884, pp. 24–7.

SHARP, H.—On the Mounting of Objects in cells with Canada Balsam medium.
Journ. Roy. Soc. N. S. Wales, XVI. (1883 for 1882) pp. 286–8.

SIMON, P.—See Coze.

SLACK, H. J.—Pleasant Hours with the Microscope.
[Spiral vessels of rhubarb, &c.—Oxalate of Lime in Wood Sorrel] [Fish scales] [Proboscis of Ophideres] [Wings of Insects].
Knowledge, V. (1884) pp. 240, 282–3 (3 figs.), 330–1 (2 figs.), 371–2 (1 fig.).

SMITH'S (H. L.) New Mounting Medium. [*Supra*, p. 476.]
[See also Cox, J. D.] *The Microscope*, IV. (1884) pp. 77–8.
Amer. Mon. Micr. Journ., V. (1884) p. 80.

STOWELL, C. H.—Studies in Histology. Lesson I. Injecting. II. Hardening, Softening, Dissociating and Normal Fluids.
The Microscope, IV. (1884) pp. 49–56, 80–6.

„ „ The Measurement of Blood-corpuscles.
[Discussion of recent articles. He considers the relative size of the red blood-corpuscles as given by Gulliver incorrect.]
The Microscope, IV. (1884) pp. 60–1.

„ „ White Zinc Cement.
[Commendation of it when properly put on, in opposition to R. Hitchcock's view that it will run in and spoil the mounts.]
The Microscope, IV. (1884) p. 62.

Walmsley & Co.'s Circular on Bacillus Staining. [Vol. III. (1883) p. 310.]
The Microscope, IV. (1884) pp. 79–80.

WEST, T.—Naphthaline.
["It is considered by Prof. Williamson of Manchester, to furnish the very best of all substances for imbedding delicate microscopic subjects in previous to cutting sections."]
Journ. of Microscopy, III. (1884) pp. 113–4. See also p. 119.

WILLS, —.—Mounting Desmidieæ.
[Plain water—gold size.]
Proc. Manch. Lit. and Phil. Soc., XXI. (1882) pp. 38–40.

WILSON, C. B.—The mesenterial filaments of the Alcyonaria.
[Contains "Methods of preparing the Alcyonaria." *Amer. Nat.*, XVIII. (1884) p. 558. *Post.*]
MT. Zool. Stat. Neapel, V. (1884) p. 3.

PROCEEDINGS OF THE SOCIETY.

Meeting of 9th April, 1884, at King's College, Strand, W.C., the President (the Rev. W. H. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 12th March last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Hinde, G. J.—Catalogue of the Fossil Sponges in the Geological Department of the British Museum (Natural History). 248 pp. and 38 pls. 4to, London, 1883	*The Trustees.*
Microscope by Chevalier	*Mr. W. Forgan.*
Martin, B.—System of Optics. xxiv. and 295 pp., xxxiv. pls. 8vo, London, 1740	*Ditto.*
Collection of Australian Reptiles and Amphibia	*Mr. W. E. Pickels.*
Portrait of H. J. Slack, Esq.	*Mr. Slack.*

The President said that since their last meeting they had received an intimation from the R. Accademia dei Lincei of Rome, of the death of Signor Quintino Sella, who as President of the Academy was one of their ex-officio Fellows. He proposed that a vote of condolence should be forwarded to the Academy expressing the sympathy of the Society with the Academy in the loss of their illustrious President.

Dr. Anthony having seconded the proposal, it was carried unanimously.

The President proposed that as they were favoured by the presence of Dr. Carpenter, who intended to deal with the subject of binocular vision in the Microscope, the other business on the agenda should be postponed. This was approved by acclamation.

Dr. Carpenter then addressed the meeting "On the Physiology of Binocular Vision with the Microscope," illustrating the subject by some large photographs, drawings on the black-board, &c. He said :—

The reason of my venturing to offer to the Society the views which I entertain upon the subject specified as the title of this communication, is that in the last number of the 'Journal' of the Royal Microscopical Society, at the end of a paper by Prof. Abbe, a doctrine is put forward on the nature of Stereoscopic vision with the Microscope, which appears to me to be inconsistent with our knowledge of the physiology, and also with our experimental knowledge of the pheno-

mena, of stereoscopic vision. It is not, I think, so much a question of optics, as of the physiology of vision. If it was one of optics, I should certainly not venture to put myself in antagonism with one who is probably the greatest living master of the theory of the Microscope. But I think I shall be able to show that it is essentially a question of physiology, and in part also of psychology. Ever since Wheatstone's invention of the Stereoscope, something like fifty years ago, I have had the subject constantly before me: and from the first introduction of the binocular Microscope, I have used it continually for objects of suitable character. So completely, indeed, am I accustomed to it, that when I look at some of the same objects under the monocular Microscope, I scarcely know them again.

The manner in which we form our visual conceptions from impressions produced upon the retina, is a matter of both physiology and psychology, lying on the border line between the two. Our visual conceptions are formed by the process which is known as "suggestion"; that is, they do not necessarily conform to the visual impressions produced upon the retina, but they are suggested to us by these visual impressions; and it sometimes occurs that our conceptions are erroneous. All who have given attention to the physiology of vision, agree in considering our ordinary interpretations of the solidity of an object placed before us, to be dependent upon a mental co-ordination of our visual and tactile sensations. A child moves its hands towards an object presented to its vision, and educates itself to a conception of its form by the conjoint use of its sight and its touch. It has happened that in some cases persons have obtained sight for the first time, having been born blind, at an age when they have been able to record their impressions of objects presented to their sight, and to manifest their difficulties of interpretation. Many years ago I had the opportunity of observing a child three years old, who had been operated on for congenital cataract. He was too young to describe his impressions to us, but we could observe when he was guided by sight and when by touch, and it was very interesting to watch him under these circumstances. In the lodging where he was staying whilst under treatment, everything about him was strange, and he used his sight and his touch conjointly in familiarizing himself with them until he had learned to correlate the two impressions. But when taken to his own home where the surroundings were perfectly familiar to him, he was for some time entirely guided by touch; he seemed to be quite puzzled by the sight of them, and often shut his eyes in order to understand where he was. Many of you have heard of the case recorded by the celebrated Cheselden, the subject of which, being much older, could describe his own sensations. For a long time after he could see distinctly, he could not distinguish solid objects by vision alone from flat pictures. Not very many years ago, the case was published of a young woman who from birth had possessed enough sight to enable her to distinguish light from darkness, but who could not see the form of any object about her. She had been accustomed to work with her needle; and her thread, needle, scissors, balls of cotton, &c., were all perfectly well known to

her by touch. You would suppose that the peculiar form of a pair of scissors, as suggested to the mind through the medium of touch, would be recognized through the sight more readily than anything else; and yet when it was first shown to her, she utterly failed to recognize it as the implement which she had been in the habit of handling. This recognition of a solid form from a visual picture, then, is the result of the experience we gain in very early life, from the association of the mental impressions made by the retinal pictures with those we obtain through the sense of touch,—by which I mean not only the contact with the fingers, but the muscular action which gives movement to them,—so that, in course of time, the visual picture comes to suggest the solid form of the object to the mind. Our best evidence of this is derived from pictures obtained by means of photography; especially those in which the relations of light and shade are strongly brought out; for these pictures suggest the idea of solidity much more perfectly than any others can do. Some of you will probably remember the old Dioramic pictures in the Regent's Park, with their wonderful appearance of solidity, especially in the case of architectural designs; the impression produced being so entirely that of solidity, that it was only by moving the head from side to side that the illusion was detected. These pictures were based on photographs; Daguerre and others having worked out the original "daguerreotype" process for the purpose of producing them most effectively.

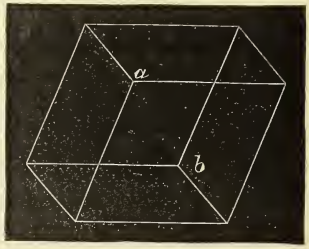
In ordinary drawing and painting, an artist is subject to continual changes in the conditions of the light and shade, even in the course of half an hour; and therefore no painting, except one by artificial light, can give a true representation of light and shade at any particular moment. Therefore it is that photographs of many subjects are most wonderfully illusive, and most especially so *when they are looked at with only one eye.* The explanation of this effect is, that when you look at the picture with both eyes, and it is tolerably near to you, you are forced to see it as a flat surface; but when you shut one eye and keep the head still, you lose the power of measuring relative distances; and a visual conception of solid form is suggested by its chiaroscuro and its perspective. If you look, for example, with one eye at the photographs of relievos hanging upon the opposite wall, you will, if you have not tried the experiment before, be astonished at the way in which the figures seem to stand out with all the effect of stereoscopic relief. This is a pure case of mental suggestion; and is due to the perfect similarity of the photograph to the retinal picture produced by natural vision of the object itself upon a single eye. The camera, like the eye, projects a flat picture, which is recorded by photography; and you have then permanently just the picture which one eye would form of the object. You look at this with one eye, and, trained by experience, you interpret what you see according to your preconceived conceptions. A similar effect is obtained when you look at such pictures with both eyes, at a distance great enough for the axes of the eyes to be virtually parallel.

I remember some large imitation relievos on the cornices of some of the apartments in the Louvre at Paris, and some still larger pic-

tures of the same kind in the Bourse, by which the impression of solidity is so well given, that, though the paintings are quite flat, they are generally taken by strangers for real relievos. I have a photograph of a figure in such low relief, that, looking at it with both eyes at a distance of only two feet, you could almost swear to its solidity; the suggestion of solidity given by its lights and shadows being so vivid, as to overcome the corrective effect of the binocular perception of its flatness.

I dwell upon this point, because it underlies the whole inquiry before us. I have here four large photographs of plaques representing the Four Seasons, with the ornamentation and figures in high relief. When you look at three of these with one eye, you will scarcely be able to persuade yourselves that you are not seeing actual relievos, so vividly do the figures stand out. But I have hung one of them upside down; and though you may not all see it as I do, I think the impression upon most persons will be that the figures are hollowed out, instead of raised. In each case the illusion depends mainly upon the light; and it is most complete when there is but one source of light in the room, corresponding with the lights in the photograph. The mental impression is entirely due to suggestion; you know the position of the light, and can tell in which direction the shadows would fall; and when the shadow is made to fall as it would if the object were hollow, then the mind interprets the object as such. Another remarkable instance of suggestion is afforded by this figure of a rhomb (fig. 80), which, as you look at it, may seem to change from one position to another, sometimes appearing to stand upon its narrow side, at other times to be lying on its broad side. Sir D. Brewster says that the perception changes from one to the other, as you feel your mind changing; but I believe that the perceptional and therefore the mental change is the result of the wandering of the eye from the point *a* to the point *b*; for I have never failed to see one or the other aspect, by making my eyes converge upon one or the other of these two points, which then becomes the *salient angle*. This is a case in which two different effects of projection may be produced by the same visual impression; a consideration much dwelt upon by Sir Charles Wheatstone in his original memoir,* as proving that the conception of solid form is *visually suggested* to the mind, not a mere optical effect.

Fig. 80.



I now come to the subject of *Binocular* Stereoscopic vision, which was first elucidated in that memoir. Painters had long been aware of the fact, that if you look at a near object with both eyes, you form different pictures with your two eyes. How is it, then, that we are not

* "On some remarkable and hitherto unobserved phenomena of Binocular Vision." Phil. Trans., 1838, pp. 371–94.

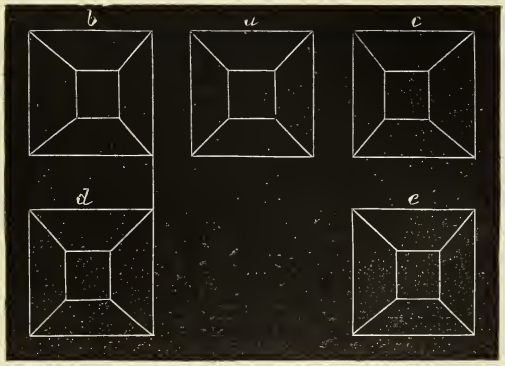
puzzled by these different pictures, presented to the mind at the same time? Wheatstone applied himself to the study of this question; and in the course of his investigations it occurred to him that the dissimilarity of the two pictures was really the cause of the sense of projection; and that though we have this sense with a single eye, it is in such case by no means so unmistakable. He therefore reasoned in this way; if you draw two pictures of an object, one as it appears to the right eye, and the other as it appears to the left, and then throw the images of these dissimilar pictures upon the two eyes respectively, you will get a solid effect. The original form of the Stereoscope was a reflecting apparatus, consisting of two mirrors placed together at a right angle, so that each reflected the image of its own picture direct to its own eye; and with this instrument Wheatstone found that two mere outlines of a solid, drawn as already described, and reflected so that each was seen only by the eye for which it was drawn, resulted in the production of a perfect perception of the solid form. No one welcomed this discovery more than Sir David Brewster; who said that it was the greatest that had been made in vision since the time of Newton. This combination of two dissimilar pictures is the fundamental principle of the Stereoscope. In the form of that instrument now familiar to you all, a pair of small photographic pictures, taken in different perspectives, are brought one before the right eye, the other before the left, by two halves of a double-convex lens placed back to back, so as to act both as prisms and as magnifiers. The points of view from which the two pictures are taken, are generally, I believe, about 15° apart; that being the usual angle of convergence of the axes of the eyes at the ordinary reading distance. The late Mr. Claudet, who paid a great deal of attention to this subject in relation to portraiture, tried various angles; and having taken pictures at 5°, at 10°, at 12°, at 15°, and at 20°, he found that 5° gave very little projection, 10° was more satisfactory, but 12° was much better; and for people with nearly approximated eyes it was found to be sufficient; but for most people, 15° was required to bring out the full stereoscopic effect, whilst if he widened the angle to 20° all the projecting parts came out with ludicrous exaggeration. (I have an early stereoscopic photograph of an equestrian statue of Napoleon, showing this exaggeration in a very marked degree, the two pictures having been taken at too wide an angle.)

As an illustration, take a truncated pyramid which is placed end-on before one eye, as is shown in fig. 81 *a*; with that eye alone you would be unable to measure the relative distances of its parts, and the borders of its base and truncated top would appear like two squares symmetrically placed one within the other. But if placed in front of the nose, the right eye would see more of the right side of the pyramid (as in the fig. 81 *c*), whilst the left eye will at the same time see more of the left side of it (as in fig. 81 *b*); and if these two pictures are put into the Stereoscope, and each is seen at the same time —the one by the right eye, and the other by the left—the apparent solidity of the figure is brought out perfectly; that is, these two dissimilar pictures, viewed simultaneously, suggest to the mind a con-

ception of the projection of the solid from which they are taken. But if the figure, instead of being solid, was hollow, and was placed before the eyes so as to show its interior, then the right eye would see more of the left side, and the left eye would see more of the right side (as in figs. 81 *e* and 81 *d*); and when these two pictures are put into the Stereoscope, the centre appears to recede in an unmistakable manner. I have here a stereoscopic slide showing these two pairs of pictures at the same time; and if you look at it in the Stereoscope, the "conversion of relief" produced by the "crossing" of the right and the left hand pictures of the pyramid, will be at once apparent.

But in addition to these impressions of solid form, another very curious fact now comes out. The four small squares are of exactly the same size in the pictures; and yet as you look at them in the Stereoscope, you will all say that the square at the end of the hollow pyramid seems larger than the other. The apparent excess differs

FIG. 81.



in different persons; for some see the receding pyramid as if much deeper than others, and describe it as like a tunnel; and to them the small square looks very much larger. This is another case of mental suggestion, and one which no optical diagrams can explain, because it is clear that the retinal pictures must be of exactly the same size, however different they may seem *visually*. Sir Charles Wheatstone in his second Memoir (Phil. Trans., 1852) clearly proved, by experiments made with his improved reflecting Stereoscope, that our conception of the size of an object pictured on the retina ordinarily depends on our appreciation of its distance; and that this again (in the case of a near object), depends upon the convergence of our optic axes. If we have an object of known size, and we bring it nearer to the eye, it does not seem to be a larger object: because we know that though it subtends a wider visual angle, making the retinal picture larger, its distance from us has diminished. And he showed that by making the optic axes converge, and so suggesting to the mind that the object was approaching, though it was not brought

nearer (its retinal picture remaining of the same size)—it seemed to become smaller; while, by opening out the angle of convergence, the pictures seemed to grow larger. Here, then, we have a most perfect example of an automatic mental interpretation, in which the apparent size is determined by the conjoint impressions we are receiving from the convergence of the optic axes and the actual size of the retinal pictures. And so when the mental interpretation of the stereoscopic form throws the small square back, and the visual picture remains of the same size, the fact of its receding without diminishing suggests the mental impression that it is of a really larger size. There is no gainsaying these things; they are simply facts in Mental Physiology; and, as I have already said, they are not a matter of Optics, but the results of a *mental* process of *interpretation* of the visual impressions received.

I might go on to demonstrate this still further by means of the Pseudoscope, if time permitted. This is an arrangement of prisms for bringing the right-hand picture of an actual object to the left eye, and the left-hand picture to the right eye; and just as the "crossing" of two stereoscopic pictures produces a conversion of relief in the composite image, so does this reversal of the combination suggest to the mind a reversal of the relief of the image of the actual object. The effect of "suggestion" is well shown by a simple experiment. Here is an ordinary tin cake-mould; now if you place this before one eye so that the light falls directly into it, and you look at it with that eye alone, inasmuch as you are more accustomed to see the solid form than the hollow, you will probably see it projecting towards you. (To see it in this way, there must be no shadow, for this will oblige you to recognize its concavity.) The experiment is best made by daylight, the mould being held up so as to face the person looking into it with his back to a window. The picture that falls on his retina is virtually that of a flat surface; seeing it as such, he has to interpret the meaning of that picture; and as he is more accustomed to see the solid form than the hollow mould, the latter is preferentially suggested to his mind. As another very curious instance of this kind of suggestion, I have here a mask, which I long ago got one of my sons to paint inside, just in the same way that the outside is usually painted. If this is held up so that there is no shadow, and a person looks into it steadily with one eye, the mental impression is that of projection. I was about to write a paper on Binocular Vision and the Stereoscope for the 'Edinburgh Review,' and I asked the editor to come to my residence and see a few experiments. I placed him with his back to the window, and then, holding up this mask with the inside towards him, so that the light fell into it without causing shadow, I asked him to look at it with one eye, and to say what he saw. He said at once that he saw the face of an ordinary mask. I then told him to open the other eye, and he was utterly astonished to find that he had been looking at the inside. Sir Charles Wheatstone told me that by long looking at a bust with his Pseudoscope, he had been able to reverse its relief; but that he could never do so with a living human face. And I have found that although, by crossing the pictures in the

Stereoscope, any conceivable reversion can be made, no such conversion of relief will take place when two portraits taken stereoscopically are thus crossed—the mind refusing to accept the suggestion.

Having thus fully prepared my ground, I shall briefly deal with my proper subject. Prof. Abbe, as I understand him, says that the perception of relief in the case of the Binocular Microscope is something different from that of ordinary stereoscopic vision; and that it depends more upon the relative planes of portions of the object. I maintain, however, that it depends upon the combination (as in the Stereoscope) of two dissimilar perspective projections. We all know that the conception of solid form or projection which we get with the *stereoscopic* Binocular (in which the prism divides the cone of rays into its right-hand and left-hand halves), is very different from that which we get with the *non-stereoscopic* Binocular, in which half the rays of the entire cone are sent into each of the two bodies respectively. Every one also knows that in viewing a solid object he cannot get adequate focal depth with a very wide-angled objective. When our makers were bringing out 1/2 in. objectives of very wide angles, up to 90°, I tried one of them on a slide of *Polycystina*, but could make nothing of it; for a portion of a spherical form (which was all that could be brought into focus) looked very much like the small end of an egg. When I reduced the angle to 60°, the same portion of a sphere looked like the large end of an egg; but when I further reduced the angle to 40°, I saw every form in its true projection. I got Mr. Powell to construct for me a 1/2 inch objective of 40°; and this has been the progenitor of a goodly offspring of low-angled objectives, which give, in the Binocular, the real solid forms of opaque objects. I maintain that the pictures which we receive from the two lateral halves of such an objective, are as dissimilar as two portraits taken at an angle of 15°; and that it is by the stereoscopic combination of these, that the impression of solidity is suggested.

It is interesting to go back to Mr. Wenham's first paper on this subject,* written just thirty years ago. He was then working out the problem of the Binocular Microscope: rightly apprehending the principle of the Stereoscope, he attempted to reproduce its effects in the Microscope; and you know how he ultimately succeeded, although his first results were unsatisfactory. Prof. Riddell also at first failed, and for the same reason,—that they both lost sight of the fact that as the Microscope itself reverses the pictures, it is necessary that they should be made to cross before reaching the eyes of the observer. Some among you will no doubt remember, that the first binocular Microscopes which were made, gave such a view of the objects, that though you sometimes saw them stereoscopically, the general effect was pseudoscopic. Now, Mr. Wenham in the course of his investigations did this;—he took a very suitable object for the purpose, the egg of a bug, and having put it under a 2/3 in. objective, he covered up half the lens and made a drawing of the object

* Trans. Micr. Soc., ii. (1854) p. 4.

as it then appeared; he then covered up the other half, and made another drawing. You can see for yourselves that these two figures are two dissimilar pictures; and I have found that they pair perfectly well in the Stereoscope, bringing out the object in relief. I have at home two photographs taken in the same way, showing by their combination precisely the same result.

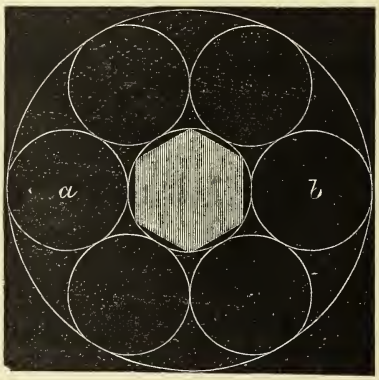
Another very curious piece of evidence, furnished by the dissimilarity of the pictures given by the two lateral halves of a portrait-lens, will strengthen my case. In 1857 Mr. Claudet brought before the Royal Society this very interesting fact:—"I have noticed that when I hold my head in a certain position behind the focusing ground glass, I see the sitter, not as a flat picture, but as an image in relief. But this image is only to be seen when my head is in a certain place; if I move it to either side, or either forwards or backwards, I lose the effect." He found the explanation of it to be, that in that particular position the picture taken by the left half of the lens came to his right eye, while the picture formed by the right half came to his left eye; whilst, if he moved so that he broke the lines of these two images, he lost the effect; he further found that if he covered up either half of his lens, the solid image gave place to a flat picture, proving the combination of the two to be required to give the impression of solidity. He found that the effect of relief was most decided, when rays forming the picture were only allowed to pass through an aperture at each end of the horizontal diameter of the lens, all the rest being stopped out; while the appearance of solidity was lost when only the central portion of the lens was employed. Further, he found that the illusion of relief is not produced when the image was received on translucent paper instead of on ground glass; the reason of this difference being that, as all the molecules of the ground glass are in themselves transparent, though their surfaces are turned into lenses or prisms by grinding, some of the rays *pass through it* to the eyes; whilst, when the image is thrown upon paper, the rays are stopped by the opacity of its fibres, each molecule of which, becoming self-luminous, sends out its rays in all directions, so that one and the same picture of the object is seen by both eyes. Mr. Claudet obtained further proof of the correctness of his interpretation by placing a blue glass before one of the marginal openings of his portrait lens and a yellow glass before the other. The image seen when the eyes were in a position to receive and combine the two pictures was of a grey tint. But if one eye was closed, the image became blue; and if the other was closed, it became yellow,—the same effect being produced by moving the head to one side or the other.* Although Mr. Claudet's view of this matter was denounced by Sir D. Brewster as completely at variance with the laws of optics, yet he subsequently succeeded in establishing it beyond question by the construction of his Stereo-monoscope;† in which the like effect was given by throwing on the same part of a ground glass, by two separate lenses, two

* Proc. Royal Soc., viii. (1856–7) p. 569.
† Ibid., ix. (1857-8) p. 194.

distinct pictures of the same object taken stereoscopically. These apparently coalesced into a single flat picture; but when the head was so placed that each eye received the rays issuing from the picture of the opposite side, the same effect of relief or projection was obtained, as if the two pictures had been combined by means of the ordinary Stereoscope.

Now I cannot see how these facts are to be accounted for in any other way, than by the admission that the pictures formed of any object in relief, by the different parts of a lens of sufficiently wide angle of aperture, are sensibly different in their perspectives,—as a very simple construction shows that they ought to be. Thus, if we were to place a hexagonal prism under a lens of three times its own diameter (fig. 82), and were to take a picture of it first through the central circlet only, and then through each one of the peripheral circlets in succession—all the rest of the lens being stopped out—we should have seven dissimilar pictures: that given by the central circlet showing only the hexagonal top of the solid, but in its true figure; whilst that formed by each of the peripheral circlets would give a foreshortened view of the hexagonal top, but would also bring in oblique views of three sides of the prism. Now, in the case described by Mr. Claudet, we should only receive the images from the two *lateral* circlets *a b*; and these "pair" so as to bring out the effect of relief, because they correspond with the two dissimilar perspectives which would be formed upon our two retinæ, if we were viewing the solid prism (enlarged to its apparent size) at the ordinary visual distance.

Fig. 82.



But, it may be asked, if this is the real state of the case, how is it that we obtain anything like a distinct image of any solid *projecting* object viewed monocularly—that image being the composite resultant of a number of superposed pictures differing sensibly one from another. When the object is either flat or in low relief, the pictures will not sensibly differ, unless taken with a lens of much wider angle than the 40° which (as I have already stated) I regard as the true limit for an objective to be used with the stereoscopic binocular. Now we have in Mr. Francis Galton's remarkable "composite portraits," a proof that pictures even of different individual men, having the same general facial proportions, but expressions so different that each may be at once distinguished from the other, may be blended photographically into one image which would not be remarked-on as wanting in definition. And so the pictures formed of such an object as a Polycystine, *Eucyrtidium*

or *Podocyrtis*, by the several circlets (as in fig. 82) of a lens of 40° aperture, though actually different, will blend into a composite image —a sort of visual average. But when the two lateral halves of such a lens are made, by the stereoscopic binocular, to give to the right and left eyes respectively separate and sensibly dissimilar pictures, corresponding in their perspective projections to what the real object would give to the right and left eyes, if enlarged to the same size, and placed at 10 in. distance from them — then the visual conception of solidity is vividly called up. As I have already shown you, this conception may be excited also by other suggestions—a one-eyed person being able to see objects in relief, as a microscopist sees them in a monocular instrument. But there is nothing which so strongly and uniformly excites this visual conception of solid form, as the combination of the two dissimilar perspectives; and this seems to me to be effected by the instrumentality of the Stereoscopic Binocular, exactly as (by Sir C. Wheatstone's admirable demonstrations) we know it to be effected in ordinary binocular vision.*

Mr. Crisp said that at that late hour he would compress into a brief compass his remarks in support of Prof. Abbe's view.

So far as Dr. Carpenter intended only to insist that stereoscopic vision in the Microscope resulted from two dissimilar images, there was no disagreement between himself and Prof. Abbe, and this being so, nearly all of Dr. Carpenter's interesting discussion was not really in controversy so far as Prof. Abbe was concerned.

The difference between Dr. Carpenter's view and that of Prof. Abbe was as to the mode in which the two dissimilar images were formed. Dr. Carpenter suggested that they are formed in the Microscope just in the same way as in the case of the naked eye, i. e. perspectively; whilst Prof. Abbe insisted that oblique vision in the Microscope is entirely different from that in ordinary vision, inasmuch as there is no perspective; so that we have no longer the dissimilarity which is the basis of the ordinary stereoscopic effect, but an essentially different mode of dissimilarity between the two pictures.

If we look at a small cube with the naked eye from an oblique direction it will be agreed that we shall see it as a perspective projection upon a plane at right angles to the direction in which we are looking, with the well-known perspective shortening of all lines which are not parallel to that plane. In the Microscope, however, according to Prof. Abbe's view, there is no such perspective shortening, but the cube is imaged in the manner described in his paper. †

That the latter is the correct view is proved by the fact that there is no difference in the outline of an object viewed under the Microscope by an axial or by an oblique pencil; there is simply a lateral displacement of the image—an entirely different phenomenon to that which occurs in non-microscopic vision. Again, in ordinary

* [*Addendum.*—I wish it to be distinctly understood, that in this discussion I refer exclusively to microscopic images formed *dioptrically* by objectives of low power and small angular aperture, and not to those formed (as Prof. Abbe has shown) by the combination of *diffraction-spectra*.—W. B. C.]

† *Ante*, p. 20. See also i. (1881) pp. 422-3.

vision, a lined object will appear to have its lines closer and closer together according as it is seen more and more obliquely. In the Microscope, however, we have the same number of lines to the inch whether the object is seen by an axial or an oblique pencil.

This essential difference between naked-eye and microscopic vision by oblique pencils (which Prof. Abbe had been the first to point out) was most important to be kept in mind, as the opposite assumption had led to some of the greatest of the mare's-nests of microscopy ("All-round Vision," &c.).

The admission of this difference, however, did not invalidate any of the practical illustrations which Dr. Carpenter had given. The experiments of Mr. Claudet and Mr. Wenham, for instance, were performed with objectives of low aperture. Now the difference between the two modes of oblique vision varies as the cosine of the angle of obliquity, so that up to the limit of angle for objectives suitable for binocular work, say 40°, the difference does not exceed 1 per cent.—an amount quite inappreciable by the eye.

Dr. Carpenter said he was not sorry to find that Prof. Abbe and himself were not so much in difference as he had thought to be the case. With large apertures, however, the whole conditions of vision were so entirely different that they could scarcely be compared; while, as regarded images of lines, they were so mixed up with diffraction effects that the question was necessarily in a very unsettled condition. If, however, Prof. Abbe was in agreement with him as to apertures under 40°, then clearly there was no question between them.

The President, in proposing a vote of thanks to Dr. Carpenter, said that he was sure he was in accord with the unanimous feeling of all present, in expressing the gratification which Dr. Carpenter's presence that evening had afforded them.

Mr. E. M. Nelson's observations on the *Bacilli* of tubercle were referred to by Mr. Michael, who said that Mr. Nelson had found that when examined with dark-ground illumination they take the light in an unexpected and peculiar manner, appearing like grains of gold-dust on black velvet. The best effect was obtained by Swift's 140° condenser, with stop, illuminated by a lamp having a large-angled bull's-eye accurately centered and focused, and the plane mirror. Excellent images are obtained by this method with a 2/3 in. and 1/2 in. eye-piece or a 4/10 and a 1 in. eye-piece. Mr. Nelson thinks three advantages accrue from this kind of illumination:—1st. The low power by which the organisms may be studied. 2nd. The great ease with which they may be detected in tissue; and 3rd. Saving to the eyes.

Mr. Badcock described some observations he had recently made on some specimens of *Surirella bifrons*, which showed small processes similar to those found in the Arcellinæ, and by means of which the diatoms seemed to be moved to and fro (see p. 352).

Mr. Guimaraens described a slide showing a true *Xanthidium* in Halifax coal strata, discovered by Mr. James Spencer, of Halifax, who also prepared the slide.

Mr. Bolton's note was read on the finding in Epping Forest of the Rhizopod *Clathrulina elegans*, which forms a transition from the fresh-water Heliozoa to the marine Polycystina. This was, Mr. Bolton believed, the first discovery of it in England.

Mr. Crisp asked that any Fellows finding *Megalotrocha albo-flavicans*, or *Lacinularia socialis*, would send living specimens to Dr. C. T. Hudson, who was much in want of them for his forthcoming work on the Rotatoria.

The President announced that the following resolution had that evening been passed by the Council, and gave notice that a special meeting of the Society would be held on the 14th May next, for the purpose of taking it into consideration, and passing such resolutions as might be considered desirable, whether by alteration of the by-laws or otherwise:—

"That it is expedient that ladies should be admitted as members of the Society, either as Fellows or Associates, or under such other title as the Society shall determine, provided that they shall not attend the ordinary meetings."

The President also announced that in consequence of the change of librarian, the second Conversazione would be omitted for this session.

The following Instruments, Objects, &c., were exhibited:—

Mr. Badcock:—Slide in illustration of his paper.
Mr. Bolton:—*Clathrulina elegans.*
Dr. Carpenter:—Photographs in illustration of his paper.
Mr. Crisp:—Paraboloid for rotating illumination in azimuth.
Mr. Guimaraens:—*Xanthidium* in Halifax coal strata.

New Fellows.— The following were elected *Ordinary* Fellows:—Messrs. Charles Botterill, Aristides Fournet, Rev. T. M. Gorman, Henry Gradbe, M.D., G. Massee, Benjamin Owen Meek, Gerald Sturt, and John Michael Williams.

SPECIAL AND ORDINARY MEETINGS OF 14th MAY, 1884, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (REV. W. H. DALLINGER, F.R.S.) IN THE CHAIR.

The President, in opening the special meeting (called for the purpose of considering the proposed admission of ladies as Fellows of the Society), requested Mr. A. D. Michael to move a resolution.

Mr. Michael said he found himself unexpectedly charged with the resolution under circumstances which he would explain. He thought he should not be making any unnecessary disclosure by saying that the Council were led to the consideration of the matter by an application which was received from a Fellow of the Society (Sir Henry W. Peek, Bart., M.P.), inquiring if it was in order for him to nominate a lady as a Fellow of the Society. Being thus appealed to, the Council considered the matter, and on its being found that under their present by-laws it was not possible to do what was asked, some of the Council were of opinion that it would be desirable to admit ladies, pure and simple. He, for one, however, was not able to see his way clear to agree with so large a proposition, and his share in the matter was connected with the proviso at the end of the resolution which was approved by the majority of the Council. As it thus originated with him, he became charged with the duty of submitting it to the meeting. The feeling of the Council, as expressed by the resolution, was that there could be no objection to ladies being admitted as Fellows, provided that they did not attend the ordinary meetings. For his own part, he could not but see grave objections to the admission of ladies at the ordinary meetings, because in the course of their proceedings subjects were often introduced which English gentlemen could not freely discuss in the presence of ladies. At least, this had been found to be the effect at other societies where ladies had been admitted without limitation. For this reason he was opposed to the proposal as originally made; but if there was a feeling that ladies should be admitted to the other privileges of the Society—the library, the instruments, Journal, &c., he did not see any objection to it. He thought that probably the majority of the very few ladies who might be called practical workers with the Microscope would desire to share in those privileges only, and that those who could give the Society the most assistance would not, under any circumstances, attend the meetings. He also wished it to be understood that in moving the resolution there was no desire on the part of the Council to force the matter upon the Fellows. All that was intended was to submit the question to them for their consideration and to invite discussion upon it. With this view he moved —"That ladies shall be eligible as Fellows of the Society, and shall be subject to all the obligations and entitled to all the privileges of Fellows, except that they shall not be entitled to attend the ordinary meetings of the Society."

Dr. Anthony seconded the motion.

Mr. Crisp called attention to the fact that a special notice of this meeting had been posted to all Fellows in the United Kingdom.

Dr. Coffin moved as an amendment that the last fifteen words of the resolution (from and including the word "except") be omitted, so that ladies should be admitted to all the privileges of Fellows, including attendance at the ordinary meetings.

No one rising to second the amendment, the President put the original resolution to the meeting, and declared it to be carried.

The special meeting then terminated.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting, was submitted, and the thanks of the Society given to the donors.

	From
Catalogue des Collections du Musée de l'Industrie. 241 pp. 8vo, Bruxelles, 1846	*Le Bibliothécaire.*
Musée R. de l'Industrie—Bibliothèque Technologique—Catalogue. 275 pp. 8vo, Bruxelles, 1878	*Ditto.*
45 Slides illustrating vol. i. of the 'Monograph of British Oribatidæ	*Mr. A. D. Michael.*
Slide of *Halecium halecinum*	*Mr. H. C. Chadwick.*
Slide of Objects found in Flue-dust and Coal-ash	*Miss Dancer.*
Slides of Sand obtained by washing clay from the boulder drift of Minnesota	*Mr. B. W. Thomas.*
Fish-trough	*Mr. A. W. Stokes.*

The following letter from Mr. Michael referring to his donation was read:—

"I send the type series of British Oribatidæ which I proposed giving to the Society. It corresponds exactly with vol. i. of my work on the British Oribatidæ, just published by the Ray Society.

The series includes all the species mentioned in the book, except two, of which I have not any duplicates. It also includes many of the immature stages.

I have marked the slides with a running number so that if they get out of order they can at once be restored to the arrangement of the book. I have also put a separate list of the slides with them.

Blanks are left for the two species of which I do not possess duplicates. Should I obtain any at any time I will fill up these blanks; I shall also hope to deposit a similar series illustrating the second volume, whenever that shall be published.

I have announced in the preface of the book that the types have been deposited with the Royal Microscopical Society.

Finally, I venture to hope that others may follow my example, and that it may assist in ultimately placing the Society in possession of such a collection of typical and interesting slides as it ought to have."

Dr. C. H. Golding-Bird exhibited and described his new freezing microtome, which was intended to be put into the hands of students and intermittent workers. It was graduated to cut sections of less than the 1/1000 in. in thickness, whilst in one form it was adapted for the use of ice and salt, and in another for use with ether spray.

Mr. Groves, in reply to the President, said that he had had the

pleasure of seeing and examining the microtome, and it seemed to him to be a most perfect and useful little instrument.

The President considered one of its advantages to be that it maintained the temperature at the same point for a much longer period than most others.

Dr. P. Herbert Carpenter gave an account of his views respecting the nervous system of the Crinoidea, which he illustrated by diagrams drawn upon the board, and by numerous preparations exhibited under Microscopes. He directed attention more particularly to the branches from the axial cords of the skeleton, which extended upwards into the ventral perisome at the sides of the ambulacra both of the arms and of the disk. The material was chiefly derived from the collection of the 'Challenger' expedition, and the results when complete will be embodied in the volume in course of preparation.

Dr. Carpenter, C.B., said he was very glad that his son had brought this subject forward, because it formed an extremely good illustration of the value of microscopical investigation where important questions had to be determined. In this instance a great deal hung upon the point whether these cords were nerves or not; for if they were, then it was clear that the whole of their present system of classification of Echinodermata must undergo revision, because all morphologists had been trying to show the analogy of this group to the star-fishes, of which they were considered to be only a family. He had, however, always held, from a careful study of them during the last thirty years, that the general structure of the crinoids was formed upon a plan very different from that of the star-fishes. Of the various arguments which his son had brought forward to prove the truth of that idea, the anatomical argument was the most important, as being a confirmation of what he had himself previously advanced; for it must be remembered that at the time to which he had referred, many things could not be demonstrated because they had not then known how to cut thin sections. Very early in his investigations he had found that a cord which had been discovered by Müller, and considered by him to be a nerve, was a genital rachis, which would develope afterwards according to the sex of the specimen. But by the adoption of thin section-cutting a flattened band was discovered beneath the ambulacral groove, which all the German observers, and Professor Huxley also, at once concluded to be the nerve, because a nerve ought to be there. In the star-fishes it certainly was so; but it was certainly not the only nerve in crinoids. He was early led to regard as a nerve a cord running continuously through the calcareous segments of the arm, and originating in a central organ in the base of the calyx. This organ, which is an expansion of the summit of the original crinoid stem, is divided into five chambers, from the outer walls of which proceed five radial branches; and these branches inosculate with each other laterally so as to form a circular commissure from which branches are given off to the arms, thus establishing a nervous connection amongst them all, of which no one could doubt the existence who has ever seen these feather-stars in the act of swimming, or simul-

taneously coiling up their arms on irritation of the oral pinnules which arch over the mouth. He had experimented upon the matter in various ways. Having turned out the visceral sac, he passed a needle down and irritated this central organ, and immediately all the arms coiled up together. Again, he turned out the visceral mass entirely, thus getting rid of the centre of the *ventral* nerve-system, and put the animal—which then consisted of a mere skeleton—into the water; it swam just as well as before, with the same beautifully co-ordinated movements of its ten arms. He then tried the experiment of dividing this ventral nerve, but found that it did not paralyse any of the parts beyond. But when he removed the centro-dorsal cup containing the central organ of what he regarded as the *dorsal* nervous system, the whole of the arms were tetanized, from the contraction of the ligaments without any muscular antagonism. He then endeavoured to cut through this nerve without separating the arm; but was unable to do this successfully, as the animal threw off the arm at once. He therefore contrived to burn it away with nitric acid, and then found that the arm was paralysed.

These experiments, and the anatomical descriptions which his son had given, so entirely agreed that he thought there was no getting over the proof that the muscular apparatus of the arms of crinoids is put in action, not by a *ventral* nerve-system homologous with that of other Echinoderms, but by a *dorsal* nerve-system peculiar to themselves. He thought they were perfectly conclusive; and referring to the well-known story of George Stephenson and the cow, thought that if the homologists still persisted in going against the facts, so much the worse for the homologists. What, therefore they had to do was to ascertain exactly what was the true morphology of the crinoid; and it seemed to him that its most beautiful skeleton was more like that of the Vertebrata, because it was modelled upon a nervous system. The joints of the crinoidal stem, and all the segments of the rays which issue from its summit are penetrated by a canal for the nerve-cord; but this canal is not found in the dermal or accessory plates which constitute a large part of the skeleton of many fossil crinoids. The existence of this canal became, therefore, of great importance; if it was a canal for the passage of a nerve, then it became a fundamental feature in the organization of a crinoid. The crinoids were exceptional also for the wonderful activity of their movements; no star-fish certainly had anything like the activity or co-ordinated movements of a crinoid. He thought, then, that they ought to say that the skeleton which incloses the nervous system is the fundamental basis of the crinoid; and that there was but a very imperfect analogy between it and that of the star-fishes. The question afforded, to his mind, a very important lesson as to not allowing theory to go against fact; and also that microscopical examination was of the greatest value in the determination of questions of this kind.

Dr. Matthews inquired what reagents were employed by Dr. P. H. Carpenter in the preparation of his specimens.

Dr. P. H. Carpenter said he had used hæmatoxylin sometimes, also osmic acid, or picro-carmine or borax-carmine.

Herr H. Boecker's collection of slides of Bacteria, Bacilli, &c, exhibited in the room, were referred to by Mr. Crisp as one of the best yet seen in this country.

Mr. Crisp exhibited a curious Microscope, with a sliding nose-piece for three objectives, marked "Joseph Brum, Opticus in Instituto Bononie, F.A., 1772," but identical (except the nose-piece) with plate II. in the 4th edition of G. Adams, sen.'s treatise on the Microscope (1771). The nose-piece was an anticipation of the plan adopted in more modern times in the Harley Microscope and others. He also exhibited the two Microscopes by Reichert and the apparatus mentioned in the list of exhibits.

Mr. Griffith's multiple eye-piece was exhibited by Mr. Crisp, and discussed by Dr. Matthews, Mr. Powell, and others.

Mr. Crisp mentioned that notice had been received that the American Society of Microscopists would hold their annual meeting at Rochester, N.Y., on the 19th of August next, and as their President, one of the Vice-Presidents (Mr. Glaisher), and a member of the Council (Mr. A. W. Bennett), were going to Canada, the Council had resolved, subject to the confirmation of the Fellows, to ask them to attend the meeting as a deputation from this Society.

The proposal having been put to the meeting, was approved unanimously.

The following Letter and Report were read and ordered to be entered on the minutes:—

"New York, March 31st, 1884.

Dear Sir,—At a regular meeting of the New York Microscopical Society, held on the evening of the 21st instant, at No. 64, Madison-avenue, the report of the Committee appointed to present in a formal manner the sentiments of the Society in view of the death of Mr. Robert B. Tolles was read and accepted. On motion it was ordered that a copy of said report be sent to the 'American Monthly Microscopical Journal' and the 'Royal Microscopical Journal.' I have the honour herewith to enclose a copy as stated.

I am, &c.,

Edward G. Day,

Mr. Frank Crisp, Sec. Royal Microscopical Society. *Cor. Sec.*"

"Your Committee, appointed at the meeting held December 21st, to present in a formal manner the sentiments of the Society, in view of the death of Mr. Robert B. Tolles, find in the remark made by Mr. William Wales at that meeting a fitting and satisfactory expression of said sentiments. Mr. Wales said in substance:—

'The death of Mr Tolles has been to me a source of deep regret. For modesty, for uprightness, for earnestness of purpose, he was one of the most estimable of men. A larger capacity than his, a firmer

and finer skill, a more artistic feeling, a sterner conscientiousness, has seldom, if ever, been devoted to the work of making the Microscope a thoroughly efficient and trustworthy aid in scientific research. The fortunate owner of one of his fine lenses possesses one of the most exquisite pieces of mechanism ever produced by the mind and hand of man. Mr. Tolles loved his beautiful art. He loved it better than riches; for he died a poor man. He loved it better than life; for its pursuit, necessitating the constant inhalation of glass dust, shortened his days. The labours of such a man entitle him to the lasting esteem and gratitude of all lovers of the Microscope, as well as of that field of investigation to which this instrument is the indispensable portal.'"

Mr. B. W. Thomas's slides of sand obtained by washing clay from the boulder-drift of Meeker county, Minn., U.S.A., were explained by Mr. Crisp. In similar specimens, Professor Leidy had recognized some well-preserved and characteristic Foraminifera, of which two forms appeared identical with *Textularia globulosa* and *Rotalia globulosa*, now living in the Atlantic Ocean. The fossils Mr. Thomas supposes to be derived from a soft yellow rock, cretaceous shale and lignite forming part of the drift. He also reports the finding of fragments of marine diatoms in the clay.

The following Instruments, Objects, &c., were exhibited:—

Dr. C. H. Golding-Bird:—Microtome.

Mr. H. Boecker:—Slides of Bacteria, Bacilli, &c.

Mr. Chadwick:—*Halecium halecinum*, mounted as described *ante*, p. 151.

Mr. Cheshire:—Curious form of *Spirillum*.

Mr. Crisp:—

(1) Old Microscope.
(2) Reichert's Microscope, with modified Abbe Condenser.
(3) Reichert's Polarization Microscope.
(4) Griffith's Multiple Eye-piece.
(5) Glass Frog-plate.
(6) Getschmann's Slides of arranged Diatoms, &c.
(7) Bradley's "Mailing Boxes."

Miss Dancer:—Objects found in flue-dust and coal-ash.

Mr. Guimaraens:—The slide of *Xanthidium* exhibited at the last meeting.

Mr. A. W. Stokes:—Fish-trough.

Mr. B. W. Thomas:—The slides mentioned *supra*.

Dr. G. C. Wallich:—A Rotalian from closed flint nodular cavity metamorphosed into chalcedony.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Henry W. Fuller, H. A. Johnson, M.D., James C. Stodder, H. Thomas, M.D., and G. F. Turton.

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AUGUST 1884.

TRANSACTIONS OF THE SOCIETY.

XI.—*Researches on the Structure of the Cell-walls of Diatoms.**

By Dr. J. H. L. Flögel.

(*Read 12th December*, 1883.)

Plates VIII. and IX.

The various objections made to my previous researches have induced me to undertake a re-investigation, and although this has for the most part been simply corroborative, it has appeared to me desirable to publish the results, together with some obtained in reference to other diatoms of which only preliminary communications (7) have hitherto been published.

Day by day the old erroneous views on the structure of diatoms are repeated in the text-books of Botany, and nobody seems to have approached the subject seriously; the present paper may therefore, I hope, arouse sufficient interest to induce further investigation.

I. Method of Investigation.

I have already (6) described the methods which I have followed in the investigation of *Pleurosigma*; but it is necessary to refer here to the method of section-cutting. In applying my greater experience to *Pleurosigma* and other diatoms I have obtained generally much better results than formerly, which have lent additional confirmation to my paper of 1870.

Time of making Sections.—Accidentally I made my original investigations during the summer. When in the winter I wanted to replace some preparations, I found it impossible to obtain successful results. The cause was the artificially heated room. It is useless to attempt to bring the gum to the right degree of hardness by the addition of glycerin, sugar, &c., as, in consequence of the

* The original paper is written in German, and has been translated by Mr. J. Mayall, jun.

proximity of the face and the hands, the aqueous contents of such strongly hygroscopic substances are subject to an uncontrollable change, so that we must work with pure gum arabic and in the summer.

Slight differences are caused by the weather or by the position of the sun. Sections of the coarser diatoms which are not required to be of extreme thinness are best made with a clouded sky or in rainy weather. Sections of *Pleurosigma* succeed best when the sun shines directly into the laboratory without striking upon the Microscope. I can hardly too strongly dwell upon the necessity of entering upon such experimental investigations under the best physical conditions, absence of vibration, noise, &c.

Placing the Frustule.—By my earlier method sections in different directions were obtained hap-hazard because the frustules were lying pell-mell in the gum. I have now improved the method as follows:—I take a number of frustules like a bundle of rods and cut sections in the exact transverse or longitudinal direction. With this important but difficult method every one must become familiar if he intends to check the results (hereafter described) which I obtained with *Pinnularia*.

(1) If we wish to examine uninjured specimens, the diatoms are first stained, usually by picro-carmine; they are then put in absolute alcohol. A glass slip is coated with collodion, and allowed to set. To avoid peeling when dry, the collodion must not be too thick. A drop of thick gum is then put on. A cluster of diatoms is taken direct from the alcohol with forceps and placed in the gum. In consequence of the current set up, the diatoms immediately distribute themselves equally through the gum. As soon as the edge of the gum begins to harden, one frustule after the other is drawn to the edge by a very fine needle, where, with proper manipulation, they can be piled up like a bundle of rods. All those which interfere with this piling up should be removed. Owing to the staining, the frustules can be readily seen on the transparent ground. As soon as the edge dries, a drop of fluid gum is added by a needle, and this process is repeated until the solid layer of gum has reached such a thickness that a displacement of the frustules need be no longer feared; a small patch of collodion is then put on. The preparation is now cut out by four cross-cuts and carefully removed from the glass; the bundle of diatoms in gum being contained between two films of collodion. It is advisable to make a drawing with a high power to show the position of the individual frustules and aid in the identification of the sections. The preparation is then put upon a nearly dry flat drop of gum on a piece of cardboard, and the base and the edges are made to adhere, if necessary, by a few drops of water, and by the addition of minute drops of gum it is so imbedded that at last it is entirely surrounded. This must be carried

out so cautiously that the collodion films do not separate; very careful watching of the imbedding process is therefore necessary, especially also to avoid cracks which commence at the edge and might easily extend to the object. From this bundle, sections may be made according to the method described by me in 1870.

(2) Any one wishing to study the structure of the individual valves and mark their manner of combination can shorten this somewhat detailed process. A cluster of diatom valves is taken out of the alcohol and placed in a large drop of water on a slide; and the water is allowed to evaporate after the valves have been evenly distributed. A drop of gum already dry—if possible with a flat surface on a piece of cardboard—should be in readiness; another piece of glass is coated with oil of turpentine, which is allowed to run off so that a very thin film is left, which does not readily dry. In this the point of a fine needle is dipped vertically, taking up sufficient oil so that by touching a frustule lying on another slide it will adhere. Thus the frustule can be put on the hardened drop of gum which has been moistened by the breath; this is repeated with a number of valves *ad libitum*, and finally they are covered with minute drops of gum till the required thickness is attained. This transference of dry frustules upon the dry gum is much easier than the process with fluid gum described under (1), because, with the latter, it frequently occurs that in bringing a new frustule into place the others are disturbed. With uninjured frustules process (2) is not available, because these, after the drying of the thin upper layer of gum moistened with the breath, will at once become charged with air and baffle any cutting. This absorption of air can only be avoided by transferring the frustules from the alcohol directly into the fluid gum, which then diffuses equally through them. At the most the frustule at the moment of hardening is slightly compressed, which injures somewhat the appearance of the sections.

Making Sections.—Numerous attempts to cut diatoms on the microtome failed, and I always returned to cutting by hand, under a dissecting Microscope. Gum is not favourable as the imbedding medium for the microtome. If a better medium were discovered (paraffin is useless), then a new era would open for these researches. Knives with broad backs should be employed; the angles of inclination to the cutting edge I have used are 21° 20′.

Piling-up of the Sections.—Pfitzer (19, p. 42) formerly proposed to moisten by the breath the gum-chips containing the diatom sections after they had been put upon the slide, whereby they naturally adhered. Anything more unpractical cannot be imagined; the very thing one wishes to avoid—namely, the disturbance of the sections—is by his method certain to occur, and in the most favourable case we have a hardened drop of gum in

which are scattered all sorts of fragments of the diatom sections, which the observer may be able to define with reference to their previous position, but which are utterly useless for the study of real details of structure. The unavoidable proximity of finger and face during the cutting is injurious, because the immediate surrounding atmosphere of the operator always contains a quantity of moisture which causes the delicate chips of gum immediately to adhere. In piling-up the sections we should most carefully avoid every increase of moisture, and during the operation the breathing should be suppressed. If after discharging the sections from the knife we do not intend to put on the cover-glass at once, then the slide with the chips should only be lifted up when in sunlight and under protection from dust. As a rule, time should not here be lost. It is advisable before putting on the cover-glass to touch two corners, which first come in contact with the slide, with small drops of balsam, so that during the lowering of the cover-glass it does not slip out of place and so grind up the very brittle chips of gum. The lowering of the cover-glass should be done slowly and steadily. If let fall, the puff of air will blow away the chips. If the chips, on account of too little moisture in the atmosphere, are curled up, the cover-glass will flatten them out, the gum on the edges may split, but the centre becomes flat and is often very useful. In general, however, it is recommended, on the days when these difficulties occur, to postpone the operation. Once for all, I state that flat sections are always the most instructive. After putting on the cover-glass a proportionately small drop of thin fluid-balsam is added on the edge—only so much that the sections are imbedded in it. After a few days the vacant spaces are filled up by fresh drops of balsam; a derangement of the previously filled-up sections is no longer to be feared.

Series Preparations.—With *Pinnularia* the making of series sections is almost a necessity, especially for the longitudinal sections. My procedure is as follows, though I am well aware it is capable of improvement. I cut off No. 1, leaving it on the edge of the razor; then I take a second section a little further off, and so on, until five are on the edge. These I transfer to the slide with a needle, and as nearly as possible in a straight line. This is repeated with the other five sections which form the second line. Then I take a new slide, and thus get decades of sections from a bundle previously prepared. A disadvantage is that sometimes the sections do not remain on the edge; by falling upon the table they are lost. Also that not seldom one cuts a gum-chip as a numbered section, which on further examination proves never to have touched the bundle of frustules. By disregarding these very troublesome mishaps, the series-section method according to my view gives the most beautiful results obtainable with such

delicate objects. As an example, I may mention a bundle of *P. balticum* in my possession in 150 sections, of which 100 were successful; of these about 70 could be identified as being from one frustule.

Preservation of Preparations.—This subject is unfortunately for me at the present moment one of the most troublesome. One would anticipate that by taking quite dry gum imbedded in balsam slowly hardened, the preparation would be almost indestructible. I regret to say this is not always the case. My preparations of 1869 remained stable six to seven years. But afterwards a fatal change took place with many. The sharp straight edges of the gum-chips lost their sharpness, the edges rounded off, and lastly a kind of oil-drop took their place, in which the former beautiful sections almost disappeared. Whether my present house is too damp, or whether moisture works through the balsam along the glass up to the sections, I do not know; but I suspect something of the kind. The serials I made last June and July have kept *in partibus* well up to the present, but a portion commenced in October to change, although as a protection I had covered the edges with asphalt and kept them in a room which was warmed every day. The real cause of the destruction of these preparations is still a mystery, and I would recommend that sections should be studied immediately after being made.

II. Results of the Investigations.

My first paper was confined to the varieties of *Pleurosigma*, and I now give an account of all the other diatoms the structural details of which I have investigated. I may at once say that a general sketch of diatom sculpture cannot be given. We cannot take the structure discovered by me in *Pleurosigma* (consisting of chamber-like holes in the interior of the cell-membrane) and thus explain the structure of all diatoms, nor can we conclude from Möller's proved structure of *Triceratium* (viz. chambers open externally) that this is the same, *mutatis mutandis*, with all others of this numerous order.

1. *Pinnularia.*

Probably the cellular envelope of a great number of diatoms follows the type of *Pinnularia*, which may therefore be put first, all the more so since the views regarding their structure (chiefly based on Pfitzer) adopted in most text-books, are totally erroneous. Moreover, the structure of their cell-walls is very remarkable. For my material (*Pinnularia major*) I have again to thank Herr J. D. Möller. It consisted principally of isolated valves which were

treated by different methods, viz. (1) by the section method, (2) the cast method, (3) the staining method.

§ 1. I commence with the section method, remarking that most of my sections were made as described under (2). It is requisite that investigators should keep strictly to this method, otherwise they will not see the details of structure here described, or they will obtain from oblique sections images very difficult to interpret. We require very thin (e. g. 1/1000 mm.),* exactly transverse and longitudinal sections, whilst with *Pleurosigma* it does not matter if the direction of the cut deviates more or less from a right angle to the midrib. The transverse section of a valve of *Pinnularia*, if it has not touched the central nodule, has either the form of fig. 1 or fig. 2, plate VIII., except that in close proximity to the two ends the general form, by the disappearance of the rounded-off right angle, becomes semi-circular or semi-elliptical. In order to elucidate the change in the appearance of the inner structure we must remember that the surface image of *Pinnularia* exhibits coarse transverse striæ, ending near the midrib, and which are regarded by Pfitzer and others as superficial furrows, and they have therefore been designated by various improper terms, such as furrows, surface sculpture, &c. In reality the outer surface, independently of the midrib, has neither elevations nor depressions, but is quite plane. If the section passes through the middle of a so-called furrow, it appears as in fig. 1; if it passes through the interspace, then it appears as in fig. 2. The separate parts of the image are, as will be shown later on, to be explained as follows :—Each so-called furrow is an inner chamber of the membrane, and, in proportion to the chambers of *Pleurosigma*, of enormous size, since it extends from the edge of the frustule to very near the midrib. It is also of almost equal thickness throughout. But what is most remarkable is the fact that each chamber has a rather broad opening on the inner side of the cell-wall, by which it can be readily examined. The outlines of the opening are easily observed in the surface view, and have been often represented in the better class of illustrations (*vide* Pfitzer, 19, pl. 1, fig. 2). The draughtsmen, however, do not seem to have had a clear conception of the signification of these lines. *Pinnularia* is represented as a definite proof that the cell-envelope is broken through in the midrib, thereby allowing free exit to the protoplasm. All former reliable researches having apparently proved the non-existence of openings, and the endosmotic process having been generally accepted as the cause of movement (*vide* Naegeli, Von Siebold, W. Smith, Rabenhorst), Prof. Max Schultze (24) in 1865 put forward the opposite view and considered it proved that at the raphe of the

* Sections as made by Pfitzer (19, p. 43) which are twice or thrice the thickness of a furrow, cannot, as a matter of course, be used for a delicate observation. At the best one recognizes only the general outline.

diatoms there was a glutinous organic substance which could only be protoplasm. In 1870, Prof. Dippel's work (3) appeared refuting Schultze's view, and drawing attention to the fact that the midrib is not a cleft but rather a thickened line, having on the sides narrow longitudinal striæ without perforations.* Then came Pfitzer's work (19), who discovered the long-searched-for cleft and represented it so well that its existence is no longer doubted. He declares the detection of this cleft to be a task to be solved only with the highest powers, and draws a figure of a very narrow V-shaped opening through the thick envelope. Under existing circumstances it was of great interest to test Pfitzer's statements. The conclusion I came to was to agree entirely, without reserve, with Dippel, and I must therefore deny the perforation of the cell-wall. This result cannot, however, be easily obtained. The number of more or less good transverse sections of *Pinnularia* I have is about 600; in most of them I actually observed in the midrib a fine transverse cleft. Its direction and its fineness are shown in figs. 1–3. They can be well seen with 300–400 where the section is good. With regard to direction I rarely see the cleft so V-shaped as drawn by Pfitzer; on the contrary, in most instances it commences on the outer surface at right angles to it. Then arise a great variety of changes in the appearance. We meet with sections in which it goes straight to the inner surface; others where the vertical portion has a small hook turned inwards; again, others where the portion facing the inner surface is obtuse to the vertical,—this case (not at all uncommon) is represented in fig. 3. Such a change may be explained by a real difference in the object, which Schumann also quite correctly found with the surface view (23, p. 73). A careful comparison of a great number of transverse sections, made according to method 2, will show in most cases the cleft going up to the inner side of the membrane. The question remains very doubtful whether the base is closed by a very thin envelope. After having made collodion casts, the image of the outer surface could be easily interpreted; the fine cleft became filled with collodion, and in hardening a distinct midrib remains, almost exactly the same image as we see in the surface view. But the inner surface remained quite obscure. If a perforation of the membrane really exists, a similar midrib should be seen; but this is not the case. I have made a considerable number of such impressions, and not the slightest trace of a midrib could be seen, even with oblique light.

These impressions fully convinced me that the fine cleft was closed at the base. That the transverse sections mostly show a fully developed perforation may be attributed to the following

* This is what I proved simultaneously with *Pleurosigma* (striæ without spores).

cause :—In transferring a frustule to the gum it may, of course, be done according to method 2 without injury, but not always. In further experimenting the mass, in hardening, may suffer unequal pressure on the valves, causing them to break, as also stated by Pfitzer (19, p. 50), and this is very likely to occur in the midrib. In this case they were injured before cutting. It is, however, more probable that injury occurs during the cutting. The entire thickness of the silicified membrane adjoining the midrib is about 8-10 times as large as that of the fine envelope. As soon as the knife presses against this solid mass, the cap easily breaks off, which appearance is also observed with thicker masses at the central nodule crumbling out. In order to clear up this point I have made another series of sections according to method 1, in which injuries are more avoided. The best thereof show unmistakably at the base of the furrow this fine capping envelope exactly as represented in figs. 1–3. If the transverse section goes through the central nodule, the image then becomes as in fig. 4. Hence the nodule is also here a strong thickening of the midrib inwards ; outwards it has no distinction beyond that the middle line is broken and does not appear in the transverse section of the cleft. The membrane is flat. Here it should be noted that Schumann (23, p. 74) observed two focal images of this nodule in *Pinnularia lata*. I have seen them oftener in *Pinnularia major*. But they do not arise through a channel, as supposed by Schumann, but are produced by a depression in the centre of the nodule. This may often be seen without difficulty in a side view of the entire frustule. Similarly, the end nodules are inward projections.

I will now proceed to the description of the longitudinal sections. Their appearance must of necessity differ, depending upon whether the section goes through the openings of the chambers, or near the midrib, or near the edge of the frustule. Fig. 5 represents a section through the chamber-openings showing the siliceous membrane with numerous long pegs projecting inwards in the frustule ; these are the vertical partition-walls of the chambers.

In fig. 6 we have a median longitudinal section ; the chamber-spaces appear like beautiful squares slightly rounded off in the wall-substance. The longitudinal section taken from the chamber-opening towards the edge shows hardly any difference from that last described. A vertical section along the midrib and through the central nodule has hardly any importance. If a longitudinal section goes a little obliquely towards the midrib, it shows in places the image in fig. 5, and in other places that of fig. 6. In all cases the outer limit of the cell-wall is perfectly straight throughout ; nothing in the outline suggests furrows on the surface. From this representation it may well be supposed that transverse as well as longitudinal sections of *Pinnularia* are vexatious prepa-

rations in the hands of the tyro. In one and the same section he observes the most beautiful closed chambers and is fully convinced that my description of the *Pleurosigma* chambers is accurate. A few micro-millimetres further on he notices the magnificent projections of the wall, not inferior to those of the epidermis or the vessels of higher plants, and with this he proves that I have erred in all points. If he follows Pfitzer's advice with regard to breathing on the sections and thence obtains a mass of fragments, he will know neither what is outside nor what is inside the valve. For instance, if he turns round fig. 5 he will then see, according to his taste and intelligence, Pfitzer's furrows on the outer surface, and then he confirms all Pfitzer's fairy-tale. Therefore I admonish every one to use the utmost precaution in interpreting the images!

§ 2. *Collodion Casts.*—For the technical process I refer to my former essay (6, pp. 489–90). These casts are of much greater importance with *Pinnularia* than with *Pleurosigma*; I can therefore seriously recommend sceptics to try my experiments. The method is so easy in practice that even inexperienced manipulators, unable to do the cutting, will in this way obtain a general view of the details. It has been already observed that the chambers can be injected from the opening, so that in pouring fluid collodion on the inner side of the valves, it enters the opening and fills the chambers. With the evaporation of the ether the mass contracts, and after the collodion has hardened one sees the contents of the long cylindrical chamber shrivelled-up to a thread. The image takes the shape of the letter T. The vertical line is the collodion filling up the chamber-opening; the horizontal is the collodion which fills the space of the chamber. If, therefore, the *Pinnularia* valve is taken away from the cast, these small T's stand in military order in lines parallel to the midrib on the film. This T is mostly so elastic that without breaking it can be pulled out of the chamber.

Fig. 7 is intended to bring clearly before the mind in a diagrammatic form what I have described above for a small portion of the cast; it is impossible to draw it exactly, because the interpretation chiefly depends on the alteration of the focus. With the lowering of the tube the horizontal T threads appear before the surface of the envelope is seen, and they disappear when the latter becomes visible. It is, of course, desirable always to examine for oneself such a cast. The central nodule leaves behind a pretty bold depression of elliptic shape. Sometimes are seen two small flat cavities adjoining each other, which also indicate the depression in the centre of the nodule (as above stated). Except the broken line in the middle, the collodion cast of the outer surface of a valve shows only a perfectly plane surface; but this line increases in distinctness near the central nodule and ends with a thickened point. This fact

implies that the cleft furrow is very deep, a fact which is also confirmed by the transverse sections. This is simply the consequence of the gradual increase in thickness of the entire membrane, whilst the closing envelope is probably of even thickness. Closer observation will show that the surface is not everywhere alike; the area along the midrib, i. e. the portion free from chambers, appears quite plane; the other, on the contrary, a little granulated, and occasionally one can even see a kind of glitter of chambers. In this case the cast teaches more than the longitudinal section, since it seems to display an unusually fine surface-difference which is not brought to the eye by the longitudinal section. Similar experiments were made with *Pleurosigma*. As a matter of course, this condition of surface has nothing to do with transverse striæ of *Pinnularia*. I am still in doubt whether this image is not called forth by the different evaporation processes above the chambers, therefore perhaps it may not correspond to any real difference between the valve surfaces. It is true that where air-bubbles are in the collodion the surface after hardening looks different from what it does when free of bubbles.

Thus a complete and exhaustive explanation is given of all appearances of the surface image of a *Pinnularia*. In the imbedding of the valves in balsam, chamber and opening are filled with the strongly refractive substance and thus produce the coarse transverse striæ. Each stria is a chamber.

§ 3. *Staining Processes.*—I cannot call these experiments more than tentative; they were intended, after I had recognized this most interesting condition of the chambers, to provide preparations in which the chamber-spaces alone should be filled with colour. The wall-substance, as is well known, does not take the staining. The experiments were made with solution of silver, picro-carmine, and Prussian blue; with the latter substance only I obtained preparations which were partially serviceable. The valves were put in aqueous solution of Prussian blue, poured off after some time, immersed in alcohol and constantly shaken to remove the blue which had deposited in and upon the valves. They were then put into balsam. In successful instances, not occurring frequently, the chamber is seen blue in the colourless wall. I have not persevered with these experiments.

§ 4. Passing on now to the literature on *Pinnularia* sculpture, Schumann as far back as 1867 was approximately correct in his views. In his work (23, p. 73) he says that "in a fragment in partially reversed position the channels were most raised at the middle; each channel seems to consist of two vertical walls, the vault across being open towards the middle line." On pl. IV., fig. 54, B, he exhibits such a fragment, from which one can imagine what he means. The real state of affairs could not be discovered

by Schumann's method; it is therefore unnecessary to enter into the details of his statements. A considerable retrocession is found in Pfitzer's works of 1869 and 1871 (18 and 19). In the former is briefly indicated that in *Pinnularia* we had to deal with smooth, narrow, elliptical spaces, concave outwards (pores = costæ, Smith). In his second he substantiates this view by details. His views do not require special refutation; they are wholly wrong.

In my lecture (7) I first gave a correct representation of the real details, with preparations. It seems a pity that this lecture, referred to by Pfitzer (1873) in Just's 'Jahresbericht' (11, p. 28), did not give him occasion to make once more transverse sections of *Pinnularia*, for in all probability he would have been luckier. The most recent paper, however, which has come to my knowledge is a notice by Prof. Hallier, April 1882 (10, p. 136), according to which he holds a similar view with regard to the structure of the silicified membrane of *Cymbella* as Pfitzer expounded for *Pinnularia*. If this can be looked upon as a confirmation for *Pinnularia*, then I do not envy Prof. Pfitzer's new triumph, which places Hallier's reputation in an unfavourable light.

Among the supporters of this unfortunate furrow-hypothesis seems to be Borscow, whose work I have not seen (*vide* Pfitzer, Just's 'Jahresb.,' 1873, p. 28).

The literature as to the supposed perforation of the cell-wall along the middle line has been given above. I need only add that Pfitzer (19, pp. 175–80) has tried to dispose of Dippel's objections to Schultze, and seems to have succeeded tolerably well in his so-called proof of the longitudinal cleft. But when he states that, in explaining the apparent movements, Dippel has put by far too great weight on the endosmotic processes, this objection falls to the ground, since Prof. Engelmann (4) has discovered a means in Bacteria to demonstrate the development of oxygen by diatoms under the Microscope, thereby furnishing the proof that the unseen gas-molecules escaping from the cell cause movement. Be this attraction or not of the Bacteria, these currents of gas, like entering or flowing currents of water, must have such force that they can carry away a detached cell.

2. *Navicula.*

Of the numerous species, I have only examined the coarser striped *Navicula lyra*, Ehrb. The material was obtained from the mud gathered during the expedition of the "Pomerania" (9). I chose a serial slide, on which were placed twenty-seven transverse sections through one valve. The lengths of the first and last sections led me to suppose that three or four sections had already been made from the valve at either end, and by mischance are not on

the slide; consequently the sections are not all perfect, for a medium-size valve often contains more than sixty rows of dots. Be this as it may, several sections are excellent. From this I infer that the "lyra" figure is produced by thickened and chamberless portions of the cell-wall. In like manner, the central nodule is a large flat thickening of the wall. Fig. 9 probably shows the section exactly through the middle of the valve (No. 13 of the series); fig. 10 section not far from the middle (No. 17 of the series); fig. 11 section not far from the end (No. 1 of the series). In the two last we see the thickenings, which I have designated as "lyra plates," clearly project inwards. The sculpture of the dotted portion of the valve may really be regarded as similar to *Pleurosigma*; but here are clear rows of isolated chambers closed all round. Towards the edge the valves become thinner and the chambers smaller. The midrib with the chambers adjacent to it can only be seen faintly on most sections, especially the projection inwards is seldom distinct, and in the first section, fig. 11, is not seen. Longitudinal sections were not made; they probably would illustrate the details more beautifully. Combining with these results the surface view of a valve, fig. 12, we arrive at the conclusion that the doubts I formerly entertained (6, pp. 482–4) with regard to the existence of closed chambers, and of double membranes connected by column-like supports, are unfounded. The clearly separated spherules of the surface image also show separated chambers, and this is equally true of the entire series of rows. The space between such rows of dots, which is not rarely twice the breadth of the chamber diameter, represents without doubt the solid wall, which has not suffered a visible separation; hence there is no communication between the separate rows. If we have thus before us the connecting link to *Pleurosigma*, it only requires another step to arrive at *Pinnularia*: if the chambers forming one row are brought together a little closer and coalesce with each other, then we get the extended cylindrical chamber of the former. It is true that the large opening is unconnected.

3. *Pleurosigma.*

§ 1. *Addenda to my former researches.*—I add a few recently obtained results, chiefly due to the method subsequently learnt of placing the frustules in position and making serial sections (*vide supra*, "Method of Investigation," (1).

(1) I was formerly obliged to neglect the transverse section of the central nodule (6, p. 478), because I could not find it; but in serial preparations of *P. balticum* as well as *P. angulatum*, cut exactly transversely through a bundle, there is no difficulty in

detecting it. In order to remain quite objective on this point with regard to the sculpture of *Pleurosigma* in general, I have made photographs of a number of transverse sections, and amongst these one of a central nodule of *P. balticum* (French specimen, 6, p. 480). This shows without doubt that, as already proved by the cast process, the nodule is a solid thickening of the wall projecting inwards.

(2) The *Girdle-band* was formerly described by me (6, p. 480, figs. 11 and 13) as a simple membrane. Pfitzer refuted this correctly (19, p. 20). In my present sections made exactly transverse to the median line, I see it sometimes single and sometimes double, probably due to the close proximity of the two plates. If I gave no figures of this formerly, the reason was that in cases where it appeared double I concluded that accidentally with the imbedding in gum foreign matter adhered there, a supposition which might be excused by the fact of using only sections made through frustules lying pell-mell.

(3) What I termed with *P. balticum* accessory rib (6, p. 481, and fig. 13), namely, a small second rib-like edge on the one side of the real median line, does not change position in all cases. For example, if it lies on the right of the main rib in one valve it will, as a rule, be seen in the other valve on the opposite side, that is, on the left. Exceptionally it may be found in both valves on the same side. Numerous experiments by crushing *Pleurosigma* valves under heavy pressure have taught me that, contrary to the former (6, p. 484) negative result, we can sometimes find fragments in which the one membrane is isolated, that is to say, it appears without any markings because the chamber-walls are rubbed off. This, however, is only found in a very narrow edge-portion of such fragments. Which membrane it is—whether the inner or the outer—cannot be determined as a matter of course. Mistakes with such fragments of uninjured valves, in which the markings are indistinct because the chambers are filled up with a glutinous substance, are avoided by convincing oneself of the much higher refraction of the valve in this case, whilst the isolated membrane is seen only very faintly.

§ 2. *Investigations by others.*—(1) Pfitzer in his essay (19, p. 174) speaks of the sculpture of the cell-wall of *Pleurosigma*; but since nothing new is mentioned, I refer on this subject to the General Remarks given in the third part of the present paper.

(2) Müller has also studied the question. I had sent him a slide of *Pleurosigma* sections from the same gathering as the French specimen described in my original paper, and soon after I received from him two essays (14 and 15). As he was a novice in section-making who had occupied himself with coarse objects only, I treated his strange attacks with silence, in the hope

that an able observer would take up the matter and confirm my work, whereby I should have been relieved of the trouble of replying. In this hope I have for ten years been disappointed, and I am obliged now to refute Müller.

I do not know whether Müller has made *Pleurosigma* sections according to my method, or whether his statements are made from examination of my own preparations. He says that my drawings are incorrect, especially that the diameter of the transverse section of the walls is proportionately much too thick, whilst the strong refractive thickenings at the ends of the same are not sufficiently given, hence he will not admit the existence of closed chambers (15, p. 621).

With regard to this question, I have to reply that all my preparations of *Pleurosigma* were not only submitted to the late Max Schultze, and every doubtful and difficult point demonstrated before him by me personally, but that my diagrams were recognized by him as correct, and by his express desire my paper was communicated to his 'Archiv.' This I mention without putting high value on the influence of mere authority. Next I refer to my own paper: on pp. 82–84 I discuss in considerable detail, with reference to the coarsely marked *P. balticum*, the point as to the existence of columns between two envelopes or closed chambers. Nobody will infer from my description and diagram that I meant cylindrical columns or chamber-walls of equal thickness, nor that I intended to deny the thickenings at the ends. No such idea was in my mind. But if such end-thickenings do exist it is an understood thing that they are of pyramidal shape, the base towards the membrane, the point towards the space between the membranes, and they must operate as strong refracting bodies just like small convex lenses. On p. 511 I illustrate for this purpose the most striking comparison—the liver-wort leaf with large mesh-work. Choosing for study sections of a considerable thickness, and in which therefore two entire chambers might be found lying one over the other, then the effect is doubled; the two membranes will be seen more conspicuously projected from the inner space with the thinner walls. But such sections I did not select for my diagrams, it being the rule, whenever the finest structural details were under investigation, to examine and to draw the thinnest sections or the extreme margin as the most reliable portion. In examining such sections one sees the detail exactly as I have represented it, and I must continue to assert that my diagram is true to nature.

A second point of attack to be disposed of is Müller's idea that his flooding experiments (14, p. 75, and 15, p. 621) could not be brought into harmony with chambers closed from outside. I put entirely aside the value of such flooding for the elucidation of details of diatom structure. That all the fluids named by him

will penetrate the interstitial molecules of thin membranes with the greatest facility is known to every novice. Were one to suppose or to search for holes with this experiment we should cancel every investigation made during a century with regard to endosmose. This point needs no refutation. I refer to what I said, pp. 487–8, about the penetration of water into the valves, and it will be the same with all other fluids. The further deductions by Müller, pp. 622–5, in connection with his flooding experiments are by far too obscure for me. Even admitting the facts with regard to *Pleurosigma* were as Müller believes, that the chamber had an opening outwards as with *Triceratium*, there is no reason whatever to infer that the microscopical surface-image could be altered in air, balsam, bisulphide of carbon, &c. The chambers whether elliptical or spherical in connection with the wall-nodule operate in the one case as concave lenses, in the other as convex lenses; whether they have an entrance from outside or not is immaterial. If entrances do exist, but which up to the present have not been observed, I would sooner admit that they lie on the inner side of the membrane. In support of this statement is the analogy of *Pinnularia* and the collodion cast showing a delicate relief-image of the inner side (6, p. 493).

(3) Müller seems to think (14, p. 76) that we ought to investigate the real condition of diatom structure indirectly, and especially the *Pleurosigma* sculpture, and in illustration he describes his investigation of *Triceratium favus*. On pp. 79–80 he has no hesitation in applying to *Pleurosigma* what he found with *Triceratium*. This means, in other words, that everything said by Flögel with regard to *Pleurosigma* does not quite agree with what I (Müller) found out with *Triceratium*, therefore the former must be wrong!

(4) The fourth point is Müller's representation of a transverse section of *Pleurosigma* (15, fig. 1 *a* and 1 *b*). He writes (p. 637) that he succeeded in finding it amongst numerous sections, and then he terms it (p. 621, and explanation of fig. on p. 641) *P. scalprum*, with a sign of interrogation. What he has represented there is a fragment of a very thick transverse section of *P. balticum!* I cannot avoid calling this a prodigious blunder. For Müller, after his researches with diatoms, ought to know that the small delicate *P. scalprum* could never furnish such a colossal transverse section, in whatever direction made. Further, on p. 488, fig. 19, I have described and figured the transverse section of *P. scalprum*, and the fig. is on the same scale as the transverse section of *P. balticum*, fig. 13. A confusion between these two is utterly impossible.

4. *Surirella.*

In a very primitive form Rabenhorst, 1864 (22, p. 9, fig. 12 *d*), gave a transverse section of *Surirella*. It is rectangular, with short straight lines at the corners. The sculpture of the valve was minutely described by Pfitzer (19, pp. 108–10, pl. I., figs. 8–10, pl. V.), and the former researches by Smith and Focke were considered. About the finer sculpture which produces the transverse and longitudinal striæ Pfitzer said nothing. The representation of the coarser details may serve as a model, and I shall refer to it frequently. The only species closely examined by me occurs in fresh water, and I believe it to be *S. biseriata*, Ehrenb. The minute drawing on the surface is like the well-known test-object *S. gemma*. From a single valve of this species I made a series of transverse sections, from another a series of longitudinal sections, and lastly a collodion cast of the inner side of a valve.

The general outline of the valve, best seen from the cast, is an elongated oval almost like a lancet. In the middle lengthways is a ridge, on the margins are the wings as described by Pfitzer in *S. calcarata* (19, pl. I., figs. 8–9, pl. V., fig. 6). The surface between the middle line occupying the highest edge of the ridge and the wings is bent somewhat wave-like. The wings are not simple membranes, but are double, a fact already established by Focke and Pfitzer. They are really folds in the cell-wall. Both membranes adjoin closely in some places; in certain intervening spaces corresponding to the waves on the surface they are not close together, but show a tube-like space. All these communications end in a delicate continuous tube, which forms the tip of the wing.

The diagram of *Surirella* consists of (1) a midrib without nodule or any other distinction; (2) numerous transverse ribs which extend at pretty regular distances from the midrib towards the edges; (3) transverse lines between these ribs and perfectly parallel to them; (4) longitudinal lines of extreme delicacy which cut the transverse lines at right angles. We will now examine the result of the transverse sections. The transverse section series commences with a section the shape of which suggests that three or four had been taken before; the last, No. 66, has had at least ten successors of equal thickness. From these facts we may appreciate the delicacy and extreme usefulness of this series. Fifty times over these sections substantiate the correctness of Pfitzer's images. I have drawn Nos. 2, 9, 39, 40, and 66. Of the longitudinal section series I draw only the first, pl. IX., fig. 18, and another, fig. 19, which goes through the middle of one valve, and is the most instructive, as it shows most distinctly the waves on the surface. My longitudinal section series has not that technical

perfection which distinguishes my transverse sections, although it shows nearly all one can reasonably expect. Putting transverse and longitudinal sections together, one readily sees that the former must look a little different when they are cut through the elevations or when through depressions. Pfitzer has already drawn attention to this fact, and as far as I can judge he has deduced it from the optical transverse sections of the raised frustules (p. 109). The real transverse sections confirm his view. It is not uncommon that the section is so thick, that lying at the declining edge of a wave its outlines in the upper part differ from those in the lower. Figs. 13, 15, and 16 illustrate this by finely drawn lines. These are differences which occur with the transverse section of the wings. The section goes either through a place where the membranes holding together the wing lie closely one upon another, exhibiting the image fig. 14; or else it goes through the intervening space, then the wing looks like a flat-pressed smooth surface having a lumen in open communication with the cell (fig. 15). In the former case one observes at the highest margin of the wing the transverse section of the extremely thin tube above mentioned. Pfitzer (*vide* p. 110) has expressed the opinion that along the entire wing-margin runs a fine cleft, or that there exist a large number of extremely small openings standing in one line. This cannot be taken for more than a mere opinion. My transverse sections in no way corroborate this opinion; on the contrary, they show these fine marginal tubes closed everywhere outwards. These details can be best understood by comparing it with the surface view of the wing, fig. 18. By comparing the figured transverse sections together it will be seen that the proportion of the size of the wing to the surface towards the end is different from what it is in the middle of the valve. We see further that there is a difference in the curvature of the surface of the valve, about which more further on. With regard to the finer sculpture, the transverse sections exhibit the midrib as an irregular thickening; one sees there a point. However, the membrane in its whole extent is so extremely delicate (the measures give $0 \cdot 4$–$0 \cdot 5\ \mu$, even this is too high) that it becomes very difficult to distinguish differences of thickness. Transverse ribs are delineated in the longitudinal section (figs. 19 and 20) clearly like small ovals on the crests of the waves, and these ovals are mostly more pointed whilst the valleys are rounded. I see the transverse striæ in the delicate longitudinal sections as clear pearl-like punctures, as in fig. 20. No rib-like projection can be observed, however, for the shadow permeates the whole mass so that it must necessarily be caused in a manner similar to *Pleurosigma*. The longitudinal striæ I could not perceive with the desired clearness in the thinnest transverse sections, not even with oblique light. Sometimes I observed a kind of glimmer, but nothing

beyond this. With central light the transverse sections appear homogeneous, and flat on both sides. In examining the sections I could not trace differences in the membrane thickness; nor did I observe projections or continuations with one exception near the edge of the valve outside the wing, and this occurs pretty constantly and may stand in connection with the attachment of the girdle-band. On this matter I cannot give more definite explanations. If we examine the cast in view of these facts, the wave shape of the surface is thereby substantiated; it follows that the fluid collodion must have entered into the tube-system of the wings, and in pulling off the valve there must have been left behind contracted tubes. In reality, not far from the edge, such protuberances of collodion are seen at regular intervals. The cast shows absolutely nothing of the transverse striæ however oblique may be the illumination with which it is examined. From the above we infer, with regard to the finer sculpture, that midrib and transverse rib are both wall-thickenings of which the transverse striæ have probably been produced by the cylindrical hollow spaces within the membrane. Small hollows of these cylinders then suggest an appearance of longitudinal lines, and the condition is similar to the transition of the simply striped *Pinnularia* to the pointed striped *Navicula*. This lesser definition remains obscure. For microscopists these investigations about *Surirella* sculpture are of some importance, since they explain various peculiarities of *S. gemma* which may be looked upon as similar to *S. biseriata*. At first sight the longitudinal section, fig. 19, teaches us that it really is no brilliant performance for an objective when it shows the much-spoken-of longitudinal striæ everywhere at the same time. All that is proved is that the objective possesses the power of showing at the same not only striæ which are within the focus but others which are beyond. This can be easily obtained with bright sunlight, but with ordinary daylight an objective should only show clearly either the striæ on the elevations or those on the depressions. Secondly, the transverse section near the end, fig. 14, establishes the fact that in order to see both striæ at the same time it is best to examine the end portions of a valve under an obliquity of illumination of 45° to both directions. Here the surface of the valve is smoother. Altogether *Surirella*, on account of its uneven surface, is a very unsatisfactory test-object.

(*To be continued.*)

XII.—*On a New Microtome.*

By C. Hilton Golding-Bird.

(*Read 14th May*, 1884.)

The necessity for providing some instrument which offered the advantages of modern microtomes and yet was within the reach of those whose work being of intermittent character did not warrant their employing the somewhat elaborate instruments that are found in laboratories, made me originate the instrument shown in figs. 83 and 84.

The microtome is intended to be held in the hand during use, and is of two forms—one for ice and salt, the other for ether. The former (fig. 83) consists of a cylindrical vulcanite chamber closed at the bottom by a brass screw-lid, and at the top by a

Fig. 83.

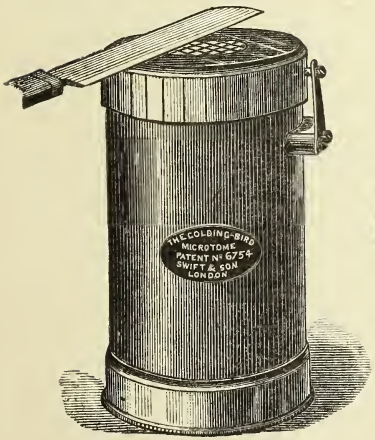
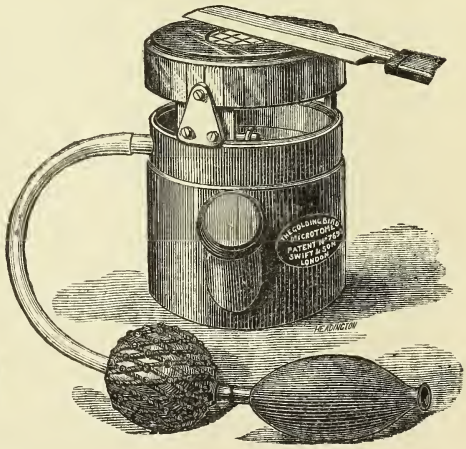


Fig. 84.



disk of vulcanite, having in the centre a plate of brass (freezing plate) 7/8 in. in diameter, and terminating in the chamber by a rod of brass. A metal cap surmounted by a glass plate and pierced in the centre to allow the freezing plate to project, screws over the upper end of the cylinder, the outer surface of which bears a male screw of hard metal on which the cap turns. As the cap is turned round a spring catch clicks at given intervals; these are so arranged that as the cap rotates from left to right each click shows that it has sunk on to the cylinder 1/1000 in.; hence any tissue fixed on the freezing plate projects, at each click, 1/1000 in. through the hole in the glass plate of the cap, and a

razor now passed over the latter cuts off a section of the same thickness. By turning the cap through half an interval, sections of half that thickness may be obtained. To fix the specimen it is only necessary to fill the cylinder with ice and salt, the specimen being previously prepared in gum, according to the general rule when freezing is employed as the means of imbedding.

The form in which ether is the freezing agent employed (fig. 84) differs mainly in the fact, that the lower half of the cylinder is a chamber for holding the ether, with the two nozzles that give the necessary jet. The freezing plate, cap, and regulating apparatus are the same as in the ice and salt machine. Mr. Swift (to whose skill and ingenuity the details of manufacture are due) has introduced a very ingenious but yet simple means whereby some of the ether can be saved from the spray; much must of course escape, but much also falls back on to the jets again (since the spray is a vertical one); this portion impinges on to a funnel-shaped diaphragm, which acts as a lid to the ether chamber, and through which, by means of a minute opening, it again finds its way back to the ether chamber.

For those who, like myself, have to work for a large histological class, there is nothing equal to the Groves-Williams ether microtome in the laboratory: but for intermittent and home work I believe that the form of instrument that I present to-night, leaves scarcely anything to be desired in accuracy of work, simplicity, convenience, and portability.

XIII.—*On some Appearances in the Blood of Vertebrated Animals with reference to the occurrence of Bacteria therein.*

By G. F. Dowdeswell, M.A., F.R.M.S., &c.

(*Read* 11*th June*, 1884.)

The occurrence normally, of micro-organisms in the blood and tissues of healthy animals, has been the subject of many observations, in some instances with contradictory results. It is, however, now well established that, both in man and other animals, they are constantly present in certain situations, not only in the mouth and lower intestine, but in some cases at least, in the liver and pancreas; on the other hand it has been shown that in the blood they are not usually present in a state of health. To determine this latter point microscopical examination is inadequate, inasmuch as mere negative observations are inconclusive, and the question has been decided by physiological experiment, viz. by taking blood from the heart or vessels, with precautions against contamination, when it is found that it may be preserved indefinitely, free from septic changes; and even in some instances, as has been demonstrated in King's College by Professor Lister, without coagulation.

In some pathological conditions—in certain infective diseases,—as is now well known, micro-organisms are found constantly present in the blood, and in a few cases are shown to constitute the true contagium, the actual *materies morbi*. It is possible too, that in other conditions not yet investigated—as for instance in a temporary access of fever—they may appear here, starting from those situations in which they are normally present, and again shortly disappear. For the determination of the question of their occurrence in these situations, it is essential that such other bodies as may be, and have been, in some instances mistaken for them, should be well known.

The appearances in the blood which I have to record to-night have been already described by myself or others, and I have but little that is new on the subject now to offer. Mistakes, however, that have been made—in one case in a report published quite recently—show that these phenomena are by no means generally known or recognized.

1. *Max Schultze's Corpuscles.*—The first instance to be here mentioned is, that in the blood of man and many animals, besides the red and white corpuscles there are present normally, though in very variable numbers, small corpuscular bodies, the nature of which has been the subject of great diversity of opinion, and is far from being as yet determined. These are known as Max

Schultze's corpuscles, so-called from their first observer. The most careful investigation of these is that by a Fellow of this Society, Dr. Osler,* who has given a full description of them, with drawings. He observed them both within the blood-vessels and in preparations on the slide under the Microscope, but he leaves their nature and function quite undetermined, though his observations are valuable, inasmuch as he showed that whereas in preparations under the Microscope they are found in masses, within the blood-vessels they occur singly, isolated forms being distributed throughout the blood-plasma. Though their appearance should be familiar to every student of histology, they have undoubtedly often been mistaken for Bacteria, as obviously is the case in the recent report of one of the most important investigations of the day, to which I have just referred—a circumstance which fully justifies their careful examination and description in this relation. In size they are very variable, from half the diameter of a red corpuscle to very much less. In shape many are spherical or discoid, some pyriform, or more exactly, shaped like a comma, or spermatozoon-like, as Osler terms them; others quite irregular. Some appear distinctly coloured as the red corpuscles, though paler, from their smaller size or thickness.

I have made frequent and prolonged examination of these bodies, and can state from my own observations, that they are not independent organisms or microphytes, as has been supposed, and I believe that a large portion of them at least, are mere débris, disintegrated red corpuscles; they may be indefinitely increased in numbers, with identically similar forms, by treating a preparation of blood on the slide with a 10 per cent. solution of sulphuric acid; though somewhat strangely, this has been stated to be a good preservative fluid for the red corpuscles.

It has been shown by Riess that they have a pathological significance, in so far that they vary in number in different states of health; it also seems to me that they increase and diminish at certain periods of the day, as do the white corpuscles; both these conditions agree with the view that they are disintegration products; and if this be so, their numbers would probably be enormously increased in cholera and similar wasting diseases, in the abnormally active metabolism of the tissues. On the other hand, however, they appear to have been regarded by some as representing an early stage of the development of the red corpuscles, the so-termed hæmatoblasts, but the description of these is so vague that it is difficult to arrive at any conclusion respecting them.

It appears to me, however, that in many cases in the descriptions of these corpuscles hitherto published, bodies of two different characters have been classed together, the one of regular discoidal

* Proc. Roy. Soc., xxii. (1874) pp. 391–8, and Mon. Micr. Journ., 1874.

or spherical form, very variable in size, from the most minute up to nearly half that of a red blood-corpuscle; these appear to be the blood-plates of Bizzozero, and very possibly have an evolutional significance: those of the other class, which more particularly relate to the present subject, are always comparatively small, and more or less irregular in form as above described.

Though the bodies here in question—Max Schultze's corpuscles—are not mentioned in many treatises on microscopic anatomy, yet as they appear to be always present in varying numbers in the blood, whether they are evolutional or involutional forms, they must be regarded as part of its normal constituents; and with respect to the subject here under consideration, viz. investigation of the micro-organisms which occur in these situations, must not be overlooked. The occurrence of the mistake I have mentioned, which shows that they are not always well known, where pre-eminently they ought to be so, has induced me to refer to these bodies at some length.

2. *Proteid or Addison's processes of the red corpuscles.*—The next appearances which I have to mention, resemble Bacteria far more closely than the former, indeed morphologically they are indistinguishable from them; they have been described by several writers independently, in many cases apparently without knowing what had been observed by others. In general, in a preparation of blood under the Microscope, they appear first as small protuberances or bud-like processes on the surface of the red corpuscles, very similar to the first stage of gemmation in a yeast-cell; these sometimes develope—as when the preparation is treated with a 5 per cent. solution of ammonium chromate—to broad pseudopodial processes, in some cases of comparatively considerable dimensions; at other times they form long fine filaments, apparently continuous, unsegmented, three or four times in length the diameter of the corpuscle, of variable thickness, but frequently so fine as to be with difficulty recognizable with the highest powers of the Microscope; at other times they form rosaries of minute spherules, similar to the torula form of micrococci, or the spores of *Penicillium*. In general they very shortly become detached from the parent corpuscle, and may then be observed free in molecular movement in the field of view, simulating exactly Micrococci, Bacteria, or Bacilli; at other times they are retracted within the plasma of the parent corpuscle. I have previously regarded this occurrence as due to the spontaneous contractility of the substance of the red-corpuscles, thereby shown to be protoplasmic; but I must here qualify that opinion, inasmuch as it has lately been demonstrated in a very ingenious experiment, by Haycraft, of Edinburgh,* that egg albumen, inclosed in an indiarubber ball perforated with minute apertures, and placed in a

* Proc. Roy. Soc. Edin., 1880–1, p. 29.

neutral solution of suitable specific gravity, upon the ball being pressed will throw out filamentous processes, which are retracted on the ball again expanding, showing that such processes are not necessarily protoplasmic; they, however, demonstrate another point in the constitution of the red corpuscles, viz. that they have no true cell-wall or membrane, as has been sometimes supposed.

These appearances were first described and figured in the Quart. Journ. Micr. Sci. for 1861, by the late Dr. William Addison, F.R.S., and after him may be appropriately termed Addison's processes. He induced them by treating blood on the warm stage with a solution of sherry and salt solution or quinine; they may also be produced by many other reagents and conditions, as I have previously described in the same journal, 1881, where I have collated the previous observations upon them. They are readily produced by solutions of septic matter, and I have frequently observed their occurrence spontaneously—that is without the addition of reagents—in the blood of septichæmia examined under the Microscope, where they have also been observed by others, but without apparently recognizing their nature. In the report of the French Cholera Commission in Egypt just published,* filamentous processes from the red corpuscles of the blood kept in the incubator for some days † are recorded, but without further observations upon them. They probably occur also in many other pathological conditions. They are produced by heat, as described and figured by Dr. Beale and by Max Schultze, through a mere disintegrating action; also by treatment with gas, as recorded and figured by Professor E. Ray Lankester. In the blood of the frog they occur conspicuously, and are more readily produced there than in the higher animals. The appearances herein have been described in sensational terms by some German writers, but so vaguely that it is impossible to be certain what is intended, whether these processes of the red corpuscles or true micro-parasites, one form of which has been fully described by Professor Lankester; others are said to occur frequently at certain seasons, but I have not been able to confirm this latter observation.

These processes when detached from the parent corpuscle, are not, as I have said, to be distinguished morphologically from Bacteria, and their behaviour to micro-chemical reagents is difficult to observe, from the impossibility of keeping these minute bodies within the field of view. Upon and during such treatment they are not appreciably swelled or decolorized by water, as are the red or white corpuscles; nor is the action of acids or of alkalis much more apparent; they may, however, be distinguished from

* 'Archives de Physiologie Normale et Pathologique,' 1884, p. 411.

† And others after a longer interval, at the temperature of the air (Lostorfer's corpuscles ?).

Bacteria by their behaviour with the anilin dyes, by which, as by methyl-anilin-violet, they are only stained faintly, like the red corpuscles, while all forms of Bacteria, with a very few exceptions, are readily and deeply coloured by this salt. Since the publication of my own account of these bodies, their formation by the action of some reagents has been observed and described by Dr. Stirling,* and most recently in the blood in cholera as mentioned above.

Conclusion.—Thus it is seen that there are several appearances in the blood which may readily be mistaken for micro-parasites—to use a comprehensive term—though the occurrence of the latter is probably more frequent in abnormal and pathological conditions than yet recorded. The increasing importance of this subject renders it desirable that every observer should be familiar with these appearances. I pass over here coagula, granules, and pigment, which frequently occur in blood, the external form of which, if carefully observed, sufficiently distinguishes them from the cells of living organisms.

But while, on the one hand, other bodies are mistaken for Bacteria, in some cases veritable forms of the latter have been asserted to be but fibrinous coagula, or in another case mere organic crystals.

Apart from the subject of pathological appearances and the occurrence of foreign or parasitical bodies in it, the normal form elements of the blood, after the observations of nearly two centuries, are far from being exhaustively known; the varieties of the white corpuscles, of which there are several, have been little more than suggested; some phases in the evolution of the red corpuscles, as is asserted, have been but very recently observed; whilst the functions, origin, and destination of Max Schultze's corpuscles are scarcely more than conjecture: and whilst, on the one hand, the micro-parasites of the blood, its abnormal or pathological features, furnish a subject for examination with, and an excellent test for, the highest powers of the Microscope, its normal characters offer a field of investigation for moderate powers, with a prospect of most valuable results, one that is always readily available, but which has hitherto been somewhat neglected by microscopists generally.

* Journ. Anat. and Physiol., 1883.

XIV.—*On Protospongia pedicellata, a new compound Infusorian.*

By Frederick Oxley, F.R.M.S.

(*Read 11th June*, 1884.)

This interesting organism was first discovered by me in a pond near Snaresbrook, Essex, in the spring of the year 1882. I was searching the numerous ponds in that neighbourhood for *Volvox globator*, and happened to dip a bottle amongst some rushes in a quiet corner, which appeared to be a likely place to find what I was looking for. On holding the bottle up to the light I observed in it a number of minute flocculent bodies, the nature of which I could not determine with a pocket-lens, and therefore carried them home for further examination.

With the Microscope I found them to consist of colonies of monads possessing collars and flagella, and connected together in vast numbers and in rather close proximity to one another on the periphery of some exceedingly transparent hyaline substance.

Being out of health, and, moreover, having only a very slight acquaintance with the group of Choano-flagellata, derived from Mr. Saville Kent's papers in the 'Popular Science Review' and 'Monthly Microscopical Journal,' and from some specimens shown me by my friend Mr. Charles Thomas, of Buckhurst Hill, I did not at that time recognize that any new discovery had been made, but I gave some specimens to Mr. Thomas which we examined together, and also spoke of them to another microscopical friend, Mr. C. Livingston, who resides near the pond out of which they had been obtained.

In the spring of the present year, 1884, I again visited the pond in company with Mr. Livingston and Mr. Thomas, and there found the organism again in great abundance. Mr. Livingston took great interest in the little creatures and examined them under very high powers, and made measurements and computations from which it appeared that the bodies of the individual monads are from the 1/3000 to the 1/2500 of an in. in length, the collars when extended being about twice, and the flagella five to seven times the length of the bodies, and that the number of individuals composing a colony amounted to from 10,000 to 20,000 or more. Mr. Livingston was not able from Kent's 'Manual of the Infusoria' to identify the species, the nearest approach to it appearing to be that described by Mr. Kent under the name of *Protospongia Häckeli*. He therefore sent Mr. Kent some specimens for identification. Mr. Kent considered the specimens undoubtedly new, and interesting to him as tending to support the conclusion he had arrived

at as to the relationship between the Infusoria and the sponges, but being on the eve of his departure for Tasmania he was unable to pursue the subject. Mr. Kent also pointed out the fact, which my friends' and my own observations have since confirmed, that each individual monad is furnished with a short pedicel or footstalk by which it is held in position in the zoocytium, this footstalk, according to Mr. Livingston's measurement, being about the 1/10,000 of an in. in length.

Specimens, accompanied by a short description, were sent to Herr von Stein, who gathered from the description that the species was new; but the specimens themselves were lost in the post. A specimen mounted with osmic acid has, however, since been sent, which has enabled him to confirm his opinion.

The drought we have experienced for some weeks past has so dried up the pond from which my specimens were obtained, that no more are to be had at present, and I have not therefore been able to satisfy myself that *Protospongia pedicellata* agrees in all points with Mr. Kent's description of the genus; but so far as my obser-

Fig. 85.

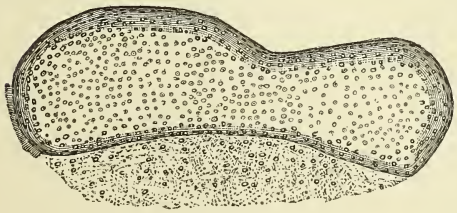
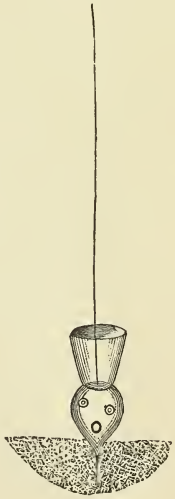


Fig. 86.



vations have extended, it differs from *P. Häckeli* in the possession of a footstalk and in the number of individuals comprised in a colony, fifty or sixty only being the number assigned by Mr. Kent to *P. Häckeli*, whilst I have not met with any colony of *P. pedicellata* that did not contain a thousand or more.

I am indebted to Mr. Thomas for the drawing accompanying this paper (fig. 85), which is an attempt to represent the appearance of a moderate sized colony as viewed by a 2/3 in. objective with A eye-piece, but no drawing can give an adequate idea of the beauty of the organism when illuminated by the paraboloid and displaying its thousands of flagella in active vibration causing the entire colony to sail slowly about the field of view. Fig. 86 represents an individual monad very highly magnified showing the footstalk.

The collars are of course not seen in these circumstances, as they require a high power to observe them properly, but after having been seen and studied under a 1/16 they are easily recognized with a 1/4 in. or even a 2/3 under favourable circumstances of illumination. The mucilaginous zoocytium can only be seen with difficulty owing to its extreme transparency and freedom from foreign particles, and is best distinguished under black-ground illumination with a low power.

The shape of the colonies is usually more rounded than that of the specimen from which Mr. Thomas's drawing was taken, sometimes approaching a spherical form, but always presenting indications of having been attached to some other body. They probably grow on the stems of rushes, &c., but attached so slightly as to be easily displaced when the water is agitated by dipping a bottle, mouth downwards, amongst the rushes, moving it about a little and then suddenly reversing it, taking care not to stir up the mud from the bottom of the pond.

XV.—*On a New Form of Polarizing Prism.*

By C. D. Ahrens.

(*Read* 11*th June*, 1884.)

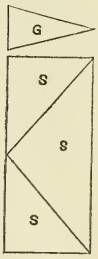
The prism which I desire to bring to the notice of the Society is intended for use either as a polarizer or an analyser. It will, I hope, be found especially useful as an analyser for the Microscope.

The employment of a Nicol prism above the eye-lens is subject to the great inconvenience that, owing to the necessary length of the prism, the eye of an observer is so far removed from the lens that a portion of the field is cut off. Double-image prisms of the usual construction are shorter, but they have another defect, viz. that the angular separation of the rays is so slight that the eye sees both images at once, and some confusion is thus caused.

My object in constructing this improved prism has been to obtain a much wider separation of the two beams of light; so that one of them, although not actually removed entirely by total reflection (as in the Nicol prism), is so far refracted to one side that it may be neglected altogether. I made several attempts to construct such a prism some years ago, but failed (as probably others have done) owing to the difficulty or impossibility of avoiding distortion and colour, and of obtaining a wide separation of the ordinary and extraordinary rays in a prism made up of only two pieces of Iceland spar.

I have now effected the desired object by making the prism of three wedges of spar cemented together by Canada balsam, as shown in the accompanying drawing (fig. 87). The optic axis in the two outer wedges is parallel to the refracting edge, while in the middle wedge it is perpendicular to the refracting edge, and lies in a plane bisecting the refracting angle. This disposition of the optic axis is the one originally suggested by Dr. Wollaston, and has the effect of causing a greater angular separation of the rays than Rochon's construction. By the employment of three prisms instead of two I am able to give the middle prism a very large angle, and yet to correct the deviation of the rays so far that on emergence they make approximately equal angles with the central line of the combination.

Fig. 87.

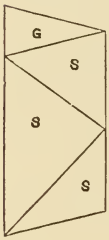


Nearly in contact with one of the terminal faces of the prism I place a prism of dense glass of such an angle that it just corrects the deviation of one of the rays and also achromatizes it, while it increases the deviation of the other ray to such an extent that it

may be practically disregarded altogether; an eye, even when placed almost close to the prism, receiving only the direct beam. This beam is, of course, perfectly polarized in one plane, and can by a proper arrangement of the glass compensator be rendered practically free from distortion and colour.

Other methods of effecting the compensation have suggested themselves in the course of my work, and I have obtained the best results by adopting the arrangement represented in fig. 88. In this, the glass compensating prism, instead of being mounted separately, is cemented upon one of the terminal faces of the compound spar-prism; the angle of this latter, and also of the other terminal face, being suitably modified.

Fig. 88.



This seems distinctly preferable to the original arrangement, for several reasons.

1. The total length of the compound prism is rather less, being scarcely more than twice its breadth.

2. The field is rather larger, so that the prism can be used over deeper Microscope eye-pieces (A and B) without any of the field of view being cut off.

3. The whole arrangement is more compact, all the components being firmly cemented together, and therefore not liable to accidental displacement.

4. There is less loss of light by reflection, the reflecting surfaces being reduced to two.

A ray of light entering the prism in a direction parallel to its axis is divided into two rays; one of which, on emergence, follows a course parallel to that of the original incident ray, and is practically free from distortion and colour: the other ray is deviated to the extent of about 59° 30′ (for yellow sodium light), being, of course, strongly coloured and distorted. The angular separation is so great that this latter ray does not interfere with ordinary observations.

I hope that the prism, which has cost me much time and labour, will meet with the approval of the Society, and take a place as a useful accessory to the Microscope and other optical instruments.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Polar Globules and other Elements eliminated from the Ovum.†—In this important contribution to the theory of sexuality, A. Sabatier sums up our knowledge as to the phenomena of spermatogenesis:—

A cellular element belonging to the so-called male gland (and not specially an epithelial cell) grows and acquires a thicker zone of protoplasm; this first differentiation gives rise to the primitive reproductive cell; this cell multiplies by division of the nucleus and of the protoplasm; the resulting agglomeration or group of cells is that which forms the male tubes of Pflüger, or the polyblasts. The first generation of cells (protospermoblasts) becomes more or less independent, and gives rise to one or more generations of protospermoblasts.

Later on, each cellular element, which is definitively male, acquires a thicker "atmosphere of protoplasm," while in the zone which is in direct contact with the nucleus there arise, by concentration and differentiation, that is to say by true genesis, homogeneous hyaline corpuscles, which undergo a further differentiation, and may multiply by simple division. These corpuscles, once formed, take a centrifugal direction, pass to the periphery of the cell, and become converted into spermatozoa. In this way is formed the deutopolyblast, at the surface of which the deutospermoblasts are eliminated.

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Rev. Sci. Nat., iii. (1884) pp. 362–462.

The spermatozoa, which are derived from these last, obtain their nutriment from the nucleus or the protoplasm of the male cell. When completely developed they are detached, become free, and are capable of acting as male elements. The nucleus undergoes disaggregation.

Between the early history of spermatogenesis and oogenesis there is a remarkable resemblance, but there is a difference on which the author specially insists; in the female element the multiplication of the ovular elements is generally limited to an early period, so that the female tubes of Pflüger contain a proportionately small number of ovules, each of which is of a considerable size, while, on the other hand, the male cells undergo a relatively more numerous series of segmentations, and the resulting elements are large in number and small in size. The view of many authors that the fundamental process of spermatogenesis is a simple succession of cell-divisions, ending in the formation of a cell small enough to be a spermatozoon is erroneous.

The essential conditions of oogenesis are the following:—

A cellular element of the tissue of the ovary (not specially an epithelial cell) grows and acquires a more important layer of protoplasm; the nucleus multiplies more or less by division; each of the nuclei acquires an atmosphere of protoplasm, and we thus have the female tubes of Pflüger. The fundamental distinction only becomes apparent in the fourth stage, when the ovules, increasing in size, become differentiated by segregation and concentration, that is, by the formation of corpuscles, more or less hyaline, which make their way to the surface of the ovule. Here the essential difference commences, for in one case the centrifugal elements are developed and organized at the expense of the central element or nucleus, which is lost in the nourishment of the peripheral elements, in the other cases it is the centrifugal or peripheral element which is broken up or serves as food for the development of the central element, which then forms the egg.

From these facts it is clear that the two elements of different sexualities are the result of the elimination of one of them from a cellular body which at first possessed them both, and were, therefore, capable of a parthenogenetic mode of development.

The theory of sexuality put forward by Sabatier allows us, in his opinion, to understand how it is that one and the same sexual gland may, as in the ovotestis of hermaphrodite molluscs, give rise to both male and female elements, as well as such cases as those of *Bufo*, where one end of the organ is male and the other female; the theory applies likewise to the occasional hermaphroditism in Vertebrates, which, most pronounced in *Serranus*, has been noticed by various observers in other Vertebrates, and even in man (Heppner).

The sexual element is not always completely differentiated after a single elimination; two or even more may be necessary, and this is especially the case with the female. The sexuality of the reproductive cell is due to the appearance of the precocious globules or "globules de début"; though a cell which has suffered such an elimination is

truly an ovum, it is in many cases not completely so; later eliminations are often needed to complete the work.

The different kinds of globules given off from the egg-cell between the time when it is an asexual cell and a complete ovum are these:—

1. Precocious globules which generally form follicular elements, and which give, so to speak, the first impulse to the cell towards a sexual condition.

2. Globules which are more or less tardy in putting in an appearance, and which may be formed some time before or only just before maturity; like the first, they arise by a simple differentiation in the protoplasm, and not by karyokinesis; they are the "globules tardifs" properly so called.

3. There are globules which are cotemporaneous with the period of complete maturity, or the globules of perfect maturity. Most of these are due to phenomena of cell-division, and they are the polar globules properly so called.

The author thinks that it is an error into which all embryologists have fallen to regard the cellular nature of the polar globule as a point of capital importance; the principal, the necessary thing is the expulsion of a mass of protoplasmic substance which represents the male element; it is only an accident that it is effected by a cellular mode of segmentation. The essential fact is, in other words, the completion of a sexual polarity.

The lesson to be learnt from all the known facts may be thus summed up: Their common and very general character proves them to be of the highest value; they all point to an elimination, or a tendency to elimination, of a differentiated or undifferentiated portion of the central protoplasm, and they show that the concomitant phenomena are due to secondary circumstances which have no real importance on the significance of the globules or of the substances expelled by the egg.

Considerable support, even if not categorical demonstration of the validity of Sabatier's theory, is to be sought for in a comparative study of the method of oogenesis in animals which are both sexually and parthenogenetically reproductive; if the theory is applicable to the facts, we ought to find in parthenogenetic eggs either a complete absence of, or a relatively small number of eliminated elements, the number and presence of which in sexual cells ought, on the other hand, to be distinct and pronounced.

What observations (as yet few in number) the author has made on the history of the ova in Aphides seem to afford him the support he needs; still stronger support is given by Weismann's account of what obtains in the Daphnoidea.

In his historical survey Sabatier refers, of course, to the well-known views of Balfour, and points out that that embryologist looked upon the portion of the germinal vesicle which the polar globule contained as being the essential point in the sexuality of the egg, and he urges that the phenomena of karyokinesis are of no real importance;

we must, however, note that the author speaks of "les obscurités et les indécisions des idées de Balfour," and cannot refrain from suggesting that it is possible that the English naturalist has suffered in translation. In many points, Balfour's article, published in 1878, is in complete agreement with that now before us.

Sabatier tells us that his essay is to be looked upon as offering a rational explanation, which may be acceptable for the present, and promises a future essay on the relations of heredity to the sexual polarization of the elements.

Embryonic Germinal Layers and the Tissues.* — A. Kölliker states the conclusions of a valuable descriptive and critical essay in the following terms :—

1. In all multicellular organisms all the elements and tissues arise directly from the fertilized egg-cell and the first embryonic nucleus; and there is no such difference as is expressed by the terms archiblast and parablast.

2. The tissues first differentiated have the characters of epithelial tissues, and form the ectoblasts and endoblasts.

3. All the other tissues arise from these two cell-layers; they are either directly derived from them, or arise by the intermediation of a median layer, which, when developed, takes an important part in forming the tissues.

4. When the whole of the animal series is considered, each of the germinal layers is found to be, in certain creatures, capable of giving rise to at least three, and perhaps to all the tissues; the germinal layers cannot, therefore, be regarded as histologically primitive organs.

5. In birds and mammals there is no primitive organ for the formation of connective substance, blood, or vessels.

6. The elements of tissues already formed have, as it seems, the power of forming other tissues; those of the heterologous neoplasms are probably due to the remains of the embryonic cells or to elements similar in character to them.

7. There is no justification for the classification of the tissues as archiblastic and parablastic, but, on the other hand, the old division of the tissues under four primary types, as suggested by the author and by Leydig, is still the most appropriate.

Origin of the Mesoblast of Cartilaginous Fishes.†—C. K. Hoffmann commences his essay with the description of a developmental stage of *Pristiurus metabolicus*, which is a little later than Balfour's stage B. In this there is as yet no trace of the notochord, and the mesoblast is only beginning to be formed. There is still a distinct medullary groove, and the intestine is in course of formation.

The study of a number of sections, here described from before backwards, proves that the mesoderm forms a bilateral cellular layer, which grows forwards and backwards. Anteriorly it commences

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 179–213 (2 pls.).

† Arch. Néerland. Sci. Exact. et Nat., xviii. (1883) pp. 241–58 (2 pls.).

with the bilateral evagination of the primitive intestine, so that it arises by delamination. This mode of development appears, however, to obtain only during the period in which the intestine is not yet formed. When the intestine becomes a closed tube, the mesoderm is formed directly at the expense of a mass of indifferent cells; in other words, the endoderm and the mesoderm are intimately united at the point where the embryo is growing forwards. The part of the mesoderm formed by a process of delamination is, comparatively, very small. At the edges of the blastoderm and of the blastopore—the point where the embryo grows backwards—the three germinal layers are closely united.

The notochord is formed by the endoderm, and, like the mesoderm, it grows forwards and backwards. Anteriorly the layers are so closely united that the cord there appears to be solid, and the anterior portion of the notochordal groove is, therefore, only feebly developed. Posteriorly the delamination is very pronounced, and the groove is wide and deep. The animal portion of the endoderm, or that which gives rise to the notochord, is separated, on either side, by a narrow but distinct cleft from the intestinal endoderm. Anteriorly the notochordal and intestinal endoderm are completely fused, and directly continuous with one another; posteriorly they are for a long time independent. This would seem to show that the mesoderm originally arose, at the hinder extremity, by a bilateral delamination of the primitive intestine, and this has, in the course of phylogenetic development, been replaced by a process of folding.

The author applies his knowledge of the development of the cartilaginous fishes to an explanation of the phenomena of the development of the notochord and mesoderm in birds; and comes, in conclusion, to the result that the phenomena observed in the meroblastic ova of cartilaginous fishes amply demonstrate the truth that there is no well-marked division between mesoblast and mesenchyme, as has been insisted on by the brothers Hertwig. In these fishes only a small part of the median germinal layer is formed by the bilateral evagination of the primitive intestine—the mesoblast of the Hertwigs. The greater part of the layer would be, for the Hertwigs, mesenchyme. As a matter of fact, the two unite so early that it is impossible to say which had the earlier origin. The cells of the part which arise as mesenchyme have the same epithelial appearance as those which are formed by the evagination of the primitive intestine. The body-cavity—enterocœle—which was at first found only in the part of the median layer which arose by delamination, soon extends into the region which, from its mode of origin, should be called mesenchymal.

Intra-cellular Digestion in the Germinal Membrane of Vertebrates.*—J. Kollmann commences with an account of his observations on the cells of the endoblast in the lizard; these cells vary considerably in size, and in their protoplasmic contents one finds spheres which are to all appearance of a fatty nature, and which are also

* Recueil Zool. Suisse, i. (1884) pp. 259–90 (1 pl.).

present in large numbers in the fluid yolk; the nucleus of the endoblast-cells is most remarkable for the changes which it undergoes in position. The author was most struck by the cells which appeared to open superiorly, and took them at first for artificial products; observation, however, led him to conclude that this was a definite physiological stage, and that being so he is compelled to suppose that the endoblast-cells do not merely maintain existence by diffusion, but also by direct massive wandering; there would appear to be not only a completely mechanical intaking, but as complete an outgiving of yolk-spheres.

The author has also made some observations on the chick, and the result of his studies is his conviction that the cells of the endoblast take up food in an amœboid manner. He finds that ectoblastic cells have a similar power of incorporating yolk-material, which they do by means of amœboid movement. In *Lacerta agilis* he has observed protoplasmic processes directed towards the vitelline membrane, and has found in the interior of the cells small yolk-granules, and others which seemed to have been just incorporated.

In the acroblasts—as Kollmann terms the cells in the layer which lies between the ectoblast and endoblast—each of which is quite independent of the mesoblast, and in the cells derived therefrom which he calls "poreuten," a similar phenomenon has been observed. The latter are quite easy to find in the lizard, but are more difficult of detection in the chick, where they can only be seen after staining. In the lizard the author has been able to observe a direct movement of masses from the endoblast to the poreutes, a poreute sending out processes towards an endoblast-cell.

The author concludes with referring the reader especially to the work of Metschnikoff, in connection with which he would wish his own fragmentary contribution to be studied.

Larval Theory of the Origin of Cellular Tissue.*—A. Hyatt reviews the history of investigation among sponges; concluding that, though true Metazoa, they possess characteristics which show them to be derived from Protozoa. The parallel between the development of the cell and egg in the tissue is strictly parallel with the evolution of nucleated from unnucleated forms in Protozoa. Recent investigations have removed all objections to the homology of the egg or any cell with the adult of the nucleated protozoon; and the principal mode of reproduction by division is the same in all these forms. The egg builds up tissue by division after being fertilized by the male or spermatozoon, just as the spermatozoon builds up colonies after fertilization.

Spontaneous division of a cell which undergoes encystment takes place and the spermatozoa which result from this are true larval monads. These resemble the monads derived from division of the encysted bodies of Protozoa in their forms and in their activity. They differ in being able to fertilize the female or ovum at once,

* Science, iii. (1884) p. 337.

instead of being obliged to grow up to maturity before arriving at this stage.

Thus all cells may be regarded as larval Protozoa, and eggs and spermatocysts as encysted larval forms, the spermatozoa being equivalent also to larval forms which have inherited the tendencies of the mature forms in the Protozoa at the earliest stages. Thus the origin of the tissues in the Metazoa is in exact accord with the law of concentration and acceleration in heredity. The cells are larval, which, in accordance with this law, have inherited the characteristics and tendencies of their adult ancestors in their earliest stages. The three layers can be accounted for as larval characteristics inherited from colonies of Infusoria flagellata, which had two forms (protective and feeding zoons), and then three (protective, feeding, and supporting), these corresponding to ectoderm, endoderm, and mesoderm.

Development of Protovertebræ.*—H. Fol, from a number of experiments on the order of appearance of the protovertebræ of the common fowl, comes to the conclusion that "the first-formed somites of the body appear to be the most anterior of the whole series, and that they correspond, perhaps, to the cephalic region; the long series of protovertebræ are formed successively from before backwards." Thus the vertebrate embryo commences, so to speak, as a head only, the rest of the body appearing by degrees.

Experiments in Arrested Development.†—Another communication by M. Fol deals with some observations made by himself and S. Warynski which tend to confirm a previous discovery, that by momentarily heating the left side of an embryo chicken, a complete visceral inversion is obtained. The experiments consisted in pressing with the blade of a scalpel a portion of the embryo without injuring the vitelline membrane; by so doing, the development of that portion lying outside the line of pressure was completely stopped. The development of the left side of the embryo was hindered by separating it from the afferent portion of the vascular area, and it appears to be by an arrest of development of the left side that a visceral inversion is produced, "from which it may be concluded that this side ought to predominate to bring about the normal torsion."

Morphology of the Directive Corpuscles.‡—O. Bütschli points out that, for a satisfactory comprehension of the morphological significance of the directive corpuscle, it is necessary to bear in mind the mode of sexual reproduction in the colonial Volvocineæ, a group of the Flagellata, which not only by their structure, but also by the characters of their method of reproduction, approach most closely to the Metazoa, even though their mode of nutrition is vegetable in character. The simplest case of sexual reproduction has been made known to us by the researches of Pringsheim on *Pandorina*.

In it, at certain times, the cells of a colony give rise by successive

* Arch. Sci. Phys. et Nat., xi. (1884) p. 104.
† Ibid., p. 105.
‡ Biol. Centralbl., iv. (1884) pp. 5–12.

division to small sexual colonies, which arise in exactly the same way as the ordinary colonies which are merely formed by parthenogenetic reproduction. These small sexual colonies finally break up into the separate cell-individuals, which then copulate by pairs and form a resting zygote; a difference between the sexes of the separate individuals is not, or is only slightly, demonstrable. In the closely allied genera *Eudorina* and *Volvox* the facts are very different; in the former there appear at certain times colonies, which can be distinguished as male and female, some produce nothing but ova, others as distinctly give rise, after repeated division, to spermatozoa, which copulate with and fertilize the female colonies. In *Volvox* it seems possible to homologize the male and female colonies, and indeed we cannot here correctly speak of colonies, but ought rather to regard what are so called as multicellular individuals of the simplest kind, and we have in it the best marked intermediate stage towards the sexual reproduction of the Metazoa.

If we bear these facts in mind it is not difficult to suppose that the separation of a few small cells indicates the formation of a multicellular colony of "gametes" corresponding to the bundle of spermatozoa.

As to the physiological significance of the directive corpuscle we have to decide between the views of the author that we have here to do with an elimination of certain nuclear constituents of the egg-cell, and that of Minot, that it is an elimination of the male element. Against the latter we have the fact that in the simpler cases of sexual reproduction in plants, as the algæ, there is no process of elimination, such as is required by the hypothesis, and also the fact that it cannot be brought into accord with the known phenomena of parthenogenesis.

In a note the author states that the recent observations of Fol, Sabatier and others, only came to his knowledge after his essay was completed, and he has not yet had the opportunity to bring them into accord with his own views. He takes occasion, however, to refer to some observations lately made by his assistant, Dr. Blochmann, who has discovered a very remarkable mode of cell-multiplication in the ovarian ova of ants; these have certainly nothing to do with the formation of the cells of the follicle, for the ovum was already surrounded by a chorion, before the numerous small nuclei, which appear in an altogether unexplained way, had become developed. The observations of Blochmann on ants are possibly to be brought into association with phenomena observed in the ova of Myriopods and Tunicates.

Morphology of the Pineal Gland.*—F. Ahlborn has a short essay on the significance of the pineal gland, a subject which is of especial interest to English students on account of the recent hypothesis of Sir Richard Owen. The author comes to the conclusion that the pineal gland of vertebrates is to be regarded as the rudiment of an unpaired optic rudiment, and he bases this conclusion on the

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 331–7 (1 fig.).

similarity in the mode of its development and of the optic vesicle, that is, by a hollow outpushing of the central wall; on the origin and connection of the epiphysis with the optic region of the brain, and especially with the thalamus opticus; on the morphological resemblance between the organ and the primitive optic vesicle; on its almost peripheral position in Petromyzontes, Selachii, and Ganoids, as well as its completely peripheral position (outside the skull and at the same level with the eyes) in the Amphibia; and, finally, on the primitive connection, detected by Van Wijhe, between the epiphysis and the neural ridge.

The author, regarding the pineal gland as a frontal eye, thinks it justifiable to compare it with the unpaired eye of the Tunicata, and possibly also, of *Amphioxus*.

Segmentation of the Vertebrate Body.*—F. Ahlborn, after a résumé of the theory of Gegenbaur as to the composition of the vertebrate skull, points out that an advance was made when later investigators discovered evidence in favour of the mesomeres of the head; Götte, who was the first in this line of inquiry, recognized four segments in the cephalic region. The author's own observations on *Petromyzon* led him to the conclusion that the first two spinal nerves correspond to three mesomeres, and that the first neuromere nearly corresponds to the fourth and fifth mesomeres. From this it seems to follow that the first three myocommata were innervated not by a spinal but by a cerebral nerve; and that in the hinder part of the head of *Petromyzon* the parts of three true mesodermal segments are still retained. A further inquiry shows that the three first spinal nerves of Petromyzontes and of anurous Amphibia are completely homologous, and that the first cervical vertebra of the Amphibia corresponds to the fourth myocomma of the lampreys; if this result be correct it follows that the three first myomeres of the lampreys—which we have already recognized as typical cephalic segments—are homologous with the three hinder segments of the skull of the Anura. This remarkable agreement is further supported by the close systematic relation between these two groups which is spoken to by the large number of characteristics that they have in common.

Götte was followed by Balfour who attacked the problem by the road of the developmental history of the Elasmobranchii, and demonstrated the presence of a somatopleure and a splanchnopleure in the mesodermal elements of the head, as of the trunk; this considerable support to the doctrine of the metamerism of the head by the discovery of the head-cavities was succeeded by Marshall's investigations, which resulted in showing that metamerism first appeared in the ventral (or branchial) portion only, and by Van Wijhe's work along the lines of the same theories. The studies of the last-mentioned anatomist lead to the conviction that the mesomerism, which is independent of the branchiomerism, as Marshall proved for the anterior, is true for the whole of the cephalic tract; it is a

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 309–30.

typical segmentation which, primitively, completely agrees with the primary metamerism of the mesoblastic somites of the trunk. Of these cephalic somites there are nine. We may, in fine, conclude that the head of the Vertebrata ordinarily contains nine mesodermal segments, which, like the segmental musculature, might become of use to the specific cephalic organs; but the earlier stages generally disappear and the metameres are no longer clearly seen to be separate segments.

Ahlborn next addresses himself to the question of whether the gill-arches are homodynamous with the ribs, and comes to the conclusion that the history of development clearly shows that the metamerism of the gill-arches, which according to Gegenbaur's hypothesis is an expression of the primary mesomerism of the skull, is really nothing of the kind, but a segmentation which is caused by the primary branchiomerism of the enteron, and completely independent of the segmentation of the mesoderm. This conclusion is found to be confirmed by what obtains in *Petromyzon* and the Anura; the whole answer may be summed up in saying that the ribs are, but the gill-arches are not, segmental.

The other problem proposed is: How far have the cerebral and spinal nerves a segmental nature, of the kind supposed by Gegenbaur? No primary segmentation affects the nervous system. Neuromerism, therefore, is in the peripheral nervous system nothing more than a secondary repetition of all the pre-existing metameric phenomena in the body; it is segmental, when the nerves are distributed to the segments of the body, but not in the branchiomerous organs.

If the view be just that the nine rudimentary cephalic segments of the ancestor of the craniote Vertebrata were developed in just the same way as the trunk-segments, and if, at the same time, the medulla oblongata is a similar continuation of the spinal cord, we may conclude that there were primitively nine pairs of spinal nerves in the hind-brain, of which the third, fourth, and sixth had only motor roots. But at the same time the so-called spinal-like cerebral nerves of the Craniota cannot, when we consider their morphological and physiological significance and the secondary character of neuromerism, be any longer compared with the segmental pairs of spinal nerves.

Embryology of Alytes obstetricans.*—M. Heron-Royer gives a detailed account of the external modifications observed during the embryonic development of *Alytes obstetricans*. For the purposes of observation the eggs were placed on moist muslin between watch-glasses, and kept exposed to light and to a warm temperature. The egg has a large vitellus and a small cicatrix. Segmentation, which is limited in extent, commences after 12 or 13 hours with a dorsal streak with a broad, shallow blastopore. The vitellus is now spherical, but soon becomes oblong with the formation of the elongated embryo. The embryo has paired ocular lobes anteriorly, and cor-

* Bull. Soc. Zool. France, 1883, pp. 417–436 (1 pl.).

responding branchial lobes posteriorly. In front of, and between, the anterior lobes is an air-bubble supposed to be respiratory in function. By the 3rd day the four lobes have increased and coalesced to form a "racket-shaped figure." During the 4th and 5th days the cranium and sense organs (excepting the eye) are developed, the olfactory organs appearing much later than in other Anura. The branchiæ appear as digitiform processes of the lateral masses. By the 6th day they are six in number on the right side and seven on the left. By the 7th day there are ten for each side. In addition there are tentacular ramifications which coil about beneath the walls of the ovum. M. Heron-Royer compares these (provisional) organs with the arborescent vascular processes described by M. Bavay in the developing ovum of *Hylodes Martinicencis*, and justly explains their origin by reference to the terrestrial conditions of the development of the young *Alytes*.

The heart, first observed on the 6th day, is covered merely by a pericardium, and not by the vitelline sac, as in other Anura. On the 8th day appears the abdominal investment, inclosing a portion of the disappearing vitellus, and distinguished therefrom by pigmentation. By the 9th day the yellow-coloured intestine is completely formed, and the vitellus absorbed. The eye is completed on the 13th day, when the choroidal fissure disappears, and the iris, hitherto white, finally assumes its metallic yellow colour.

On the 14th day the external branchiæ disappear, the right operculum being the last structure to be formed. The natatory membranes now develope, the caudal appendage elongates, and the embryo is ready to escape from the egg.

There are three investments to the egg: (1) an "external envelope," inclosing an albuminous layer; (2) an "inner capsule," oval in shape; and (3) the "chorion," directly investing the ovum proper, which is spherical.

M. Heron-Royer disagrees entirely with the previous observations on the mode of the escape of the embryo from the egg. He finds that the young *Alytes* does not (as de L'Isle and others had asserted) simply split the envelopes of the ovum, like a bean-pod; but rather that the exit of the embryo is at first conditioned by moisture. Exposed to moist conditions, the albuminous layer beneath the "external envelope" absorbs moisture and expands its investment. The "inner capsule" in the presence of the moisture becomes more supple and allows greater freedom of movement to the embryo, which now employs the external comb-like lamellæ on its jaws to effect an opening, first in the chorion, then in the 'inner capsule,' and finally in the "external envelope." Finally, bending its body into a bow, and fixing its tail against the capsule, the embryo, by a final effort, forces its way from the egg "comme un projectile." Sometimes the young *Alytes* sticks half-way or endeavours to emerge tail first, usually with fatal consequences.

M. Heron-Royer, by applying abnormal warmth and moisture, brought about the development of *Alytes* within 15 days. In normal circumstances, however, 24 days intervene between fecundation of

the ovum and the escape of the embryo, the male *Alytes* retiring with the eggs wound round its legs to holes in the ground away from light and warmth. On warm nights in July (with the thermometer at 20° C.) the male *Alytes* carries his charges down to the water, and they then effect their escape, as above described. If the atmospheric conditions are unfavourable the *Alytes*, guided by "son instinct barométrique," defers its passage from the land to the water.

Development of the Nervous System of Forella.*—An account is given by V. Rohon of his observations on the development of the cerebro-spinal system in the trout. Briefly summed up, his results are that the first nerve-cells, distinctly recognizable as such, occur in this fish in the *dorsal* (sensory) tracts of the cerebro-spinal system. These "cells of Reissner" are multipolar, lie on either side in a longitudinal series (6 to 8 pairs in a myomere at the time of escape of the embryo from the ovum), and occur in the spinal cord earlier than in the brain. In the spinal cord they have relations to the dorsal roots of the nerves of the same, and of the opposite side. These cells occur in much the same fashion in the adult trout.

Incubation of Eggs in Confined Air—Influence of Ventilation on Embryonic Development.†—C. Dareste describes the results of his experiments on the development of the embryos of fowls in a confined atmosphere.

The eggs were placed in a 12-litre incubator, all the apertures of which were kept closed for 21 days. When opened several eggs were found hatched, but the greater number had perished, owing to the development in the albumen of microscopic organisms. The organism most often met with was a plant similar to yeast.

In a second series of experiments the air was saturated with moisture, and in this case the albumen liquefied and leaked through the shell where it solidified in layers. This liquefaction appeared to be an obstacle to hatching; nevertheless, the embryos from the sound eggs had here also reached their full period, whilst those from the infected eggs had perished, stifled by a species of *Aspergillus* that developed a mycelium in the interior of the albumen, then formed green fructifications in the air-chamber, and finally on the walls of the shell.

The author concludes that air, modified by embryonic respiration, exercises no direct influence on the development and life of the embryo; but only an indirect one by facilitating the excessive development of the parasitic organisms. Hence the necessity of renewing the air of incubators. In the struggle for life between the embryo and the parasites the advantage is in favour of the former, if the air be renewed and is sufficiently dry; whilst in air that is stale or saturated with moisture the advantage is in favour of the parasitic organisms.

* SB. K. Akad. Wiss. Wien, 1884, pp. 39–56 (2 pls.).
† Comptes Rendus, xcviii. (1884) pp. 924–6.

B. INVERTEBRATA.

Effect of High Pressure on the Vitality of Micro-organisms.* —A. Certes describes some experiments which he has made on fresh-water and marine micro-organisms.

At a pressure of 100 to 300 atmospheres, maintained for 7, 24, 48, and 72 hours, some were killed; *Chlamydococcus pluvialis* were as lively as when they were put in the apparatus 7 hours previously; *Paramecium colpoda* and *Vorticellæ* (300 atmospheres for 48 hours) showed the "latent life" of Dr. Regnard.† The marine infusoria *Euplotes charon*, *E. patella*, and *Pleuronema marina* retained the power of motion, while *Holosticha flava* and *Actinophrys* were dead.

After 36 hours at a pressure of 520 atmospheres, the *Chlamydococci* were mostly in the latent state, the completely green individuals having resisted the pressure better than those which were turning red. Rotifers were taken out in full activity, while Tardigrades revived after a time.

In a case of bacteridian anthrax, blood submitted to a pressure of 600 for 24 hours maintained its full virulence.

Micro-organisms of the Deep Sea.‡—The researches of A. Certes on water and ooze from great depths tend to show that microbes that can live without air are absent from the bottom, while air-breathing forms are there present. The series of cultivation experiments which he carried on showed that the micro-organisms of deep-sea water were always much smaller and more active than those of the ooze. Ciliated or flagellate infusoria were absent. Successive cultivations resulted in the appearance of a number of large bacilli in active spore-formation. It has not yet been possible to decide whether the organisms found at great depths are identical with those already known.

The researches of Regnard have shown that soluble ferments are not affected by pressure; under the influence of 1000 atmospheres starch was converted into sugar under the action of saliva. The other results obtained have been already noted.§

Origin and Formation of Glairine or Barégine.‖—Supplementing a former paper on this subject, N. Joly describes the result of his observations on the origin and mode of formation of glairine or barégine in the sulphurous thermal waters of the Pyrenees. Microscopical examination, with a low power, of glairine and "sulfuraire" in the course of formation revealed the presence of a very considerable number of animalcules, *Naïs*, *Cyclops*, &c., in the full vigour of

* Journ. de Microgr., viii. (1884) pp. 291–3.
† See this Journal, *ante*, p. 362.
‡ Naturforscher, xvii. (1884) pp. 193–4.
§ See this Journal, *ante*, p. 362.
‖ Mém. Acad. Sci. Toulouse, v. (1883) pp. 118–25 (1 pl.).

life, and this though the temperature of the water reaches 40° C. to 49° C. By their death and decomposition they furnish to the water the nitrogenous organic material which it holds in solution, and the gradual transformation of their remains into glairine precisely similar to that formerly observed is described by the author, who concludes that the concrete glairine of chemists is a complex substance, into the composition of which enters as a primordial element, a vast amount of animal and vegetable detritus. The "sulfuraire" is a very different production, but its fragments and those of various inorganic substances go to swell the mass of the glairine.

In a note to the paper is given a list of the organized bodies, to the number of 39, that have been recorded as occurring in sulphurous waters; whilst figures of *Naïs sulfuræa* and *Cyclops Dumasti* are given in the plate.

Organisms in Hail-stones.*—Boyd Moss has, on two or three occasions during the last twelvemonth, collected a few hailstones in a conical glass, so that anything contained in them subsided to the bottom as they melted, and has always found organized remains, but he never had any idea of the quantity of these till a recent hail-storm. He figures the contents of a single hailstone (about 1/4 in. in diameter), which he placed, with every precaution as to cleanliness, between the glasses of a live-box. These consisted of diatoms, a living *Amœba*, a spore, probably of fungus, pale yellowish bodies like ova about 3 to 4 times the diameter of a human red blood-corpuscle (at least 40 of these), and a dark brown mass with small bright spherules. The *Amœba* and one diatom were in active movement. The spore (?) he calls the attention of microscopists to, and would be glad to hear if they are acquainted with it, "as it is one of several of the same kind which he discovered among the fibres of the heart of animals dead from cattle disease in India in 1870, and described in the 'Monthly Microscopical Journal' for December of that year, p. 312."

Mollusca.

Suckers of Sepiola.†—M. Niemiec describes the structure of the suckers of *Sepiola rondeletii*. The general features appear to agree pretty closely with the account given by P. Girod of the suckers of other Cephalopods,‡ but present some special peculiarities.

The sucker consists of three parts: (1) the basal portion imbedded in the subepithelial tissues of the arm; (2) the peduncle; (3) the sucker proper. The basal portion is surrounded by a layer of annular muscles; within this is a longitudinal layer, while the centre is occupied by a series of radiately arranged fibres. These three layers are continued into the peduncle, and in the short arms terminate in the piston of the sucker, while in the two long arms they are inserted into a rounded cartilage. In other respects the suckers upon the

* Knowledge, v. (1884) p. 423 (1 fig.).
† Arch. Sci. Phys. et Nat., xi. (1884) pp. 100–2.
‡ See this Journal, iii. (1883) p. 636.

short arms differ from those upon the long arms, the main difference being that, while the former are furnished with muscles directly continuous with those of the peduncle, the latter contain no muscles at all, but only a mass of parenchymatous tissue between the two epithelial layers.

Histology of the Digestive System of Helix.*—From a study of *H. pomatia* var. *grandis*, Dr. F. Bonardi, who has made frequent use of double-staining methods, finds five distinct layers in the wall of the buccal mass, viz. (1) The outermost, of connective tissue, consisting of a fibrillated basis and of nuclei, and of a few distinct cells, which often contain calcareous concretions and refractive fatty globules; and next to it (2) muscular, in two layers, the outer longitudinal, the inner circular. They form an exception to the characters of the muscles in this animal, in often being in appearance transversely striated; this is, however, probably only owing to a peculiarity in the arrangement of the fibres within the sarcolemma. (3) Connective tissue, a continuation of the tunica connectiva of the other parts of the digestive system, containing granular cells. (4) Cylindrical epithelium, the cells very long; over the prominence described by Semper in the upper and lower parts of the buccal cavity it is ciliated. (5) Cuticula, of considerable thickness; it is stratified in a longitudinal direction, and some large striæ placed perpendicularly to the surface of the epithelium perhaps represent fine canals. The tongue consists chiefly of a muscular mass; this includes three distinct muscles, two of which are symmetrical and posteriorly separate, so as to embrace the lingual papilla; the third lies transversely below and unites them in the median and hinder parts of the tongue. All are isolated by connective tissue. The surface of the tongue is divided up by two sets of grooves into quadrangular spaces, on which are placed a large number of whitish pyriform papillæ. The lingual papilla (at the base of the tongue) is covered by connective tissue, beneath which lies a layer of circular muscular fibres, covering a very distinct tunica connectiva, apparently not hitherto observed, containing oval cells with distinct outlines, imbedded in granular matter. It lies next to the cylindrical epithelium of the radula.

The centre of the papilla consists of a transparent colourless substance, the external parts of which, near the radula, have the structure of connective tissue. The other parts contain fibrils going in various directions. At certain points they are inflated and have nuclei. They make up the "legs of the papilla," and become mingled with the lateral muscles of the tongue. The alimentary canal (viz. the œsophagus to the end of the duodenum) has (1) an external connective coat corresponding to the peritoneum of the higher animals, underlaid by (2) double muscular, and (3) a connective layer corresponding to the vertebrate *mucosa*, and (4) an epithelial layer covered by a cuticula. The muscular fibres are not striated; those of the one layer are longitudinal, of the other transverse, some

* Atti Accad. Sci. Torino, xix. (1883) pp. 33-46 (1 pl.).

being oblique. The connective layer (3) has a lacunar structure. The lacunæ are lined by a cylindrical endothelium. The epithelium lining the depressions of the stomach, &c., may be said to be glandular; that occurring over certain conical processes of the connective layer is absorptive. From the distribution of the glandular and absorptive organs, Dr. Bonardi is led to abandon the terms œsophagus, stomach, and duodenum as expressing physiological facts. With the exception of the buccal portion, which is used for prehension, and the extreme posterior section, acting as an expelling organ, no separate functions are assignable to any part of the canal. The wall of the duct of the salivary glands consists of an outer cellular connective layer continued from the different glandules, of a median muscular coat comprising circular and oblique fibres, and of an epithelium made up of small cylindrical cells, on which no cilia were found. The refractive granules in the cells of the inner surface of the hepatic lobules are considered, with Barfurth, to be calcareous, but the "ferment-cells" described by that author were not made out. Numerous muscular fibres were found in the peritoneum of the liver.

Aplysiæ of the Gulf of Naples.*—F. Blochmann distinguishes three species of *Aplysia* in the Gulf of Naples by the following characters:—

I. Lateral lobes free as far as the foot. A fine canal leads into the cavity which contains the shell. Behind the genital opening is a racemose gland.
   Animal 20–80 cm. long; black, with white and grey spots. *Aplysia limacina* L.

II. Lateral lobes fused together as far as the siphon. A wide hole without folded margins leads into the cavity which contains the shell. Behind the genital opening a group of unicellular glands, each of which has a separate external pore.
   a. Animal 10–20 cm. long; clear reddish to blackish brown, white spots, the margins of which coalesce. The upper side of mantle has no cilia. *Aplysia depilans* L.
   b. Animal 7–15 cm. long; same colour as the last, the spots, however, smaller, and distinct, with usually a black border. Upper side of the mantle ciliated. *Aplysia punctata* Cuv.

The paper contains further details of the anatomy of these three species, a complete list of synonyms, and a bibliography of the subject.

Morphology of the Acephalous Mollusca.†—H. de Lacaze-Duthiers devotes his first memoir on the 'Morphologie des Acéphales,' to the remarkable *Aspergillum* (*A. dichotomum*) or Watering-pot Mollusc, the animal of which is so rare, though the well-known shell is

* MT. Zool. Stat. Neapel, v. (1884) pp. 28–49 (1 pl.).
† Arch. Zool. Expér. et Gén., i. (1883) pp. 665-732 (5 pls.).

common enough. After an account of the difficulties which he personally suffered in trying to get these molluscs for dissection, and a discussion of its general characters, the author describes the structure of the shell, in which he distinguishes the true from the false shell. The former, as is well known, consists of two small valves, and possibly also of zones which extend beyond their limits; the latter is tubular in form, and presents differences in sections taken at different points. In the terminal or lower part the calcareous tissue is pretty compact, and is formed of a number of layers which can be easily separated from one another, and do, as a fact, so easily part that it is impossible to make a satisfactory circular section of the tube. The facts of structure seem to show that the secretion of the false shell and its mode of growth depend on a deposit of crystalline particles, which, when effected slowly, gives rise to spheres, and when rapidly, to needle-shaped bodies. With regard to the marks or lines of attachment of the muscles, which are so prominent a feature in the shells of ordinary Lamellibranchs, it is here difficult to speak with certainty, and such lines of insertion as can be made out are hard to describe, inasmuch as they vary in depth in different individuals, and have not always exactly the same contour.

To examine the animal that forms the shell it is necessary to break the latter, for it is impossible to extract by the lower orifice a conical body, in which the base has, of course, a longer diameter than its truncated apex. The body has a chitinous envelope which is probably, though not quite certainly, secreted by the mantle; this last has no remarkable characteristics. The description of the mantle is followed by a general account of the structure of the animal, and the author then passes to the digestive tube.

The dissection of the digestive tube was long and laborious on account of the intimate relations of the genital and hepatic glands; as in other Lamellibranchs it describes a convoluted or apparently capricious course. The form of the anus is remarkable in consequence of its being affected by a constriction quite close to the end of the rectum; the extremity has the form of a small spherule, and the orifice is bilabiate. Within the interior of the intestine there is a projection comparable to the typhlosole of the earthworm; in the stomach the same ingrowth has a number of folds. No cæcum or hyaline style was to be observed. The œsophagus is certainly much longer in *Aspergillum* than in any other Lamellibranch; the mouth is very easy to find, and appears to have a definite relation to the superior orifice of the disk of the mantle. The liver, as in all its allies, is well developed; though the condition of his specimens did not enable the author to make altogether satisfactory preparations, he thinks that it agrees in essential characters with that of other Lamellibranchs.

The organ of Bojanus is heart-shaped in form and brownish in colour; the pericardiac orifices are relatively easy to find, and, as in *Anodon*, the external orifices are situated at a high level. It is, without doubt, the organ that was described by Rüppell as the liver.

The central organs of circulation closely resemble those of other

Lamellibranchs, and the general plan of the vessels would seem to be on the same type.

The gills are simple in structure and conform to the Lamellibranch type. The generative glands are united in the same individual; the acini of the testis are large, smooth, or polyhedral, the ovary is also racemose in form, and is placed behind the male organ. After a description of the nervous system and of the muscles, M. de Lacaze-Duthiers sums up the substance of his observations by pointing out that the animal of the watering-pot shell is morphologically altogether like that of any other Lamellibranch. After an early period in which development goes on quite regularly, the body, owing to the excessive growth of its lower portion and the stationary condition of the upper, can no longer be withdrawn into its shell; then there commences a period of abnormal calcareous secretion, which gives rise to the peculiar form of the "shell." But this remarkable phenomenon does not affect the essential characters of the animal, which is much more truly lamellibranch than *Tridacna*, *Anomia*, or the oyster.

In conclusion, the author insists on the value of commencing the study of any given group by the consideration of the anatomy of a normal form.

Molluscoida.

Anatomy of Rhopalæa.*—L. Roule describes the structure of this simple Ascidian, which is very abundant in the neighbourhood of Marseilles. The body is divided into two halves, of which the anterior is triangular and free, while the posterior is irregular in form and fixed; the two halves are united by a delicate region of some length. The tunic, in its hinder portion, contains a number of vacuolated cells, which are absent from the anterior. By its general facies *Rhopalœa* resembles the Clavelinidæ, but its structure and mode of development associates it with the Phalusiidæ; and it may be considered as forming a link between the simple and compound Ascidians. In some points, such as the postbranchial position of the viscera, it approaches *Ciona* more than the true *Phallusiæ*, with which, on the other hand, it agrees by the possession of longitudinal folds in the wall of the branchia. Its affinities may be said to be numerous, and to form a bond of union between several diverse groups.

Arthropoda.

α. Insecta.

Luciola italica.†—C. Emery, after some observations on the external characters of these insects, and the differences between the males and the females, in which he points out that in the male the whole of the lower of the penultimate (fifth) and last abdominal segments is phosphorescent, while in the female, which has seven abdominal segments, only two spots at the sides of the lower surface are luminous, passes to the structure of the luminous organs, in which there are the following, among other, interesting points. Prepara-

* Comptes Rendus, xcviii. (1884) pp. 1294–6.

† Zeitschr. f. Wiss. Zool., xl. (1884) pp. 338–55 (1 pl.).

tions made with osmic acid showed that the smooth terminal branches of the tracheæ always end freely, and that they are never connected with other capillaries, either of their own or of other trunks; the author is so certain of this that he thinks that the anastomoses observed by Kölliker and others in the Lampyridæ can have no real existence. The structure of the dorsal layer of the luminous plates is very simple, no distinct cellular elements could be isolated, and the organs whether fresh, or after treatment with various reagents, showed nothing but opaque uric concretions floating in large numbers in the fluid.

On comparing the luminous plates of *Luciola* with the light-giving organs of other Lampyridæ we are able to compare the clear cellular elements of the cylindrical lobules, which surround the vertical tracheal limbs and their branches, with the terminal tracheal cells described by M. Schultze.

In *Luciola* the arrangement and distribution of the elements is much more regular than in other forms, and the plates appear to have attained to a much higher and more complete grade of development, as is expressed by the regular structure of the lobes, and by the special development of the tracheal end-cells, as well as by the constant dichotomous division of the termination of the tracheæ.

The author discusses the homodynamy of the luminous organs with portions of the fat-body, and finds powerful evidence in support of it in the complete agreement in form, size, and relation to reagents exhibited by the nuclei of the luminous organs on the one hand, and of the fat-body on the other. With regard to the loss of substance by *Luciolæ*, Emery's observations lead to the conclusion that a luminous and flying specimen loses daily about half a milligram in weight; it is to be borne in mind that the *imagines* eat nothing.

In conclusion, the physiology of the luminous activity is discussed. The males are either luminous for short and regular periods, or, when seized or injured, are without intermission, though not so remarkably, brilliant. In the latter case, which, it is clear, is the only one on which observations can be made, bright rings are seen on a dark background, and it would appear that the luminous oxidation takes place at the surface of, but outside the substance of the parenchymatous cells. These appear to secrete the luminous material, which is taken up by the tracheal end-cells, and burnt by means of the oxygen in the fine branches of the tracheæ. This combustion can only take place when the chitinous membrane of the tracheæ is extraordinarily fine.

The author does not think that this luminous power is a sexual means of exciting the rare females, but rather that it is a kind of warning to insectivorous nocturnal animals; the unpleasant smell which a *Luciola* gives off on injury makes it perhaps disagreeable to bats or other nocturnal animals.

Development of Œcanthus niveus and its parasitic Teleas.*—H. Ayers finds that the ovum of *Œcanthus*—the tree-cricket—arises

* Amer. Nat, xviii. (1884) pp. 537-40; from Proc. Boston Soc. Nat. Hist., 1884, 56 pp. (8 pls.).

from a germarium, and not from an ovarian epithelium; and that the yolk is formed by cell-degeneration and not by secretion. The embryo exhibits a primitive segmentation, before the appearance of the permanent segments, each of the seventeen of which bears a pair of appendages, though some are rudimentary and deciduous. The dorsal vessel arises as a paired organ, the lateral halves of which give rise, by fusion, to a median tube, just as in some Vermes; the blood-corpuscles are the nucleoli of endodermic cells. A rather startling discovery is that of the gills, which Ayers describes as a pair of lateral outgrowths derived from the ectoderm of the pleural region of the first abdominal segment; the gill-cavities are continuous with the body-cavity, and they appear to serve as channels through which the vascular fluid circulates. "The gill-pad is essentially a single-layered sac, with a much-constricted neck, evaginated from the pleural region of the abdomen"; they are not tracheate gills, for they contain no nuclei.

The author failed to observe any sharp distinction between a cell and its nucleus, or between a nucleus and a nucleolus; but he was able to detect the existence of segmental enlargements of the mesodermic somites, similar to those from which the nephridia of worms take their origin.

The author discusses the origin and function of the embryonic membranes (amnion and serosa), and points out that an answer is impossible if we do not clearly comprehend the relations of the embryo to its nutriment and food-yolk. They can hardly be supposed to have been primitively protective in function, and the egg is furnished with a protecting membrane (the chorion) before it leaves the body of its parent. Ayers comes to the conclusion that the serosa functions as a yolk-sac, while the amnion is the dorsal wall of the insect. It is to be noted that in *Limulus* the serosa does become a "vicarious chorion" (Packard), and after the splitting of the true chorion, forms a protective membrane.

The egg-parasite *Teleas* appears to be remarkable for the absence of embryonic membranes, and to give rise to a "larval form intermediate between the blastosphere and the cyclops-larva of Ganin."

Origin of Bees' Cells.*—Dr. Dönhoff urges objections to the views of Buffon, carried further by Müllenhoff, that bees' cells are due to pressure, pointing out that there is no relation between the forms of the cells and of the bees' bodies, and that he has observed a single female build a nest consisting of a number of six-sided cells; further, the difference seen in cells formed by bees and drones cannot be correlated with any differences to be found in the inhabitants; in the formation of the queens' cells by other bees there is no pressure to produce the rhomboid pits; direct observation of the formation of a comb was not rewarded by any indications of pressure; no reasonable amount of pressure on the walls of cells seems to have any effect in altering their form.

The author thinks that Darwin has erred in supposing that the cells

* Arch. f. Anat. u. Physiol., 1884, Physiol. Abth., pp. 153–5.

have at first the forms which they have later on, whereas this is by no means the case; at first there are nothing but rhomb-shaped spaces, the size of which is gradually increased.

Closed Poison-glands of Caterpillars.*—Dr. Dimmock states that if a *Cecropia* caterpillar "be examined carefully, the black spines upon its red, blue, and yellow knobs, or tubercles, will be seen to break easily from the tubercles, and a clear yellow fluid of disagreeable odour to ooze from each opening left by the injury. By crushing the tubercles with a pair of forceps the same strong odour is very noticeable, and by this mode of treatment one has no difficulty in proving that each tubercle, small or large, blue, yellow, or red, contains the odorous fluid. The red tubercles are seen, in sections cut with the microtome, to be divided into compartments, the cavities of each spine opening into a compartment at its basal end. The spines themselves are quite rigid and very brittle, so that they break away at a slight touch and leave a hole in the tubercle, out of which the odorous fluid pours, pushed by internal pressure. This fluid, which I have not examined carefully, but which I hope later to study chemically, is strongly acid to litmus paper, but causes a purple precipitate in carmine solution." The odour given out by these glands suggests at once their protective function. Similar glands, i. e. with no outlet until one is produced by external agency, are not rare in Bombycid larvæ. Karsten, in 1848, described the anatomy of the poison-glands at the base of the hairs of an American *Saturnia*. The secretion is "perhaps formic acid or a formate in solution."

Gills of Insect Larvæ.†—G. Macloskie states that it is usual to describe the laminæ of the pneumatic gills as containing systems of fine tracheal loops, somewhat after the pattern of a plurality of carbon-wicks in an Edison lamp. In a specimen, however, of the rectal branchiæ of the larval *Libellula*, which he rolled under the cover-glass, he found that the multitude of tracheal ramifications ended cæcally; all were of about the same length, their extremities recurved within the containing sac, and their tips not all swollen, but rounded off. "As they are elastic, and the closing sac distensible, we ‡ think it highly probable that with each water-inspiration the sacs enlarge and the tracheal spray (having air forced in by the forward compression of the large tracheæ) spreads out so as to bring the full tide of air close to the tide of water. Léon Dufour seems to have had some process like this in view, when he said that each lamella of the branchia of *Potamophilus* 'is probably swollen during life by air transmitted by endosmosis.' As we understand the case, the air is injected into the branchiæ from the rest of the body by rhythmical contractions, and its gases then communicate endosmotically with those in the tidal waters, so as to secure renovation." The action of the tracheæ, Macloskie believes to be tidal rather than due to peripheral capillary circulation; there being a flux and reflux, rather than a mere circulation of the air.

* Psyche, 1882 (4). Amer. Natural., xviii. (1884) p. 535.
† Psyche, iv. (1883) pp. 110-2. ‡ Amer. Natural., xviii. (1884) pp. 534-5.

Dangers from the Excrement of Flies.*—B. Grassi describes experiments which show that flies are agents in the diffusion of infectious maladies, epidemics, and even parasitic diseases.

On a plate on the table of his laboratory he placed a large number of the eggs of a human Nematode parasite (*Trichocephalus*). After a few hours he found, on some white sheets of paper hanging in the kitchen, the well-known spots produced by the excreta of the flies, and on a microscopical examination of these spots, several of the eggs of the parasite were found in them. Some flies coming into the kitchen were now caught, and their intestinal tract was found quite filled with an enormous mass of fæcal matter, in which the presence of eggs of *Trichocephali* were detected. As it was practically impossible to keep all alimentary substances from contact with these flies, it follows that the chances of Dr. Grassi and his family being infected with *Trichocephali* were very great. As a matter of fact, the experiment was tried with non-segmented eggs of this worm. Another experiment was in the same direction. Dr. Grassi took the ripe segments of a *Tænia solium* (which had been in spirits of wine) and broke them up in water, so that a great number of the tapeworm's eggs remained suspended in the fluid. The flies came to the mixture, attracted by the sugar, and in about half an hour the ova of the tapeworms were to be found in their intestines and in the spots. Had these eggs been in a recent and living state, they would doubtless have been just as easily transported. To those who care to try these experiments, it is suggested that lycopod powder mixed with sugar and water is a good material, as the lycopod spores are easily detected.

It is self-evident that if the mouth-apparatus of the fly will admit of the introduction of such objects as have been above noted, that there will be no difficulty in its admitting scores of the spores of many parasitic fungi, and above all of those belonging to the Schizomycetes, the possible cause of so much disease. Already Dr. Grassi has detected in fly excrement the spores of *Oidium lactis*, and the spores of a *Botrytis*, this latter taken from the bodies of silkworms dead of muscardine.

There arises, of course, the question of how far the active digestion of the intestines of the flies may not destroy the vitality of germs or spores thus taken in, but it would seem probable that in many instances the larger bodies swallowed may not serve as objects for assimilation, but may be got rid of as foreign bodies, and it will be borne in mind that the flies themselves fall victims to the growth of a parasitic fungus (*Empusa muscæ* Cohn), which is probably taken first into their own stomachs.

β. Myriopoda.

Nerve-terminations on Antennæ of Chilognatha.†—A preliminary note upon these structures is contributed by O. Bütschli; the results were worked out by Dr. B. Sacepine in conjunction with Dr. Bütschli, but having been left in an incomplete condition, a brief *résumé* of the more important new facts seemed desirable.

* Arch. Ital. Biol., iv. (1883). See Nature, xxix. (1884) pp. 482-3.
† Biol. Centralbl., iv. (1884) pp. 113-6 (2 figs.).

Previous observers have noted the occurrence of conspicuous structures upon the antennæ of Chilognatha, which correspond to the so-called olfactory cylinders of insects recently studied in detail by Hauser,* and between the two there seems to be a general similarity.

Each of the sensory processes is entered by a nerve which immediately divides into two branches, each covered with ganglionic cells which are distributed in two groups, the anterior one consisting of considerably smaller cells than the posterior ones; at the distal extremity the nerve-fibres again collect into a bundle and form the termination of the organ; that these fibres are differently constituted from those which enter the ganglion below is shown by the fact that their behaviour to staining reagents is different; the sensory process is often at the free extremity so that a direct communication is established between these nerve-endings and the outer world.

A structure essentially similar to this is found in *Vespa*, but is differently construed by Hauser; according to him the posterior group of cells is not present since he only figures one nucleus, *with several nucleoli* however, while the anterior group of smaller cells has escaped his attention; accordingly the conclusion to which Hauser has arrived at is that the whole sensory structure is a single cell; whereas in reality it consists of a great number of cells.

Ovum of Geophili.†—E. G. Balbiani records some observations made on the development of the germinal vesicle and the follicular cells of the ovum in *Geophilus*. In the fresh ovum the germinal vesicle is spherical; when treated with dilute acetic acid a funnel-shaped hollow process is seen to arise from the germinal vesicle; one end of this is in close connection with the germinal spot and a process of the latter can be observed to penetrate the cavity of the funnel. It is covered externally by a delicate layer of vitelline protoplasm. In adult females this "nuclear appendix" has the form of a long coiled thread, sometimes it is represented by a number of variously sized cylindrical masses, at other times by several round bodies scattered through the substance of the vitellus; the latter conditions are evidently the result of a division of the coiled thread-like nuclear appendix, but the division is never complete inasmuch as a considerable portion always remains adherent to the germinal vesicle. Each of these small round bodies into which the nuclear appendix splits up contains all the elements which go to form the ovum, viz. a portion of the germinal vesicle, the germinal spot, and the vitelline protoplasm. The wall of the follicle which incloses the ova is seen to contain a number of small cells which agree in every respect with these small cellular bodies resulting from the division of the nuclear appendix, and the view that they originate from the latter is confirmed by the recent investigations of MM. Fol, Roule, and Sabatier on the ovum of Ascidians. The follicular cells appear therefore to be the homologues of the spermatoblasts in the male, and the "vitelline nucleus" also corresponds to one of the same.

* Zeitschr. f. Wiss. Zool., xxxiv. (1880) p. 367.

† Zool. Anzeig., vi. (1883) pp. 658–62 (7 figs.), 676–80 (3 figs.).

γ. Arachnida.

Poison Apparatus and Poison of Scorpions.*—J. Joyeux-Laffuie, from his own studies and a consideration of what has been discovered by other naturalists, comes to the conclusion that the poison-organ of the scorpion (*S. occitanus*) is formed by the sixth or last somite of the post-abdomen, which terminates by a sharp process, at the extremity and sides of which are two oval orifices by which the poison escapes. There are two secreting glands, each of which opens by an excretory duct to the exterior. Each gland is situated in a cavity, which it completely fills, and which is formed by the chitinous skeleton and by an enveloping layer, formed by striated muscular fibres; it is by the contraction of this latter that the poison is forced out. The gland has a central cavity which acts as a kind of reservoir, and a proper wall, which is formed of a layer of cells that send out prolongations into the cavity, and of a layer of epithelial cells, which, in the fresh condition, have a finely granulated protoplasm; these are the secreting cells. The poison is very active, and, even in weak doses, soon kills most animals, and especially arthropods or vertebrates. The phenomena of poisoning are always the same, and take place in the following order—(*a*) pain at the point of injury; (*b*) period of excitement; (*c*) period of paralysis. The convulsions which are characteristic of the second stage, are due to the action of the poison on the nervous centres, and especially on the brain; the paralytic phenomena are caused by the action of the poison on the peripheral extremities of the motor nerves, where they appear to have the same influence as curare. The muscles, the heart, and the blood are in no way attacked, and the poison may therefore be certainly placed among those which act on the nervous system. The scorpions found in France (*S. europæus* and *S. occitanus*) cannot cause the death of a human subject, and are only dangerous when several poison a man at the same time, or attack very young children. To judge by his bibliography, the author is unacquainted with the observations on the habits of scorpions, published in 1882 by Prof. Lankester.†

Structure and Function of the Liver of Spiders.‡—P. Bertkau finds that the so-called liver of spiders arises by the development of a considerable number of diverticula of different sizes from the widened portion of that region of the intestine which is found in the abdomen; as these branch more and more they become united into a continuous whole by the formation of an intermediate tissue. Of the entire diverticula five are larger than the rest, and they are, like the intestine at their point of origin, glandular in nature. The epithelial cells are either small and oviform, closely packed with large colourless spheres, or they are larger and club-shaped, when part of their contents consists of small crystals and larger drops, which are yellow, brown, or green in colour. The chief function of the secretion of these glandular cells is the breaking up and altera-

* Arch. Zool. Expér. et Gén., i. (1883) pp. 733-83 (1 pl.).
† See this Journal, ii. (1882) p. 612.
‡ Arch. f. Mikr. Anat., xxiii. (1884) pp. 214-45 (1 pl.).

tion of fibrin and other albuminous bodies. Spiders do not take in food in the solid form; they dissolve the muscles, &c., of their prey, and suck in the fluid food; this passes into the final branches of the enteric diverticula.

The hind-gut commences just behind the last pair of these diverticula. The Malpighian vessels ramify in the intermediate tissue, and secrete guanin or an allied substance. This body may be found deposited in the outer layer of the intermediate tissue, and it takes a considerable share in the coloration and marking of the animal. On the whole, it would be well, in the present state of our knowledge, to substitute for the name "liver" that of "chyle-stomach."

In the substance of the organ itself we may distinguish more or less regular hemispheres of various shades, an almost completely transparent tissue, and a system of fine richly branched Malpighian canals; these last have fine canals which pass into wider collecting ducts, which open into a wide cloaca; the walls of this have a distinct muscular investment, formed by an outer layer of longitudinally and an inner of transversely disposed fibres.

The author gives some account of the differences which the cæcal diverticula present in various genera of spiders and in forms allied to them.

Anatomy of Acarina.*—J. MacLeod, in a preliminary notice, states that, in his investigation of the Acarina, he has made use of sections, after hardening in picrosulphuric acid or alcohol, and staining with carmine, but that the successful results seem to have been greatly due to chance, specimens collected at the same time and treated in exactly the same way behaving very differently on treatment with hardening and staining reagents. The genera examined were *Trombidium*, *Argas*, *Hydrachna*, and *Gamasus*.

He finds that the tracheiform excretory ducts of the salivary glands open separately into the labial groove at a short distance in front of the buccal orifice. The description given by Henking as to the presence of short narrow ducts arising from tubular glands is confirmed. The suctorial apparatus of *Argas* differs completely from that of *Trombidium*, accurately described by Henking; it has three branches, each of which is bifurcated, and is provided with three radiating muscles. Notwithstanding the difference in their structure the two organs seem to obey the same dynamical laws.

The author has been able to definitely assure himself of the communication between the stomach and the terminal intestine, which, denied by most authors, has only been regarded by Henking as probable on *à priori* grounds. The communication is effected by a pair of lateral orifices, which are extremely narrow, and have their lips almost always closely applied to one another; the difficulty of detecting them is increased by the presence of a large number of almost villiform cells which are found around them.

The terminal intestine is filled by a granular substance, which is composed of brownish-yellow granulations similar to those that are

* Bull. Acad. R. Sci. Belg., lviii. (1884) pp. 253-9.

found in the stomach, and which are probably the true excreta; and of much larger granulations formed of concentric layers, which seem to be true calculi, which are formed not in the intestine, but in tubes which open into it, and in which similar calculi are to be found. These tubes appear to be Malpighian; but the chemical examination of the calculi is still to be effected.

In conclusion, MacLeod throws great doubts on the exactness of the descriptions of the skeletal part of Acarina as given by previous writers, and promises to enter more fully into this subject.

δ. Crustacea.

Sexual Colour-Variation in Crustacea.*—Differences in the colour of the two sexes among Crustacea are of very rare occurrence. Darwin in 'The Descent of Man,' chap. ix., says he is acquainted with but two instances of this peculiarity: one in the case of *Squilla stylifera*, and a second in a species of *Gelasmus*, or fiddler crab. H. W. Conn records a third and very striking instance in *Callinectes* (*Neptunus*) *hastata*, the common edible crab of the southern coast of North America. There are a number of differences in the shape of the two sexes, but besides these they present a marked difference in colour. This colour-variation is confined to the first pair of thoracic appendages, the pair bearing the large chelæ. These appendages are of a yellowish brown on the upper surface, a whitish yellow on the outside, and of a brilliant blue on the inside and particularly at those parts which are protected from the light when the appendage is folded. It would seem therefore that this blue coloration was enhanced by not being exposed to light. The colour of different individuals is tolerably constant and uniform.

Between the colours of the male and female appendage considerable differences are discernible. The most noticeable difference is that the male appendage appears remarkably blue when compared with the female. This is due partly to the fact that the amount of blue surface in the male is much greater than in the female, and partly to the fact that the blue colour is of a much more brilliant hue. The blue colour in the male extends nearly to the tips of the two fingers of the chelæ, both the finger-like process of the propodite and the dactylopodite being largely coloured blue. The extreme tips are, however, of a brilliant purple. In the female these parts are of an orange hue, with not a trace of blue about them. Its tips are also coloured purple, but not so brilliant a purple as is found in the male. In the male the blue colour extends partly upon the outer surface. In the female it is confined to the inner surface and only extends to the base of the dactylopodite. The outer surface of the dactylopodite and of the finger-like process of the propodite are in the male white, while in the female they are reddish orange. Upon the male appendage there is no orange colour as a rule.

These differences in colour are in all cases very marked, and will always serve to distinguish a male from a female appendage. No

* Johns-Hopkins University Circulars, iii. (1883) p. 5.

colour differences are seen in any part of the crab except upon the first pair of appendages, and it is interesting to note that this sexual difference does not make its appearance till the crab reaches maturity. The chelæ of immature males and females cannot be distinguished from each other. Fritz Müller says that the same is true of the *Gelasmus* species observed by him. On the other hand, considering the habits of Crustacea, these sexual differences can hardly be considered as the results of sexual selection.

Observations on Tanais œrstedi.*—H. Blanc takes *Tanais* as his text for a study of the characters of the heteropodous Asellidæ. Commencing with a general account of the body and its appendages, he states that the differences between the cephalothorax of the male and female are not so well marked in young examples, and are not at all apparent in embryos. In old specimens the chitinous integument is incrusted with calcareous salts, which have the form of small masses, crystalline in structure, which may be either needle-shaped or rounded. The concretions are altogether similar to those found by Hoek in the Caprellidæ, and the differences in their form are due to the presence or absence of a hypodermic nucleus. The tegumentary glands are represented by three pairs of large glands which are placed beneath the lateral integument of the first three free segments of the thorax, and by twelve pairs of glands, which are much smaller than the others and are placed in the lateral portions of all the thoracic and abdominal segments, and in the head. The former are racemose in structure and closely resemble the same organs in *Phronima*, *Hyperia*, and *Corophium*. Each element of the racemose glands is formed of a mass of protoplasm, which contains two very clear nuclear vesicles, each of which is nucleolated. Each vesicle is, therefore, formed of two cells. The secretion from these cells passes out by small unbranched canaliculi, to reach the exterior by a single canal. The large thoracic glands are best developed in females carrying embryos in their incubatory pouches, and in them the glandular elements have their protoplasm almost entirely converted into a secretion. The product secreted hardens in the water and so forms a tube into which the *Tanais* may retreat; when fresh, and to the naked eye, this secretion appears to be filamentous; but when examined under the Microscope, it is seen to be composed of small rod-shaped corpuscles similar to those contained in the glandular elements. The secretion is more colloid than mucilaginous, for it does not coagulate with alcohol or form an emulsion with olive-oil. The secretion of the smaller pyriform glands probably has the function of secreting a product which prevents the animal from drying completely when it happens to float on the surface of the water.

The supra-œsophageal mass is elongated in the male, and short, widened out laterally in the female. It is distinctly divided into a superior optic portion and an inferiorly placed part which is larger and forms the true cerebrum. The differences between the supra-œsophageal ganglia of the male and female are carefully pointed out.

* Recueil Zool. Suisse, i. (1884) pp. 189–258 (3 pls.).

The arrangement of the nerve-cells in the ganglia of the ganglionic cord, as well as the double nature of the commissures which unite them, prove that the chain has arisen phylogenetically from two lateral nerve-cords. The whole nervous system of *Tanais* has a greater resemblance to that of the Isopoda than of the Amphipoda; the reasons for this statement are fully given.

After many vain inquiries the author was at last able to observe in a young specimen the presence in the auditory vesicle of very fine and very short hairs, which were arranged in a single row on a small part of its inner surface; no nerve could, however, be detected. Only twelve crystalline cones were found in the eye, and these were very short, and all of the same dimensions.

The muscles of the body and the appendages were arranged in the manner usual among the Isopoda. The fatty body completely surrounds both the dorsal and ventral faces of the intestine; below it also surrounds the ventral ganglionic chain and forms the so-called external neurilemma. In the abdomen, where it is most abundant, it forms two large masses on either side of the intestine. It seems to be more abundant in young than in old animals; in old specimens it disappears altogether, so that it seems to play an important part in the nutrient functions of the animal, and in the development of the body and its organs. The adult males take no food.

Respiration, in addition to being performed in the manner common among Decapods, is, as in Isopods, also abdominal. After a full description of the anatomy and physiology of the circulatory organs and of the digestive apparatus, in the course of which it is pointed out that the masticating stomach of the female is more complicated than that of the male, Blanc passes to the renal organs; the seat of the urinary secretion is the fatty body, and the products of secretion are deposited more or less largely along the intestine; they are yellowish in colour and have the form of agglomerated masses of small rounded or angular corpuscles. Chemical investigations have demonstrated the uric nature of their deposits, and observation has shown that they are more abundant in old than in young examples.

After some observations, not so complete as the author wished, on the sexual organs and on the "biology" of *Tanais*, Blanc discusses the question of whether they are Amphipods or Isopods; the balance of evidence seemed to him to be in favour of the latter, and to justify Milne-Edwards' establishment of a group of "Asellotes hétéropodes." As to whether *Tanais* is the ancestral form of the Isopods, as some have thought, it is necessary to be very careful, but, at the same time, one cannot fail to see such resemblances between *Tanais* and the zoëa-stage of Decapods as is represented by the mode of branchial respiration, the absence of abdominal appendages in the embryonic *Tanais*, and the possession of eyes placed on short stalks, and of an auditory vesicle which is open to the exterior.

New and Rare French Crustacea.*—In his 33rd article under this title M. Hesse deals with several new parasitic Crustacea

* Ann. Sci. Nat.—Zool., xv. (1883) art. No. 3, 48 pp. (3 pls.).

belonging to the order of the Siphonostomata, and especially to the Pelticephalidæ, of the genera *Nogagus*, *Lepimacrus* (nov. gen.), *Pandarus*, and *Cecrops;* all of these have been described and figured from living examples; they all live on fishes with an extremely thick skin, the scales of which are so closely arranged as to render penetration extremely difficult, and they all have a very special form of buccal apparatus, consisting of a rigid tube which is narrowed at its extremity, and which is deeply plunged into the flesh of the host so as to draw from it the fluids necessary for food. The fishes are all members of the group of the Squalidæ.

After a full description of *Nogagus spinacii* (*N. achantias*), we have an account of an attached embryo; the latter was 3 mm. long by 1 wide; it was provided anteriorly with an umbilical process which served as an organ of attachment, but was so flexible as to be able to be turned in various directions; on either side of this were a pair of long flattened antennæ formed of two joints, at the end of which were several divergent hairs. The eyes were relatively large and not widely separated from one another. The body was tubular in form and consisted of five rings, the first of which served as the point of attachment. These embryos were very active and lively, and on several occasions were seen to be living, even when the Crustacea to which they were attached were far gone in the way of decomposition.

The new genus *Lepimacrus* is founded on a single female specimen found on *Lamna cornubica*; the species is called *L. jourdanii.*

Several species of *Pandarus* and one of *Cecrops* are next described; and this is followed by some notes on their "physiology" and "biology." It is pointed out that the mucilaginous tegumentary secretions of the piscine hosts render the skin more supple and more easily penetrable by the organs which attempt to perforate them. When deprived of this advantage and incompletely fixed to a thick and coriaceous envelope they easily fall off when the fish is captured and withdrawn from the water, and are then difficult to find.* The parasites of the Squalidæ may be seen to select the thinnest parts of the skin, such as the axillæ or the eyes. *Scyllium canicula*, *catulus*, and *annulatus* have never been found to be infested with parasites, and it is a significant fact that their skin is very thick.

Hesse is of opinion that *Nogagus* should be placed with the Pandarinæ rather than the Caliginæ: and has some remarks on the term Siphonostomata, which has been rightly applied to those Crustacea, which, like the Pandarina, have a special syphonate buccal apparatus, by means of which they are able, after having pierced the skin of the fishes upon which they live, to penetrate their flesh and draw thence their nutriment; this apparatus is not, however, found in *Argulus*, or *Caligus*, which are ordinarily associated with them. (It may be observed that one of the best authorities on the Copepoda—Professor Claus—makes a special division—that of the Branchiura—for *Argulus.*) The forms just mentioned bite rather than prick. For the Argulina

* It may be pointed out, in this connection, that the number of parasitic Copepods collected by the 'Challenger' was very small.

and Caligina the author proposes the term of Rostrostomata—to which there is the obvious objection that it is a *vox hybrida*. The author gives a table to show the systematic changes which he proposes.

Vermes.

Nervous System of Euniceidæ.*—G. Pruvot finds in *Hyalinœcia tubicola* that the two central ganglia are so curved and connected by a thick median commissure that there is superiorly a "ventricle" which communicates by a large anterior cleft with the general cavity. In the family generally we find that the cerebroid mass is made up of two distinct parts, one cerebral and one stomatogastric; the antennæ and the organs of sense are innervated exclusively by the posterior or cerebroid portion of the mass; the unpaired posterior appendage represents a pair of appendages fused along the middle line. The stomatogastric centre alone provides the nerves of the palpi and the stomatogastric filaments, and the whole system presents essentially just the same arrangement as the general nervous system, for there is a supra-œsophageal centre, an œsophageal collar, and a ventral chain of, at least, two ganglia, the lower of which appears to the author to be constricted and to be formed by the fusion of what were primitively two ganglionic masses.

Cerebrum of Eunice harassii, and its relations to the Hypodermis.†—E. Jourdan describes the cerebral ganglia of *Eunice harassii* as being composed of a central mass of dotted substance, which is covered by a thick layer of nervous cells (the nuclear layer of Ehlers). Above this, and just below the cuticle, there are epithelial elements which are conical in form, and have their bases, instead of terminating on a membrane, prolonged into rigid filaments, which penetrate into the nuclear layer, and, by uniting, give rise to, as it were, pillars which pass from the cuticle to the mass of dotted substance. The protoplasm of these hypodermic cells is greatly reduced, and their nuclei are characteristically fusiform. They become lost in the nuclear layer, and closely fused with other fibrils, which have a similar histological character, but are of a different origin.

The nuclear layer, which is rightly regarded as being nervous in nature, is made up of various elements. In section the layer forms a delicate plexus between the hypodermic pillars, and each of the spaces is occupied by a spherical nucleus. The nerve-cells of the layer are composed of a large nucleus, hardly any protoplasm, and a fine enveloping membrane; they give off one or two processes, which are exceedingly delicate when taken singly.

The fibrils which are connected with them, but which, as has been already said, are of different origin, arise from the nerve-cells; though their function is no doubt different to that of the hypodermic fibrils their histology is absolutely the same. The spaces left in the

* Comptes Rendus, xcviii. (1884) pp. 1492-5.
† Ibid., pp. 1292-4.

reticulum are filled by a fine protoplasm, which is perhaps comparable to the granular substance of the neuroglia of Vertebrates.

The close relation between the hypodermic epithelial cells and their prolongations with their nerve cells and fibres, together with the absence of any histological differences between the two sets of fibrils, are especially interesting as calling to mind the characters of the nervous system of larval Annelids.

Varieties of Branchiobdella varians.*—W. Voigt has a careful study on the variations of *B. varians*.

He finds that we have here to do with an animal which may be of great importance in our knowledge of the mode of origin of species. He shows that it is on the very point of giving rise by its varieties to new species. The so-called *B. parasita* is undoubtedly the form from which the others have been derived. The fact that the variety *hexodonta* found on the gills of crayfishes in North Germany is replaced in South Germany by the variety *astaci* points to external influences as being the cause of this local distribution; the differences may be supposed to be due to temperature or to the qualities of the water, or the bodies dissolved therein. To such suppositions there are, however, powerful objections, and we must therefore look for the causes of variation in the animals themselves. Differences have been observed in the size of the ova, and in the characters of the dissepiments between the segments which carry the segmental products; with these other differences appear to be correlated, but their exact relations have as yet to be carefully worked out.

Ovum and its Fertilization (in Ascaris).†—The discrepancies in the recorded observations of fertilization in the ova of Echinoderms led E. van Beneden to study the subject in fresh types, and finally to pursue in the *Ascaris megalocephala* of the horse the important series of observations which he has recently published in great detail. The memoir is divided into four descriptive chapters and a general summary.

The first chapter describes the constitution of the ovum and spermatozoon.

The advantage to be obtained from studying the ovum in this Nematode is that in the uterus and oviduct definite stages of fertilization constantly occur at definite points.

On quitting the ovarian rachis the previously bilateral ovum acquires an elliptic form, and—at the point of previous attachment—shows a micropyle, underlying which is a naked protoplasmic process, the *plug of impregnation*, situated on a *polar disk* forming a slight eminence on the transverse (or short) axis of the ellipsoid. Ultimately a delicate membrane comes to cover the ovum except at the micropyle. Within the so-called "nucleus," or *germinal vesicle* (which is bounded by a membrane), is the "nucleolus," or *germinal corpuscle*, consisting of *two* disks and situated peripherally on the

* Arbeit. Zool. Inst. Würzburg, vii. (1884) pp. 41–94 (2 pls.).
† Arch. de Biol., iv. (1883) pp. 265–640 (1 pl.).

prothyalosome, a differentiated, and slightly elevated, portion of the nuclear mass.

Within the uterus of the fertilized female the zoosperms occur in four forms, marking four stages of development, though all are capable of fertilization. Except in the first, or simply amœboid, stage, each zoosperm consists of a granular, nucleated, *cephalic hemisphere*, and of a caudal process containing a refringent body and fibrils of a contractile nature. A definite membrane surrounds the "tail" of the zoosperm, ending with a free border at the neck, and not investing the naked protoplasm of the cephalic hemisphere.

The second chapter deals with the penetration of the zoosperm into the ovum, i.e. with "the copulation of the sexual products." On this subject Van Beneden has observed that, in Nematodes, as a general rule, only one zoosperm penetrates an ovum. The erroneous view that many zoosperms entered to fertilize a single ovum, is due to the presence of certain refringent bodies in the vitellus. (In Mammals, where many zoosperms commonly penetrate an ovum, one only effects fertilization, the others being assimilated as food.) The zoosperm always enters at the micropyle, round which the membrane of the ovum rises up to form a "perivitelline space." On entering, the zoosperm applies itself to the "plug of impregnation" by its cephalic hemisphere,—its axis being thus applied in continuation of the embryonic axis of the ovum, and the homologous regions of the two elements being thus brought into contact.

Aided by its own amœboid movements, the zoosperm is now borne into the ovum centripetally by the protoplasmic process to which it is applied. The membrane of the zoosperm enters into intimate relations with the egg-membrane, finally fusing with it to form a continuous *ovo-spermatic membrane*.

In his third chapter, Van Beneden deals with the "modifications which take place in the ovum from the time of copulation of the sexual products to the time when the unification of the mature ovum and zoosperm commences."

In *Ascaris megalocephala* a *Upsiliform figure* represents the first "directive spindle" of Bütschli (Fol's first "amphiaster de rebut"). This characteristic figure consists mainly of achromatic fibrils, with two chromatic disks, lying in a clear body (representing the prothyalosome) at the junction of the three limbs of the Upsilon. The chromatic elements are derived from the germinal corpuscle, the achromatic fibrils from the germinal vesicle and its membrane.

As the zoosperm reaches the centre of the ovum, the vertical limb of the Upsilon becomes connected with it by filaments (probably muscular in function), and the figure becomes T-shaped, the transverse limb taking on the appearance of a spindle. Meantime the vitellus loses all traces of its radiate structure, becoming granular throughout.

"The first *polar body* is now formed at the expense of the reduced prothyalosome and of the chromatic elements it contains. Each of the two chromatic disks furnishes to the polar body the half of its substance, and the prothyalosome divides tangentially. The elimination

is not of a pole of the spindle, but takes place in the equatorial plane."

In the vitellus a homogeneous *perivitelline layer* is differentiated peripherally, and the refringent body in the caudal portion of the zoosperm is ejected into the perivitelline space. In spite of the striking analogies, the genesis of the first polar body is not to be compared to indirect cell-division.

After the elimination of the first polar body there remains an homologous body, the *deuthyalosome*. This latter body increases in size at the expense of the vitellus and developes two "asters" on its surface, one peripheral, the other central. Complicated *pseudo-karyokinetic figures* are now formed, but disappear before the elimination of the *second polar body*, which is formed from the deuthyalosome much in the same way as the first polar body from the prothyalosome, and apparently at the same spot on the ovum. A second perivitelline layer is now formed. The second polar body (i.) is the equivalent of the female pronucleus which remains behind, and (ii.) cannot be regarded as a cell.

So far, Van Beneden concludes, no phenomena of true fertilization have occurred, merely "phenomena of the maturation of the ovum."

The formation of the pronuclei and the true phenomena of fertilization are treated in the fourth chapter. The female pronucleus (the equivalent of the second polar body) consists of chromatic and achromatic elements, derived from the germinal corpuscle and the prothyalosome respectively. Contemporaneously with the expulsion of the second polar body, the male pronucleus is formed, exclusively from the *nucleus* of the zoosperm. Ultimately the two similar pronuclei meet in the centre of the reduced ovum (or *female gonocyte*, as it is now termed), and unite partially *without fusion*. A single dicentric karyokinetic figure is now formed (derived equally from the two pronuclei), and segmentation begins.

"The egg, furnished with its two pronuclei, behaves like a single cell, and the sum of the *two* nuclear elements is equivalent to a simple nucleus. The first cell of the embryo is accordingly formed from the moment when the two pronuclei are fully developed; fertilization coincides with the genesis of the two pronuclei."

Van Beneden concludes that "fertilization consists essentially in the formation of the female gonocyte, and its transformation into a cell, that is to say, in the replacement of the expelled elements by the new elements introduced by the zoosperm. The polar bodies are replaced by the male pronucleus."

All cells of the tissues are thus hermaphrodite, and fertilization is not a generation but merely a substitution requisite for the indefinite conservation of life.

Spermatogenesis in Ascaris megalocephala.*—We have yet another contribution to our knowledge of the development of spermatozoa, from E. van Beneden and C. Julin. The Nematodes in general and *Ascaris megalocephala* in particular lend themselves remark-

* Bull. Acad. R. Sci. Belg., vii. (1884) pp. 312–42.

ably to a study of the successive phases in the development of the spermatozoa, not only on account of the comparatively large size of the spermatozoa, but also because of the simple and typical arrangement of the male apparatus, which is formed by a single tube whose diameter insensibly increases in size from the blind end to the orifice. The best method of investigation is to use the double means of first examining successively dissected portions of the seminal tube, and of making a series of sections of a tube first hardened and properly stained. If we wish to avoid the errors into which preceding writers have fallen, we must be very careful to neglect no part of the tube. The later authors, such as Schneider, Nussbaum, and Hallez have, further, committed the fault of neglecting the bibliography of the question, and especially the excellent work of Munk published as long ago as 1858.

The authors proceed to a description of the several parts of the male tube—testicle, efferent canal, seminal vesicle, and ejaculatory canal. They describe then in detail and sum up their results in the following terms:

It is necessary, in the history of spermatogenesis, to carefully distinguish between the formation of the spermatogonia at the expense of the spermatomeres, and the division of spermatogonia into spermatocytes. The multiplication of spermatogonia appears to be effected, in *A. megalocephala*, directly and not by karyokinesis, while the spermatocytes arise by the indirect or karyokinetic division of the spermatogonia. The karyokinesis presents some special characters; the typical form of the chromatic cord is replaced by a rod-shaped form, and the primary loops have the shape of truncated cones. The longitudinal division of the primary loops results from the appearance of a circular vacuole in each of the pyramids; this vacuole extends to the equatorial plane, and brings about the division of the pyramid into two quadrilateral plates, which represent the secondary loops. The polar corpuscles which occupy the centre of the attractive spheres are remarkable for their affinity for colouring matter. The asters may be distinctly seen to be the cause of the temporary division of the cell into three portions, separated by circular constrictions.

In the region where the spermatogonia are formed at the expense of the spermatomeres there are to be observed, between the cells, corpuscles which have a close resemblance to polar globules; these the authors call residual globules. They appear to have been expelled by the spermatomeres after the karyokinetic metamorphosis, and the expulsion seems to be effected in the equatorial plane of the dicentric figure, as in the case of the polar globules. If this account be correct, the residual corpuscles are comparable to the polar globules of the egg.

The spermatocyte, before becoming a spermatozoon, gives off a portion of its substance, which belongs to the cytophoral part; the formation of the cytophore is in no way comparable to a cell-division. Just as the egg, when completely matured, is a cell reduced to that which Van Beneden has called a female gonocyte, so is the spermatozoon

a reduced cell. The reduction is accomplished in two distinct stages of development; first affecting the spermatomeres, and then the spermatogems. While each spermatocyte intervenes in the formation of a cytophor, the residual corpuscles are formed by the spermatomeres, in such a way that not only each spermatocyte (and, therefore, each spermatozoon), but also each spermatogon only possesses a reduced nucleus.

Spermatogenesis in Ascaris megalocephala.*—P. Hallez, like E. van Beneden, has selected this convenient Nematode for the study of the phenomena of spermatogenesis. After a short description of the male organs, he points out that young of different ages as well as mature specimens must be examined. The spermatospores, which are formed at the blind end of the seminal tube, consist of a homogeneous extremely transparent protoplasm; by division into four the nucleus gives rise to four protospermatoblasts, which form protospermatogems. The former give rise to a (second) generation of deutospermatogems, which are formed by a large number of deutospermatoblasts. The last become isolated, and consist of a homogeneous protoplasm and a nucleus which is deeply stained by reagents. As they increase in size their protoplasm becomes finely, then more distinctly granular, while the nucleus grows larger and developes a nucleolus.

When they have reached a size of about 18 μ in diameter they divide by nuclear division; and this division is effected at about 440 mm. from the blind end of the seminal tube.

The deutospermatoblasts now become filled with refractive granules, and soon exhibit a phenomenon which has not yet been observed in the animal kingdom. They undergo conjugation by pairs, and the two become closely united with one another. The nuclei, after fusion, separate afresh. As they tend to separate from one another each gives rise to corpuscles, which resemble polar globules.

The further development of the separated and ejaculated deutospermatoblasts must be made out in the organs of the female; when they first enter the ducts they are spherical cells, 18 or 19 μ in diameter, their protoplasm is filled with refractive granules, and they have a nucleus which can be easily stained. After a certain time the refractive or nutrient granules disappear, and the deutospermatoblasts appear almost to be amœboid in character. They are now converted into spermatozoa, which are ordinarily conical or pyramidal in form; the nucleus is constantly found outside the spermatozoon. The fertilizing element is now ripe and may be seen to apply itself to and fecundate an ovum.

Nematoids of Sheep's Lungs.†—F. Karsch has a notice of A. Koch's essay on the Nematodes of sheep's lungs, in which especial attention has been given to *Strongylus rufescens* and its developmental history. The author found in the lungs of a Hungarian race of sheep a number of hair-like microscopic parasites which he regarded as new

* Bull. Sci. Dép. Nord, vi. (1883) pp. 132-5.
† Biol. Centralbl., iv. (1884) pp. 51-3.

and to which he applied the name of *Pseudalius ovis-pulmonalis*. The males are brown, the females milky white in colour; the latter lays its eggs in the finest branches of the bronchi, and the pulmonary alveoli; the young escape by the trachea, and the sexually mature forms enter by the same passage. The young make their way into mud or water, and thence pass first of all into the stomach of the sheep; to return again to the gullet and so to get into the larynx. The author believes that he has here to do with a diminutive form of *S. rufescens*, which, by constantly living in the finest terminations of the bronchi, has accommodated itself to the diminishing calibre of these vessels.

Free-living Nematodes.*—Up to the present the free-living Nematodes have received comparatively little attention; absolutely nothing is known about the exotic forms, and but few notices have been published of the forms that occur in Europe. In England Dr. Bastian has published an elaborate memoir of the free-swimming Nematodes, chiefly the marine forms; while on the Continent Eberth, Schneider, Marion, and Bütschli have contributed largely to our knowledge of the group. The Monograph of De Man deals exclusively with those species that are found in the Netherlands. The work is divided into two parts, a general and a systematic; in the first is treated the history of the group, their organization, mode of life, capture, methods of preparation, and their geographical and seasonal distribution in the Netherlands. The second half contains a description of all the species found in the Netherlands, as well as a notice of all the free-living species that have been described, with references to the published descriptions. The text concludes with two tables showing the distribution in the Netherlands of the different species, and a classification of the species according to the size of the body. The Monograph is illustrated by thirty-four plates.

Trichina and Trichinosis.†—This work is the result of a duty intrusted to J. Chatin by the French Government, who desired exact information as to the character of the preserved meats imported from America. The author concludes that "in the name of public hygiene, as well as in that of agricultural interests, public opinion demands a careful examination of all animals that enter the country, whether they be alive or dead." But he points out that it is for the legislator to prescribe the measures which are necessary for preserving the public health, and that the business of the naturalist is concluded when he has investigated the history and development of the parasite, and has drawn from these conclusions as to prophylactic methods. The work is one which should be known to all who are engaged in either the physical or legislative problems which surround the question of diseased meats.

* 'Die frei in der reinen Erde und im süssen Wasser lebenden Nematoden der niederländischen Fauna.' Leiden, 1884, 34 pls. Cf. Biol. Centralbl., iv. (1884) pp. 191–2.

† 'La Trichine et la Trichinose.' Paris, 1883, 8vo, 257 pp. (15 pls.).

Cystic Stages of Tæniadæ.*—A. Villot finds, as a result of prolonged inquiries into the characters of the cystic stages of Tapeworms that the mode of formation of the head is identical in all species, genera, and types. The true head, the future scolex, never proceeds directly from the caudal vesicle; it is always separated from it by an intermediate portion, which he has called the body, and which forms its immediate envelope. The differential characters which can be drawn from the modifications in structure and development have only a secondary value and cannot be used as the basis of a natural classification. In the next place, it is to be observed that, contrary to what is ordinarily taught, the caudal vesicle of the cysticerci may be formed in different ways; these differences have a future morphological importance. Cysticerci are either cysticerci properly so called, or are cysticercoids; the latter may be grouped under two heads and subdivided into six entirely new genera. The first section consists of those in which the caudal vesicle is formed by endogenous gemmation, and here we have *Polycercus* for the form found by Metschnikoff in *Lumbricus terrestris*, *Monocercus* for the so-called *Cysticercus arionis;* in the second section, or that of those in which the caudal vesicle is formed by exogenous budding, we have *Cercocystis* for the form found in the larva of *Tenebrio molitor*, *Staphylocystis* for *S. bilarius* and *S. micracanthus*, *Urocystis* for a form found in *Glomeris*, and *Cryptocystis* for the curious form found by Metschnikoff in the visceral cavity of *Trichodectes canis*.

The forms that are the most ancient and most closely approximated to the primitive type appear to be those that belong to the genera *Urocystis* and *Cryptocystis;* it is in these that we observe the greatest independence between the different stages of development; the proscolex, cystic, and scolex-stages are perfectly distinct; the first, after having budded off the caudal vesicle separates from it, so soon as it has attained maturity, and no part of the proscolex is found in the perfect cysticercus. In *Staphylocystis* and *Cercocystis* the caudal vesicle adheres to the blastogen, but has only the function of a support or simple appendage. In the first section of the cysticercoids the blastogen not only persists, but forms a permanent envelope. In passing from the cysticercoids to the true cysticerci we advance another stage in the scale of differentiation, and, at the same time, note a remarkable abbreviation in the history of development, for the stage represented by the budding of the caudal vesicle is entirely suppressed. This "serial co-ordination" of the cystic stages may be expressed by the simple law that the most differentiated types of organization have their development the most condensed; those that are relatively lower are more diffused; in other words, the complication of development and of organization are in inverse relation to one another.

Anatomy and Development of Trematoda.†—J. Biehringer devotes the greater part of this essay to sporocyst-stages, and has investigated the characters of *Cercaria armata*, *C. macrocerca*, *C. micrura*,

* Ann. Sci. Nat.—Zool., xv. (1883) art. No. 4, 61 pp. (1 pl.).
† Arbeit. Zool. Inst. Würzburg, vii. (1884) pp. 1–28 (1 pl.).

Bucephalus polymorphus, *Cercaria acerca* n. sp. (found in various organs of *Onchidium carpenteri*), and another sporocyst from a species of *Onchidium* from Singapore.

In describing the structure of the sporocysts, he deals with the epidermis, and points out that the so-called cuticle is not truly a cuticle, but is a membrane in which a varying number of nuclei are to be detected; its development is difficult to follow, but it would seem to be due to the fusion by peripheral growth of some of the outer cells of the gastrula, and to be comparable, therefore, to the ectoblast of the first order, which has been described by Schauinsland in the embryos of Trematodes, and to the embryonic investment of *Tæniæ*, as described by E. van Beneden. On the whole, we are justified in regarding it as an epidermis and comparing it with the "hypodermis" of other worms.

The muscular layer is always very thin, and its outer layer consists of delicate, closely applied, circular fibres; below these is a longitudinal layer, which is often much less distinct. *Cercaria macrocerca* is remarkable for having them broader and more distinct from one another than they are in other forms.

The germinal epithelium is in most cases unilaminate, and varies in form in different species, the cells being cylindrical, cubical, or flattened. *C. macrocerca* is here again remarkable for having large clear cells, which may be set in one or several layers. On their distal side there are nuclei, which lie in a protoplasmic fundamental substance, and which in section appears to form an anastomosing plexus.

The so-called paletot is a fourth layer which is often present, and which, in the opinion of Leuckart, is due not to the guest but to the host; and the author is of opinion that the substratum from which it arises is the blood of the host, while the elements of which it is composed are the cells of the snail's blood. After discussing this question at some length Biehringer passes on to the sucker or depression which is often found at one pole of a sporocyst; its structure agrees so completely with that of the rest of the body-wall that it may be considered as a mere invagination of the whole sac. It no doubt serves as an organ of attachment.

In dealing with the formation of the germinal bodies, and beginning by discussing the views of previous writers, and especially of Leuckart and A. P. Thomas, with the latter of whom he is in complete agreement, he tells us that he is led by his own observations to think that the developmental cycle of the Trematoda is a real case of alternation of generation.

In conclusion there are some remarks on the influence which the gradually developing brood exercises on the organization and activity of the sporocysts. When the brood remains at a lower grade of development the nurse contrives to grow; later on, when the daughter generation is undergoing further development, it suffers a passive extension, but this does not equally affect the whole of the body of the nurse, but depends on the number and size of the germinal bodies which are to be found in any given zone of its body. At last, the whole mass forms a mere sac without any sign of organization, for the brood at last completely destroys the body of the mother.

Worm-fauna of Madeira.*—P. Langerhans has published the fourth of his contributions on the worm-fauna of Madeira, in the course of which he describes various new species and one new genus. Among other points of interest the author has some suggestions as to the divisions of the Serpulidæ, our knowledge of which is in a most unsatisfactory condition. In that family he recognizes three types; the first of these is *Serpula* itself, in which the thoracic segments bear only one kind of dorsal seta; here belong *Serpula*, *Eupomatus*, *Pomatocerus*, and *Placostegus*. *Filograna* is the second type, and in it all the thoracic segments behind the second have, in addition to the Serpulid setæ, those of the kind first detected by Claparède in *Salmacina*. Here we have *Spirorbis* and others. The third type is represented by *Vermilia infundibulum*, in which a fresh type of seta, in addition to those already noted, is present.

Of the twenty species of Nemerteans found by Langerhans, seventeen are known to be members of the European seas.

New Species of Rotifer.†—Sara G. Foulke describes a new species of rotifer under the name *Apsilus bipera*. In common with all members of the genus, they possess, instead of rotatory organs, a membranous cup or net, which is used for the capture of food. The specific distinction of the new form consists chiefly in the structure of the net, the presence of a true stomach in addition to the usual crop, and the presence of cilia inside the net. It is proposed to unite the forms *Apsilus lentiformis* Mecznichoff, *Dictyophora vorax* Leidy, and *Cupelopagus bucinedax*, Forbes, and the new species in one genus, *Apsilus* (Fam. Apsilidæ), in consequence of their strong points of resemblance. These are, briefly, the presence of two eye-spots, of a membranous cup, of a mastax exactly similar in all, of the absence of tail or foot-stalk, of the absence of carapace, and of the similar habits.

Prof. Leidy subsequently declared all four forms to form the same species, with which opinion Miss Foulke does not agree.

Echinodermata.

Development of the Germinal Layers of Echinoderms.‡—E. Selenka finds that egg-cleavage in Echinoderms is regular, but that of Ophiurids and Asterids is really "pseudoregular," and that of Echinids regular with polar differentiation; we cannot as yet exactly define what we mean by a regular cleavage, and its various modifications are as yet insufficiently known; we may, however, distinguish under its head those eggs into which the first two blastomeres are of the same size, and those in which cleavage is on the whole regular, with the exception of the first plane of cleavage. The various modes of cleavage exhibited by the eggs of Echinoderms are of no value for the phylogenetic history of the group; the influence of cenogeny is

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 247–85 (3 pls.).

† Proc. Acad. Nat. Sci. Philad., 1884, pp. 37–41 (1 pl.).

‡ 'Studien über Entwickelungsgeschichte,' ii., Wiesbaden, 1883, pp. 28-61 (6 pls.).

apparent enough. The blastula is of the same thickness throughout; in Echinids, and probably also in Asterids and Ophiurids the blastodermic cells are broader on the lower surface, in the Holothuroidea they are of the same size all round. The mesoblast arises from the primitive cells of the mesenchym and from the diverticula of the archenteron. The former, by means of their daughter-cells, and in the form of wandering cells, make their way into the blastocœlom and give rise to the circular musculature of the fore-gut and to the cutis. The archenteric diverticula and their derivates consist first of a single layer of cells, from which later on scattered cells arise peripherally and form an outer ring of unicellular muscles. The explanation of this double mode of origin is not easy; it may be said that the two primitive cells of the mesenchym are the homologues of the two primitive cells of the mesoblast of molluscs, Arthropods, &c., and that the archenteric diverticula are new formations ("neomorphs"); while there are several good reasons to be given in support of this hypothesis there are others that favour the view that the diverticula form the primitive seat of origin of the mesoblast and that the mesenchymatous cells are cenogenetic. Lastly, and this is perhaps the best view of all, the mesenchym-cells are portions of the archenteric diverticula, which in consequence of the modification of the larval life, have precociously separated from the rest.

The "blood-corpuscles" of the water-vessels are found to arise from epithelial cells of the rudiments of the water-vessels, and those of the enterocœlom from the peritoneal or cœlomic epithelium.

Evidence of the vermian origin of Echinoderms is afforded by the primary mesoderm having the form of two primitive cells, and by the bilateral symmetry of the larval organs. The division of the archenteric diverticulum into cœlomic sac and water-vessels corresponds physiologically to that which the mesodermic sac undergoes in Vertebrates, and to some extent in worms.

New Genus of Echinoids.*—Prof. F. Jeffrey Bell institutes a new genus for the *Echinanthus tumidus* described a few years since by Mr. Tenison-Woods, on the ground that the rows of ambulacral pores, instead of being approximated at their free end, tend to widen out in a lyre-shaped fashion; and the genus is thereby removed "from the direct line of ancestry through which the *orthostichous* passed to the *petalostichous* Echinids." He alludes to the significance of this form being found in the Australian seas, and expresses a belief that further research will result in the discovery of other forms which have been unsuccessful in the struggle for existence.

Revision of the Genus Oreaster.†—Prof. F. Jeffrey Bell revises the twenty-seven known species of *Oreaster* and describes five new species; in the systematic disposal of the species he has attempted to gain some assistance from the study of their post-larval development, especially as regards the number and arrangement of their spines; he

* Proc. Zool. Soc. Lond., 1884, pp. 40–4 (2 pls.).
† Tom. cit., pp. 57–87.

believes that "in the investigation of the spinulation of star-fishes there is a wide field for the study of those mechanical causes with which the zoologist is concerned."

Organization of Adult Comatulidæ.*—E. Perrier finds in *Antedon rosaceus* and *A. phalangium* that the "axial organ" is a tubular cavity with glandular walls; of its diverticula some appear in section to be cæcal, while others are continued into canals, most of which pass towards the dorsal integument and form around the œsophagus the spongy organ of H. Carpenter. The canals (the author cannot call them vessels) take a sinuous course, anastomose frequently, and have walls which are clearly glandular; they open by ciliated infundibula. The author regards all these as parts of one and the same system, and as comparable to the madreporic plate, sand-canal, and ovoid gland of Echinids, Asterids, and Ophiurids. Perrier finds in the characters of young larvæ—such as the disposition and mode of formation of the single canal—facts which lead him to think that the organization of the Comatulid is closely allied to that of other Echinoderms. Reserving details he here points out that if we consider an urchin as a Crinoid whose arms have become firmly united with the disk (as is the case, for example, in *Eucalyptocrinus*), and whose mouth was situated at the point of insertion of the disk to the stalk, the nervous system and the ambulacral canals of the urchin would have exactly the same relations as those which are presented by the Comatulid. He further remarks that the calyx of numerous Crinoids becomes invaginated and presents points which are not without analogy to the lantern of Aristotle in certain (and especially in Clypeastrid) Echinids.

Cœlenterata.

Anatomy of Campanularidæ.†—It is generally believed that the "theca" and the chitinous layer which covers the stem in the Hydroida is a secretion from the ectoderm layer of the polyp. This however does not seem to be the case with the Campanulariæ. H. Klaatch has been furnished by a detailed study of *Clytia johnstoni* with evidence tending to show that the chitinous sheath of the Campanulariæ is a product of differentiation of the ectoderm, an epidermoid formation, the equivalent of a tissue. If this were not so, and if the chitinous layer were a mere secretion from the ectoderm, as it is in *Cordylophora lacustris* according to the researches of F. E. Schultze, we should expect to find the whole of the body of the polyp covered by a continuous layer of ectoderm entirely similar everywhere, and the growth of the chitinous covering to be increased by the deposition of fresh layers of horny substance; on the contrary, it appears that the outer epithelium which covers the tentacles, the head, and the "body" of the polyp is not continuous with that of the stem, but at the posterior end of the stomach bends back and becomes continuous with the calyx itself, actually passing into it, the

* Comptes Rendus, xcviii. (1884) pp. 1448–50.
† Morph. Jahrb., ix. (1884) pp. 534–96 (3 pls.).

process of the modification of the cells into horny matter having been clearly recognized; "in the stem no outer epithelium can be expected; its absence is a proof that the chitinous sheath is a product of the differentiation of the ectoderm."

The chitinous theca therefore of *Clytia* is not homologous with that of *Cordylophora*. Beneath this "epidermis layer" of *Clytia* follows a deeper ectoderm layer, corresponding to the neuro-muscular layer of *Hydra*, &c., which differs in the "body" and stem of the polyp; in the former there is a thick homogeneous layer to which the term middle zone ("*mittelzone*") is applied; this in the stem and the disk of the polyp becomes a distinctly cellular layer, one passing into the other without any break; the outer cellular layer of the stem is not therefore, as might appear from a casual inspection of Klaatch's figure, the equivalent of the outer ectoderm layer—the "epidermis-schicht," but really represents the "mittelzone," and has nothing to do with the formation of the outer chitinous layer which is formed by a metamorphosis of the "epidermis-schicht."

The different conditions of the middle zone may be perhaps explained by its different functions in the body and stem of the polyp respectively; in the body it undergoes alterations of diameter in various stages of contraction, and from this fact appears to be rather muscular than nervous in nature; in the stem, on the other hand, the rigidity of the chitinous investment would seem to render the presence of a muscular layer unnecessary, and it is very possible that the cells which in this region of the polyp represent the "muscular" layer of the body are modified to form nervous structures which receive impressions and control the movements of the muscular layer of the body, with which, as has been already stated, they are in direct connection.

Structure of the Velellidæ.*—M. Bedot finds that in young Velellidæ the two layers of which the crest of the pneumatocyst is formed are not united together; they first appear as a fold of the upper part of the pneumatocyst. The "liver" is of some complexity; on its upper or convex part there is a single layer of cells which is in direct contact with the pneumatocyst; below this is a lamella, in which no cellular structure could be made out; against this there are applied the canals of the "liver," which form a kind of roof for a large mass of cnidoblasts; the presence of these last demonstrates that the so-called liver does not perform hepatic functions. Below it there are again some canals which differ from the more superior by being unpigmented; they are attached to a similarly structureless lamella. The two sets of canals are connected with one another through the substance of the organ.

The complicated vascular system arises simply as two straight canals which open into the marginal one; they bifurcate at a short distance from their point of insertion. In the course of their development they become sinuous and give rise to a number of ramifying cæca, which anastomose with those of the adjacent canals.

* Arch. Sci. Phys. et Nat., xi. (1884) pp. 328–30.

Actiniæ of the Bay of Naples.*—A. Andres publishes the first half of his monograph, in which he limits himself to the bibliography and systematic descriptions of the species; this is very fully done, and the plates are of exquisite beauty.

Protozoa.

Morphology and Anatomy of Ciliated Infusoria.†—E. Maupas commences an important essay with a brief review of the more valuable works that have already appeared; after which he enters on a description of *Colpoda cucullus*, the food of which is stated to consist of bacteria, vibrios, micrococci, and small monads. *Colpoda steinii* is next dealt with, in which four forms are distinguished. These two species are very widely distributed.

A new genus *Cryptochilum* is instituted for the *Cyclidium nigricans* of O. F. Müller, which, though closely allied to *Paramecium*, *Colpoda*, *Colpidium*, and *Cyclidium*, may, the author thinks, be justly distinguished from any one of them. A new species of this genus is *C. elegans*, which is much larger than *C. nigricans;* it was discovered near Algiers. *Paramecium griseolum* of Perty is removed to this genus; and *C. tortum*, found near Algiers, and *C. echini*, which was found living parasitically in the intestine of *Echinus lividus*, are described as new species.

Some parts of the structure of *Colpidium colpoda* are fully entered upon; *Glaucoma pyriformis* (*e*) is described in detail, and the structure of the mouth of *G. scintillans* is discussed. *Ophryoglena magna* is a new Algerian species which is fully described and compared with its allies.

A new genus *Ancistrum* is instituted for the *Opalina mytili* of Quennerstedt, and for *A. veneris gallinæ*, a new species found in *Venus gallina* at Algiers. They lead the life of commensals, and the genus is allied to *Pleuronema* and *Ptychostomum*. Quennerstedt failed to notice the mouth, which is, however, really present.

Nassula oblonga (found in the sea off Roscoff), *Chilodon dubius* which might almost be made the type of a new genus, *Holophrya oblonga* (sea off Algiers), and *Lagynus crassicollis*, from a similar locality, are all new species. *Loxophyllum duplostriatum* (new species) is remarkable for the characters of its striation, which at once distinguishes it from all its allies. Interspersed with and following these descriptions are notes on some other species, after which the author enters upon a discussion of the organology of the Oxytrichida. Before defining his terminology he very justly urges that a good comparative morphology can only be established by the aid of a very exact terminology, based on as complete a comparison as possible. In the case of the Infusoria this may seem to be impossible, but it is because it has not been vigorously aimed at that such differences obtain in the comparative studies of even the best naturalists. To cite some of the terms em-

* 'Fauna und Flora des Golfes von Neapel. ix. Die Actinien.' 1884, 459 pp. (13 pls.).

† Arch. Zool. Expér. et Gén., i. (1883) pp. 427–664 (6 pls.).

ployed: the ventral surface always carries the mouth and the various appendages which function in locomotion and in the production of the nutrient currents; the prebuccal and postbuccal regions vary greatly in their proportional extent, and it would seem that the suppleness and contractility of the body stand in an inverse relation to the development of the prebuccal region; this may be distinguished into a peristome and a lateral area; and they, also, differ in the proportional extent to which they are developed. Four kinds of appendages may be distinguished: vibratile cilia; cirri, which are stylet-shaped, and much larger at their base than at their free-end, and which may be abdominal, transverse, or marginal; setæ, which are filiform, homogeneous, and simple, but rigid like needles, and which may be dorsal or caudal; the latter are much longer and stronger; lastly, the vibratile membranes are either those properly so called, or are buccal "membranelles."

Actinotrocha saltans, *Gonostomum pediculiforme*, *Holosticha lacazei* n. sp. (seas near Algiers), *H. multinucleata* n. sp. (port of Algiers), *Uroleptus roscovianus* n. sp. are then described.

The author proposes to replace the terms Protozoa and Metazoa by those of Cytozoa and Histozoa.

Attention is directed to the characters of the naked Infusoria, which are not all members of the group Acinetæ, but are found also among the Ciliata. The existence of forms without an integumentary layer shows that its presence or absence is in no way associated with the grade of development to which a Cytozoon may arrive, but that the protoplasm is ready to take on the most varied forms and structure, without the addition of an external protecting layer. The views of Häckel as to the typical constitution of the integument of an Infusorian are discussed, and the conclusion is come to that the "cuticular layer" is perfectly distinct from the skeletal cuticular formation, that the ciliary and myophanous layers have no existence, and that the layer of trichocysts is a part of the sarcode and not of the integument. Contrary to the views of Häckel, with regard to whom Maupas expresses himself in the most energetic manner, the integument of ciliated Infusoria is looked upon as corresponding morphologically to the membrane of the cell, of which it has all the physical properties. The integument is, in fact, defined as any distinct superficial layer, which is intimately applied to the surface of the cell, and lives the same life as it does. The various conditions under which it presents itself are then described.

The physiological properties of the sarcode or cytosome strike one by their resemblance to those of the body of the Rhizopoda, and lead one to think that an Infusorian may be defined very exactly as a Rhizopod inclosed in an integument and provided with appendages which are destined to fulfil the external functions which the sarcode of the Rhizopod performs for itself.

The author's observations on the trichocysts are stated by him to confirm those of Allman. The doubly refractive bodies which have been ordinarily regarded by those who have studied them as urinary concretions, offer us an important specific character, as they may be

present in one species and absent from another which closely resembles it. The fibrillated appearance of some of the appendages is regarded as being due to the coalescence of separate cilia. When the integument is highly differentiated and very distinct from the underlying sarcode, the orifice of the contractile vacuole is represented by a permanent and constantly visible pore. The author concludes with some observations on the nucleus and nucleolus, in which he insists on the fact that the latter is certainly absent from some forms, even in those that are multinucleated, and he points out the difficulty which this absence presents to our accepting the views of Balbiani as to the mode of conjugation of the Ciliata.

Trichomonas vaginalis.* — J. Künstler has now published the full text of his article on this flagellate, a preliminary notice of which was given *ante*, p. 67.

Acanthometra hemicompressa.†—Dr. L. Car gives an account of this new Radiolarian which is characterized as follows:—The spicules are long and thin, pointed at the extremity; the basal portion is quadrangular, the distal half is circular in transverse section, the proximal half lenticular, the two halves are of equal breadth, and this distinguishes the species from *A. compressa;* the spicules are elastic, but the elasticity is not so well marked as in *A. elastica;* the basal portion which is inserted into the central capsule is quadrangular and provided with triangular wing-like processes; it terminates in a fine point; although these spicules are so elastic they appeared usually to be broken. The central capsule is transparent, and the distal portion only of the spicules projects outside; as in other Radiolarians the central capsule contains a number of colourless and yellow cells. In its general characters this species is intermediate between *A. elastica* and *A. compressa.*

Orbulina universa.‡—The life-history of this foraminifer has been a subject of much discussion. Pourtalès and Krohn both observed what was apparently a *Globigerina* in the interior of many *Orbulinæ*, and came to the conclusion that *Orbulina* was merely a stage in the life-history of *Globigerina;* this opinion was combated by Carpenter, who adduced numerous reasons for retaining the two genera *Orbulina* and *Globigerina* as defined originally by D'Orbigny.

C. Schlumberger, in numerous specimens of *Orbulina universa* dredged during the voyage of the 'Talisman' from a depth of about 2000 fathoms, observed the same phenomenon; of the smaller examples some contained within their cavity a "succession of globular chambers, arranged in a spiral fashion, like those of certain *Globigerinæ*," while others did not contain any trace of such a structure; the very large specimens also were nearly always empty.

On examining with care this *Globigerina*-like body its "plasmostracum" was found to be extremely fine, and traversed by widely scattered perforations; the chambers forming the two first turns of

* Journ. de Microgr., viii. (1884) pp. 317–31 (2 pls.).
† Zool. Anzeig., vii. (1884) pp. 94–5.
‡ Comptes Rendus, xcviii. (1884) pp. 1002–42.

the spiral are quite smooth, whereas the following ones are provided with spines which reach as far as the outer wall of the *Orbulina* and are there fixed firmly to it; the several chambers communicate with each other and also with the interior of the *Orbulina*.

Now in an independent *Globigerina* the plasmostracum is always relatively thick, the perforations are close together, in short, it differs in many respects from this *Globigerina*-like body with which it only agrees in a general similarity of form.

It appears, therefore, that the most probable explanation is that *Orbulina* is another instance of dimorphism among the Foraminifera such as has already been shown to exist in other genera of that order by the author and M. Munier-Chalmas.

Nuclear Division in Actinosphærium eichhornii.*—A. Gruber has a note on R. Hertwig's observations on the division of the nucleus of this Protozoon. In the resting nucleus Hertwig distinguishes a nuclear membrane, which is best seen after the addition of reagents, the nuclear substance, and the framework of achromatic substance therein suspended. In the nucleolus there may be distinguished from the nuclein (chromatin) paranuclein which does not take up colouring matter and is much smaller in quantity; the nucleolus varies greatly in form, and may become completely broken up into two or more nucleoli; there are often as many as six or even twenty, and they then form fine rods united into a rosette.

When the nuclei begin to divide there appear two special protoplasmic cones, which lie outside the nucleus, and which, though they give rise to a spindle-shaped body, are clearly not the so-called nuclear spindles. The nucleolus next begins to break up, and the nucleus forms a sphere filled with regularly distributed and very fine granules; these pass to the periphery, where they give rise to two hyaline caps and an equatorial band of granules. In this last there appears a dark band, the nuclear plate, and in the rest of the granular mass fine filaments which give rise to the polar plates. These filaments traverse the nuclear plate and so form a system which extends directly from pole to pole. Lateral plates become formed which have the concave side directed towards the centre of the mass, and from these arise daughter-nuclei which form small, rounded, finely granular bodies.

It is clear from these observations that the nuclein in the nucleus of *Actinosphærium* is not a spongy framework; the processes described are intermediate between the phenomena which obtain in other Protozoa on the one hand, and in animal and vegetable cells on the other. As in the former, the nucleus is sharply limited at every stage of division, and undergoes a biscuit-like constriction; the internal changes remind one rather of what obtains in multicellular organisms. The remarkable polar plates find their homologues in the nuclei of the infusorian *Spirochona gemmipara*. Gruber ascribes the errors in his own previously published observations to the imperfect preservation of the material with which he had to work.

* Biol. Centralbl., iv. (1884) pp. 233–5.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Homology of the Reproductive Organs in Phanerogams and Vascular Cryptogams.*—L. Celakovsky has made a fresh detailed investigation of this subject. He maintains his previous view, held also by Warming and Prantl, of the homology of the integuments of the ovule with the indusium of ferns, as is sufficiently proved by the phenomena of phyllody of the ovule, which show that the ovule is due to a transformation of a segment of a fertile leaf together with the nucellus or macrosporangium belonging to it; the integuments being formed from it in just the same way as the indusium from the fertile leaf-tip of the Filicineæ. The nucellus is formed directly from the upper part of the ovular papilla; the integument then springing from its base and enveloping it; this being followed in most cases by a second envelope formed in the same way outside the first. The nucellus being homologous to a sporangium, the mode of formation of the ovule coincides with that of the sporiferous leaf-segment of *Lygodium*, the sporangium of *Lygodium* being formed at the apex of a segment of a fertile leaf, just like the nucellus on the ovular papilla, and the indusium round the sporangium just like the single or double integument round the nucellus. In *Trichomanes* the only difference is that the sporangium is replaced by the sporiferous receptacle. When normally dichlamydeous ovules undergo phyllody, they become monochlamydeous, and form a simple stalked cup which corresponds to the integuments, the stalk corresponding to the funiculus. The nucellus sometimes occupies its normal terminal position at the bottom of the cup, sometimes it is pushed towards its rim. The segment of a fern-leaf which bears the indusium on its under side corresponds to the outer ovular integument in Angiosperms.

In the Hymenophyllaceæ the indusium is not formed from the apex of the leaflet which corresponds to the nucellus or receptacle of the sorus, but as a lateral new formation. The single terminal sporangium appears to be more archaic than the polyangic sorus with its receptacle. The author believes that the sexually produced generation (non-sexual generation) of the first Vascular Cryptogams originated from the branching of the sporogonium of a moss. The sporangium of ferns is then homologous, from a phylogenetic point of view, to the sporangium of mosses, notwithstanding its different morphological value. The sporangium of Schizæaceæ is an older stage of development, and that of Ophioglossaceæ older still, where the integuments are entirely wanting, and the sporangium is therefore formed from the greater part of the leaflet, perfectly homologous to the naked ovule of the Santalaceæ, Balanophoreæ, and *Crinum*.

* Pringsheim's Jahrb. f. Wiss. Bot., xiv. (1884) pp. 291–378 (3 pls.).

The original position of the nucellus on the leaf-segment is always terminal; but as soon as the leaf-segment assumes a foliar character, it takes its place on its upper side; and this is a universal law for vascular cryptogams and phanerogams alike.

If we now look at the homologies of the reproductive organs outside the true Filices, we see that the fertile leaves of cryptogams with marginal sporocysts, like *Botrychium* and *Ophioglossum*, are the prototype of the carpids of Phanerogams with marginal ovules; and that the fertile leaf of *Lycopodium* with axillary or subaxillary sporocyst, is the prototype of a carpid with axillary ovule, like *Euphorbia* and *Ranunculus;* and that this is also the case with a carpid with ovule terminal to the axis of the flower, like *Polygonum*, which, notwithstanding this position, undoubtedly belongs to a carpid of the ovary.

With regard to the phenomena of coalescence in the various groups, Celakovsky makes the following observations:—

1. In Angiosperms the trumpet-shaped carpellary leaves of a flower coalesce into a septated ovary. 2. In Marsileaceæ the cornet-shaped leaf-segments of a fertile leaf coalesce into a 2- or multilocular sporocarp, the homologue of an integumented ovule. 3. In Psiloteæ the sporangia coalesce with one another as the homologue of a branched but naked ovule. In Marattiaceæ the numerous emergence-like sporangia coalesce into a multilocular homologue of coalescent nucelli of an ovule.

As regards the ovules of Gymnosperms, those of Cycadeæ are distinguished from the homologous sporangia of the Ophioglossaceæ only by being invested with an integument; and their carpellary leaves from the fertile leaves of Ophioglossaceæ only by the latter being bifurcate.

The Coniferæ are divided by Strasburger into two main groups: (1) the Araucariaceæ (including the Araucarieæ, Abietineæ, Cupressineæ, and Taxodieæ), and (2) the Taxaceæ (including the Taxeæ, Podocarpeæ, and Cephalotaxeæ), which differ so greatly in their morphological characters that they must be considered separately.

The ovules of the Araucariaceæ have only a single integument, and spring from the under side of the carpids which coalesce into a fertile scale and stand in the axil of a bract; turning towards it, according to the law of inversion, their upper side, and coalescing with it slightly in the Abietineæ, very closely in the other families. The phenomena of prolification of the cone show that in the Abietineæ the simple scale-like carpels produce each one ovule on its under side. This is a carpel in its simplest possible form, and homologous to the possible case in which the fertile leaf of a cryptogam, e. g. Lycopodiaceæ, should produce a single indusium on its under side. This is also the most probable interpretation of the structure in the Cupressineæ and Taxodieæ, though not so certainly as in the Abietineæ.

In Taxaceæ the ovule has two integuments, except in *Gingko* (*Salisburia*) and *Cephalotaxus*, and is inserted on the upper side of the carpel, sometimes higher, sometimes at the base or in the axil of the leaf. The "cones" of the Cycadeæ, Podocarpeæ, &c., are flowers

composed of carpels, while those of the Araucariaceæ are true spikes, the bracts of which produce the coalescent carpels in their axils.

The mode of formation of the anthers differs in Gymnosperms and Angiosperms. The type of stamen in the Coniferæ and Gnetaceæ is derived from that in the Equisetaceæ, and more remotely from that in the Ophioglossaceæ; the stamens of Cycadeæ corresponding to the more or less peltate type in ferns with sori on the under side, especially in Gleicheniaceæ and Marattiaceæ.

The anther of Angiosperms is developed from a sporophyll of the Ophioglossaceæ, but in a different way from that of Coniferæ, viz. from the form in *Ophioglossum* rather than in *Botrychium* or *Helminthostachys*. The difference between a pollen-sac of Coniferæ and a loculus of the anther of Angiosperms, is that the former is homologous to a single sporangium, the latter to a row of coalescent marginal sporangia. The normal anther of Angiosperms is also distinguished by the peculiarity of having not two but four loculi, as is clearly shown by the phenomena of phyllody of the stamen.

Influence of Light and Heat on the Germination of Seeds.*—A fresh series of experiments on this subject, undertaken by A. Cieslar, leads him to the conclusion that the effect of light on the germination of seeds is very complicated, and varies with the species, depending greatly on the amount of reserve food-material in the seed. The rays of different refrangibility also produce different effects. In white and yellow light much greater development takes place than in violet light or in the dark; and this difference increases with increase of temperature. He believes the effect to be greatly due to a transformation of light into heat. The production of substances which cause osmose in seedlings growing in white or yellow light is favourable to germination, by bringing about increased root-pressure. Seeds with but a small amount of reserve food-material germinate better in light than in darkness; light promoting not only the penetration of the roots into the soil, but also the copious production of roots.

A. Ritter von Liebenberg† confirms these conclusions on the whole, and regards the intermittent heat resulting from alternation of day and night as distinctly favourable to the germination of seeds.

Origin of the Placentas in the Alsineæ (Caryophylleæ).‡—Miss G. Lister, in view of the fact that in *Lychnis* the first developed ovules are developed along the unattached margins of the dissepiments in the upper unilocular portion of the capsule, the placentas being therefore carpellary, considers that as the capsule in Alsineæ is developed on essentially the same plan as that of *Lychnis*, we are bound to admit that the placentas in the Alsineæ, from *Sagina apetala*, which most resembles *Lychnis*, to *Cerastium triviale* which most widely differs from it, are carpellary also.

* Wollny's Unters. aus d. Geb. der Agricultur-physik, vi. (1883). See Bot. Centralbl., xviii. (1884) p. 13.

† Bot. Centralbl., xviii. (1884) pp. 21–6.

‡ Journ. Linn. Soc. Lond.—Bot., xx. (1884) pp. 423–9 (4 pls.).

Gemmæ of Aulacomnion palustre.*—This moss was found in 1882 growing in the propagating pits at Kew, where it flourished without, however, showing any trace of sexual organs. F. O. Bower finds that ordinary vegetative axes often bear towards their apices structures of a foliar nature, and show a special adaptation for effecting the asexual or vegetative reproduction of the plant. On passing upwards along one of these axes or pseudopodia, there is found a gradual transition from the normal leaf to the leaf-gemmæ, which are readily removed from the plant by a slight mechanical disturbance, and are then capable of immediate germination when laid on damp soil or floating in water.

Relation between Increase and Segmentation of Cells.†—Prof. Beketoff criticizes Sachs' theory as to the relations between the increase and segmentation of cells in the embryonal parts of plants. While he warns one against the application of geometrical theories to botany, he points out how some of the conclusions arrived at by Sachs could be more easily explained by the principles established by Hofmeister.

Development of Starch-grains in the Laticiferous Cells of the Euphorbiaceæ.‡—The development of the starch-grains in the laticiferous cells of the Euphorbiaceæ is described by M. C. Potter as taking place in the interior of rod- or spindle-shaped starch-forming corpuscles which lie in the parietal protoplasm of the cell.

The starch-grain is at first visible, through the agency of iodine, as a thin streak in the interior of the starch-forming corpuscle. This streak, through the deposition of starch, assumes a rod- or spindle-shape; it increases in length and breadth, the starch-forming corpuscle at the same time increasing. When the starch-grain has attained nearly to its maximum dimensions in length and breadth, the starch-forming corpuscle collects at both ends of the rod-shaped grains, and there forms the masses of starch at the end of the rod, causing it to assume its remarkable shape, resembling a bone. The starch-grains are doubly refractive, but instead of the black or white cross of other starch-grains they show a central black (or white) line surrounded on both sides by white (or black) lines.

Constitution of Chlorophyll.§—E. Schunck extracts leaves with boiling alcohol, and after some time filters; the filtrate is mixed with its own volume of ether and two volumes of water; it then forms two layers, which are separated. The lower layer is yellow, and reduces Fehling's solution. The upper layer is green, and contains all the chlorophyll; it is thoroughly washed free from everything soluble in water. When the ether is evaporated the bright green residue, dissolved in alcohol and treated with alcoholic potash, does not reduce Fehling's solution, but if it is previously treated with concentrated

* Journ. Linn. Soc. Lond.—Bot., xx. (1884) pp. 465–7 (4 figs.).

† Mém. Soc. Naturalistes St. Pétersbourg, xiii. See 'Nature,' xxix. (1884) p. 461.

‡ Journ. Linn. Soc. Lond.—Bot., xx. (1884) pp. 446–50 (4 figs.).

§ Proc. Roy. Soc., xxxvi. (1884) pp. 183–5, 285–6.

sulphuric acid in the cold, or if its alcoholic solution is boiled with hydrochloric or sulphuric acid, the alcohol driven off, the residue treated with water, filtered, and the filtrate made alkaline, mixed with Fehling's solution and boiled, the usual glucose reaction is obtained. The glucose or glucose-like substance is a pale-yellow gummy compound. The author, therefore, concludes that chlorophyll is either a glucoside, or is associated with a glucoside.

Cellulose accompanying the Formation of Crystals.*—A. Poli has already noted † the occurrence in the pith of a number of plants belonging to the order Malvaceæ, of clusters of crystals attached to the cell-wall by strings of cellulose. He has now examined more closely the structure of these strings, and finds them to be hollow tubes. They generally exhibit swellings here and there, and bright refringent spots, which are probably the points of origin of new crystals. Their composition is the same as that of the cell-wall, and they not unfrequently become lignified in the same way. They appear to occur in all the arborescent species of the order, most beautifully in *Malvaviscus mollis*, but have not been observed in *Malva sylvestris*.

Middle Lamella of the Cell-wall.‡—In the course of his investigations on the continuity of protoplasm through the walls of cells, W. Gardiner has investigated the structure of the middle lamella of cell-walls, formerly known as "intercellular substance." He found the mucilaginous degeneration of the cell-wall to be a phenomenon of very frequent occurrence; and that this mucilage is very liable to be mistaken for protoplasm, owing to its being also stained by Hofmann's blue. In certain cells, such as bast-prosenchyma cells of the pulvini of *Mimosa*, and the endosperm of many palms, the cell-walls consist of pure cellulose, and the middle lamella is but little developed; it is more resistant, but still distinctly soluble in sulphuric acid. In other instances, such as the lignified prosenchyma cells of the cortex of *Lycopodium*, it is well defined, but lignified, like the rest of the layers. In other cases it may be at once converted into mucilage. The great point with regard to middle lamellas other than cellulose is that in their substance the maximum amount of change appears to have taken place, i. e. almost the whole of the cellulose has been converted into lignin, cutin, or mucilage, as the case may be, and thus but little of the cellulose framework left. This will explain the fact that, after treatment with Schulze's mixture or other oxidizing agent, the various cells readily separate from one another; for the whole of the middle lamella has dissolved, the cellulose framework of the cells alone remaining. It would thus appear that in unaltered cellulose walls the middle lamella consists of dense cellulose, while in lignified, cuticularized, corky, or mucilaginous cells the changes which occur in the middle lamella are of the same character as those of the rest of the membrane, and have reached their maximum.

* Nuov. Giorn. Bot. Ital., xvi. (1884) pp. 54–6 (1 pl.).
† See this Journal, ii. (1882) p. 597.
‡ Proc. Camb. Phil. Soc., v. (1884) pp. 1–20.

Intercellular Spaces between the Epidermal Cells of Petals.* —While the cells of the epidermis of leaves fit close to one another without any intervening spaces except the stomata, the case appears to be very different, according to G. H. Hiller, with the epidermis of petals, where there are very often spaces between the cells, especially in Dicotyledons. The size and form of these spaces vary with the species; in *Linum usitatissimum* they have a breadth of from 2·63 to 7·175 μ, and a length of from 13·15 to 15·78 μ. The largest measured had a diameter of 18 μ. They are situated either between the walls of the cells themselves, and then usually at the point of contact of several cells, or in rib-like foldings of the cell-walls. On the inner side of the leaf they are usually open, where not accidentally covered by a parenchyma-cell, while on the outer side they are always covered by the cuticle. They almost always originate from ribs which must be regarded as foldings of the cell-wall, which ribs split at a certain stage of development. Very rarely they occur in epidermis with straight-walled cells, and then always from their effort to round themselves off. They are then always found at the point of contact of several cells. Intercellular spaces of this kind may be observed in the petals of *Musa rosacea* and *Erythrina cristagalli*.

Contents of Sieve-tubes.†—E. Zacharias has examined, by ordinary macrochemical tests, the contents of the sieve-tubes of *Cucurbita Pepo*, which flow out in large quantities when the stem is wounded, and can be readily separated from the cell-sap. They consist of albuminoids, non-albuminous organic substances, and inorganic salts.

The albuminoid substances readily separate from the juice which flows from the sieve-tubes, after standing for a short time, in the form of a transparent, colourless, moderately stiff jelly. Chemical tests show that this substance is of the nature of fibrine, mixed with a small quantity of a substance insoluble in the gastric juice and in dilute potash ley. When this substance has been removed by concentrated alcohol, the filtrate turns the plane of polarization to the right. The substance which remains is of the nature of dextrin, which is transformed into glucose by dilute sulphuric acid. The presence of a nitrate or nitrite can also be determined both in the aqueous solution of the substance and in its ash. The question of the presence or absence of amido-acids and of organic nitrogenous compounds soluble in water in the contents of the sieve-tubes was not satisfactorily settled.

Of inorganic salts there was found in the ash distinct evidence of the presence of magnesia. The probable presence in the sieve-tubes of potassium phosphate was also indicated, and to this is probably due the alkaline reaction of the juice.

Organs of Secretion in the Hypericaceæ.‡—J. R. Green describes the organs that secrete the ethereal oil or resin with which the

* Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 21–3.
† Bot. Ztg., xlii. (1884) pp. 65–73.
‡ Journ. Linn. Soc. Lond.—Bot., xx. (1884) pp. 451–64 (2 pls.).

tissues of the Hypericaceæ abound. He concludes, (1) that the view advocated by Link, Martinet, and de Bary of the lysigenous origin of the reservoirs of ethereal oil in these plants is the correct one. (2) That there exists in many parts of the plants a series of ducts or passages differing only slightly from these reservoirs; the differences being that they are not globular and isolated, but are generally connected more or less intimately with each other, and that their secretion is not a clear ethereal oil, but a viscid or resinous liquid, the points of agreement being those connected with their development and function. (3) In some species at least there is also a series of schizogenous ducts confined to certain portions of the phloëm. (4) There are certain dark glands described in the paper which are in intimate relationship with the fibrovascular system. (5) The formation of resin and kindred secretions in these plants is confined to the parts where metabolism is active, and where there is a primary meristem. All such parts give evidence of such formation with the exception of the roots.

Tracheids of Gymnosperms.*—M. Scheit describes the group of peculiarly thickened cells (the tracheid-seam of de Bary) found in the leaves of conifers on both sides of the vascular bundle, at one time considered as a part of the transfusion tissue. In the living condition these are filled with water or aqueous vapour, but not with air, as is shown by placing twigs of *Pinus Pumilio* in turpentine oil. The cells themselves are true tracheids, exhibiting sometimes a reticulate thickening, sometimes bordered pits. These "seams" occur not only in conifers, but also in the other orders of Gymnosperms, the Gnetaceæ and Cycadeæ, where they consist of very small and few cells, greatly resembling the adjoining parenchymatous cells in the mode of thickening. They are therefore an anatomical characteristic of Gymnosperms generally.

The variation in the mode of thickening in these cells corresponds to their function as a protection against the pressure of neighbouring turgid cells. Where the "seams" are separated from the parenchyma of the leaf by thickened sheaths, the tracheids have only bordered pits; when they are in immediate contact with the parenchyma, they are thickened reticulately. The extent of development of these "seams" depends on the intensity of transpiration of the species. In *Pinus Pinea*, which spreads its crown as wide as possible beneath the clear sky of Italy, they are very strongly developed; while in *Pinus Strobus*, which prefers moist climates and thrives best in bogs, they are but very feebly developed.

Apparatus in Leaves for Reflecting Light.†—O. Penzig has examined the structure of the clusters of crystals found in the leaves of the Aurantiaceæ, clothed with cellulose, and attached to the wall of the mother-cell—the idioblasts of Pfitzer; and believes they are

* Jenaische Zeitschr. f. Naturwiss., ix. (1883) (1 pl.). See Bot. Ztg., xlii. (1884) p. 74.

† Atti Soc. Nat. di Modena, i. (1883) (1 pl.). See Bot. Centralbl., xvii. (1884) p. 333.

connected with the dispersion of the rays of light in the dense palisade-tissue. They always have their principal axis vertical to the surface of the leaf, and are fixed in this position by a peculiar band of cellulose. The rays of light fall, therefore, parallel to the principal axis of the crystals, and are dispersed on all sides from their reflecting surfaces, while those which pass through the crystals are refracted obliquely. It is possible that the subepidermal cystoliths in the leaves of *Ficus* have a similar property.

Swellings in the Roots of Papilionaceæ.*—F. Schindler has reinvestigated this subject, with reference to the previous researches of other observers; and has come to the conclusion that the peculiar swellings are not due to the attacks of a parasitic fungus, but to hypertrophy of the tissue surrounding the vascular bundles, though in some cases there appears to be a phenomenon akin to symbiosis. The species in which the peculiar structures were observed, were *Trifolium pratense*, *Vicia villosa*, *Phaseolus vulgaris*, and *Lupinus*.

Origin of Adventitious Roots in Dicotyledons.†—A. Lemaire discusses Van Tieghem's statement that lateral roots have their origin in the peripheral layer of the central cylinder which he denominates the pericycle, and points out that all Van Tieghem's examples are drawn from Monocotyledons. Lemaire finds among Dicotyledons two types, the first in which they spring from interfascicular spaces, the second from the pericycle, or layer of the central cylinder immediately beneath the endoderm. In the latter case they are always produced in the neighbourhood of large primary bundles. The cellular portion of the pericycle of two plants examined (*Mentha arvensis* and *Veronica Beccabunga*) divides by tangential walls into two layers, the inner of which produces the central cylinder, the outer one again dividing into two layers. The lower of these gives rise to the cortex, while the peripheral layer developes, by successive divisions, into the cap and piliferous layer of the root.

Crystals of Silex in the Vascular Bundles.‡—Pursuing the researches of G. Licopoli, R. F. Solla has examined the clusters of siliceous crystals found in the fibrovascular bundles of a number of species of palm, especially *Chamærops humilis* and *Phœnix dactylifera*. He finds them in rows in the immature fruit of the first-named and in the trunk of the last-named species, in the latter case occurring also in the vascular sheath. They are found also in the sclerenchymatous cells in the endosperm of the seeds of *Chamærops humilis*, and in the spathe of *Cocos Yatai*. They vary greatly in size according to the species; their chemical reactions show them to consist of pure silica.

Effect of Heat on the Growth of Plants.§—Following out his researches on this subject, J. Wortmann gives the minimum, the optimum, and the maximum temperature for growth in various plants. As a general law, it may be stated that thermotropism is a phe-

* Bot. Centralbl., xviii. (1884) pp. 84–9. Cf. this Journal, iii. (1880) p. 115.
† Bull. Soc. Bot. France, xxx. (1884) pp. 283–5.
‡ Nuov. Giorn. Bot. Ital., xvi. (1884) pp. 50–1.
§ Biol. Centralbl., iv. (1884) pp. 65–71. Cf. this Journal, iii. (1883) p. 873.

nomenon of irritation altogether analogous to heliotropism, and that hence, in order to bring about thermotropic curvatures, the only factor to be regarded is the direction in which the rays of heat, if of sufficient intensity, strike the part of the plant in question.

Curvature of Roots.*—J. Wiesner has made a further investigation of the "darwinian" and the geotropic curvature of roots, with the following results:—

1. The so-called "darwinian" curvature of roots, caused by injury to one side of the apex, has a double character, a secondary curvature taking place above the maximum zone of growth, while the primary curvature is below it.

2. The primary curvature is the result of growth, the secondary curvature simply of turgidity, the cells above the injured spot increasing in length. If the root is decapitated, the zone above the wound, within which the darwinian curvature takes place, is elongated, the cell-walls becoming more extensible.

3. The darwinian curvature combines with other paratonic nutations, as for example with geotropic curvature. Geotropism frequently neutralizes the darwinian curvature.

4. The entire growth of decapitated roots grown in damp media is less than that of those that remain uninjured; while the lower zone of such roots nearest the apex undergoes great extension in consequence of the increase of extensibility of the cell-walls. In decapitated roots grown under water this pathological increase in length is so great that the total growth of such roots is greater than of unmutilated ones.

5. The decapitation of roots causes a diminution of the turgidity of the cells; and since geotropic curvature decreases with this diminution, it follows that decapitated are less geotropic than uninjured roots.

Torsion as a Cause of the Diurnal Position of Foliar Organs.†—According to O. Schmidt, light, by promoting the growth in length of the shaded side of organs, can produce curvatures, but not torsions. So-called heliotropic torsions are due to the action of gravitation. The ordinary diurnal position of leaves is a result of the combined action of light and of gravity, the latter causing the torsion without which the position could not be attained.

Assimilative Power of Leaves.‡—J. Sachs has carried out a series of experiments on a number of plants growing in the open ground, for the purpose of ascertaining the phenomena connected with the formation of starch in the chlorophyll-grains, and its disappearance under normal conditions of vegetation. The results arrived at are very remarkable, in showing the extraordinary rapidity with which starch is formed and again disappears when the conditions of vegetation are favourable. The plan pursued was to remove the chlorophyll by alcohol, and then employ the iodine test to determine the presence of starch. Leaves may be perfectly decolorized by first boiling in

* Anzeig. K. Akad. Wiss. Wien, 1884. See Bot. Centralbl., xviii. (1884) p. 95.
† Ber. Deutsch. Bot. Gesell., i. (1883) pp. 504–11.
‡ Arbeit. Bot. Inst. Würzburg, iii. (1884) pp. 1–33.

water for a few minutes, and then for a short time in alcohol. If then placed in a strong alcoholic solution of iodine, the decolorized leaf will be stained a buff-yellow if no starch is present, blue-black if starch is present in great quantities, with intermediate shades according to the amount of starch.

The formation of starch is entirely dependent on the presence of light; and Sachs's experiments show that the starch formed during the day may disappear completely during the night; the cells of the leaves being full of starch in the evening and quite empty in the morning, when the conditions of temperature are favourable. It is stated that the starch disappears in the form of soluble glucoses, which travel, through the vascular bundles, to the parts where they are wanted for purposes of growth. Although this process takes place chiefly in the night, it is also going on more slowly through the day, but is then masked by the much more energetic production of starch. The transformation of starch into sugar may possibly be due to the presence of a diastatic ferment in the cells of the leaf.

By an ingenious contrivance the quantity of starch produced and converted into glucose was approximately measured. In *Helianthus annuus* 4·64 grms. disappeared in ten hours from 1 sq. m. of leaf-surface; and in the same plant 9·14 grms. were formed in the same time on the same area. In another case, where the leaves were removed from the stem to prevent the return of the starch from the leaf to the stem, a sq. m. was found to produce starch at the rate of 1·648 grm. per hour. As a general result, Sachs concludes that, in ordinary circumstances, a leaf may produce in the day from 20 to 25 grms. of starch per sq. m. of surface; and under certain conditions it may even be larger.

Quantitative Relation between Absorption of Light and Assimilation.*—T. W. Engelmann gives the result of a number of observations on this point, accompanied by mathematical formulæ. He regards the bacteria-method † as far the most exact for the purpose. The general results may be stated as follows:—The absolute minimum of absorption lies in the outermost red. Between B and E, to the highest degree at F, lie one or more maxima and minima. The amount of absorption increases constantly, attaining its maximum in the more refrangible part of the visible spectrum. The amount of assimilation corresponds to the amount of absorption in all cases from the outermost red to the green; while in the more refrangible part the amount of assimilation falls notwithstanding a regular increase of absorption.

Causes which Modify the Direct Action of Light on Leaves.‡—Pursuing this subject, E. Mer arrives at the following conclusions:—

1. The position of leaves is not always an index of their direct relation to light; for this sometimes results from influences which modify more or less the direct action of light.

* Bot. Ztg., xlii. (1884) pp. 81–93, 97–105 (1 pl.).

† See this Journal, iii. (1883) p. 390.

‡ Comptes Rendus, xcviii. (1884) pp. 836–8. Cf. this Journal, iii. (1883) p. 386.

2. The diurnal sleep of leaves must not always be regarded as a result of this action acquired to protect them from too great radiation; for if, in certain cases, either their position or the direction of the rays of light is changed, they do not again place themselves in a position to be illuminated by the most oblique incidence.

3. The terms diaheliotropism and paraheliotropism, employed in their wide signification, must therefore serve only to indicate the positions of leaves in reference to the direction of the rays of light, without expressing an opinion on the causes which produce them.

Respiration of Leaves in Darkness.*—G. Bonnier and L. Mangin find that, in the case of green leaves growing in darkness, the same law of respiration prevails as in organs destitute of chlorophyll, viz. that the relationship between the volume of carbon dioxide given off and that of oxygen absorbed is constant, whatever the temperature, both increasing rapidly with rise of temperature.

Movements of the Sap in the Root-tubers of the Dahlia.†—K. Kraus has confirmed the remarkable observation that a tissue with acid sap may exude an alkaline fluid or at least one that becomes very rapidly alkaline. The absorption of water by the tubers of the dahlia takes place not at all or very slightly through the surface, but almost entirely through the roots which are produced in abundance in October and November. An abundant "bleeding" or exudation of sap takes place from uninjured leaves and from the axils of the leaves; also from transverse sections, which ceases as soon as the tubers are deprived of their roots.

There is not in the tubers any sharp distinction between the medullary rays and the xylem-parenchyma, the mass of the root consisting mainly of rows of radially elongated parenchymatous cells. There are, however, darker portions composed of tracheids surrounded by a sheath of thick-walled parenchyma, corresponding to the "fibre-cells" of normal wood. When the tubers are cut off sap exudes especially from the periphery of the xylem, most abundantly on transverse and tangential sections, and proceeding mostly from the closely inclosing parenchyma, partially also from the sieve-tubes and pith. That which exudes from the sieve-tubes is alkaline, from the wood and pith acid; inulin was also detected in it. The cause of this exudation of sap the author regards to be tension of the tissues. After the alkaline "bleeding" from wounded tubers has ceased, the formation of cork commences on the wounded surfaces. The alkaline reaction is probably the result of decomposition.

Absorption of Water by the Capitulum of Compositæ.‡—A. Burgerstein notices that the flowers of Compositæ possess the faculty of absorbing water from without through the epidermis; and that the under side absorbs water more rapidly than the upper side.

* Comptes Rendus, xcviii. (1884) pp. 1064–7.

† Wollny's Forsch. aus dem Geb. der Agricultur-physik, vi. (1884). See Bot. Centralbl., xviii. (1884) p. 65.

‡ Ber. Deutsch. Bot. Gesell., i. (1883) pp. 367–70.

Measurement of Turgidity.*—H. de Vries applies the term "isotonic concentration" to the degree of concentration of different solutions in which they attract water with equal force. The strength of a solution of potassium nitrate, which has the same affinity to water as the solution to be examined of any other substance, is termed the "nitre-value" of that substance. Representing the attractive force of a solution of potassium nitrate at 3, the numbers 2, 3, 4, or 5 might express that of other solutions. These numbers, representing the attractive force for water of a molecule of the substance in question in a dilute aqueous solution, are the isotonic coefficients of the different substances.

The author describes in detail three methods of determining the isotonic coefficients of a substance:—(1) The plasmolytic method, by placing as similar pieces as possible of the tissue in solutions of different concentration of the substance in question and of potassium nitrate, and observing the degree to which the parietal protoplasm is detached from the cell-wall. This method can be applied in the case of only a few plants. (2) The method of plasmolytic transport: by measuring under the camera the plasmolysis which occurs on placing the preparation in a solution of a salt which causes moderate plasmolysis; then transferring to solutions of different concentration of other salts, and again observing the plasmolysis. (3) The method by tension of tissue, by observing the curvature of split terminal portions of shoots in concentrated solutions of the substance to be examined.

By turgidity the author understands the affinity of the dissolved substance for water, and gives detailed results as to the proportion of the turgidity due to the different constituents of the cell-sap, the most important of these in this connection being sugar, oxalic acid, and malic acid. Since the turgidity is constantly being changed by substances out of which protoplasm is developed, the inquiry is one of great importance in vegetable physiology. As a general rule, the author finds the isotonic coefficients nearly to correspond for members of the same chemical group.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Origin of Roots in Ferns.†—Lachmann has studied the cauline fibrovascular system of the ascending rhizome of *Aspidium Filix-mas*, which forms a network of hexagonal meshes, from the periphery of which spring the foliar and radical bundles. The former are from five to seven in number, one, medio-dorsal, springing from the bottom of the network, the others inserted symmetrically on its borders.

* Pringsheim's Jahrb. f. Wiss. Bot., xiv. (1884) pp. 427–601; also Vers. Med. K. Akad. Wetensch. Natuurk., xix. (1883) pp. 314–27. See Bot. Centralbl., xvii. (1884) p. 170.

† Comptes Rendus, xcviii. (1884) pp. 833–5.

The radical bundles are always three in number, one median inferior and two lateral, placed symmetrically on the lower half of the network. The lower radical bundle always springs from the upper extremity of a vertical bundle of the stem, inserted on its outer side, almost always exactly in the middle, and often a little lower than the medio-dorsal foliar bundle. From this point it rises obliquely in the cortex, and after passing from 5 to 7 mm. bends, becomes thinner, and goes out at the base of the petiole with the roots of which it forms the central cylinder.

This inferior radical bundle is almost always absolutely independent, but this is not always the case with the lateral radical bundles. These latter have often a common point of departure with the lower lateral foliar bundles, to which they may adhere for a length varying from 2 to 4 mm.; but the portion of this common base which belongs to the radical bundle is generally clearly to be distinguished from that which belongs to the foliar bundle, and sometimes the two bundles are altogether distinct from their insertion. These lateral roots behave differently from the inferior root; after an oblique course they pierce in the same way the cortex of the petiole, the superficial layers of which form a cushion round their base.

The examination of other ferns confirmed the view that in the radical bundles we have a simple coalescence of two bundles originally distinct.

In all Polypodiaceæ the adventitious roots spring from the cauline network, and not from the base of a foliar bundle, even in those species where, in the adult state, coalescence frequently occurs.

Monograph of Isoeteæ.*—L. Motelay and Vendryès publish a monograph of the existing species of Isoeteæ, founded on the materials left by Durieu.

Systematic Position of Lepidodendron, Sigillaria, and Stigmaria.†—B. Renault maintains his previous view as to the relationships of these fossil organisms, against the objections of Williamson and Hartog. He considers that those Sigillariæ which can be determined with certainty belong to the Gymnosperm type, while the species of *Lepidophlois* have the characteristics of Lycopodiaceæ. The Stigmariæ must be regarded partly as rhizomes of Gymnosperms; the anterior portions must have had only leaves with monocentric vascular bundles, the anterior part, after the fall of the leaves, only adventitious roots with tricentric vascular bundles; while in the middle were both roots and leaves. This may serve to explain the conflicting descriptions of various writers.

* Actes Soc. Linn. Bordeaux, xxxvi. (1883) (10 pls.). See Flora, lxvii. (1884) p. 47.

† Renault, B., 'Considérations sur les rapports des Lépidodendrons, des Sigillaires et des Stigmarias,' 32 pp. (1 pl.) 1883. See Bot. Ztg., xlii. (1884) p. 139.

Muscineæ.

Variations in Sphagnum.*—C. Jensen discusses the causes of the great disposition to vary displayed by the different species of *Sphagnum*, and attributes it, in the first place, to the influence of water, and secondarily to variations in the light, temperature, and in the nature of the soil.

When the plant grows completely submerged, all the parts are larger and longer; the stem-leaves become larger, as also do their hyaline cells, which are often provided with pores and spiral thickenings; these leaves then resemble those of the branches in their structure. Those branches which depend from the stem, forming an envelope round it, lose this structure and grow like the other branches, the fertile branches become longer, and are often inserted at a greater distance below the apex of the stem; the bundles of the branches stand at a greater distance apart.

Plants growing in a dryer situation are, on the contrary, more compact, with shorter stems and crowded short erect branches with closely adpressed leaves, as is especially seen in arctic forms.

When the moss grows in the shade it is of a brighter green and stronger growth. The fertile branches may be inserted beneath the apex of the stem, and are then somewhat elongated.

Forms sometimes occur with sickle-shaped branches, and others which resemble the extra-European species in having the stem-leaves of nearly or quite the same structure as those of the branches. These usually occur in dry places, but sometimes also in water.

Fungi.

Sexual Reproduction in Fungi.†—H. M. Ward gives an elaborate *résumé* of the facts at present known respecting sexual reproduction in the various classes of fungi. He points out that—at all events if the Basidiomycetes are set aside—the absence of sexual organs appears to be in direct proportion to the degree of parasitism developed by the fungus. There can be no doubt that the efficacy of any act of impregnation depends on some essential difference in the nature of the protoplasm of the two cells; that, in an oosphere, for example, the molecular energy of the protoplasm is less than that of the rest of the plant for the time being, and that the access of the antherozoid reinvigorates the sluggish mass, causing the renewal of active life. The dormant interval which frequently intervenes between impregnation and germination may be occupied by molecular rearrangements in the mass. The difference in the nature of the male and female protoplasm is indicated by the attractive force which the female frequently appears to exercise on the male element, as in the case of *Œdogonium*. The reinvigorating effect of the male protoplasm may last through many generations. The fact of the sexual organs having

* Bot. Tidsskr. Kjöbenhavn, xiii. (1883) pp. 199-210. See Bot. Centralbl., xvii. (1884) p. 267.

† Quart. Journ. Micr. Sci., xxiv. (1884) pp. 262-310.

partially or entirely disappeared in certain classes of fungi may be explained on the hypothesis that the very strong development of their parasitic character enables them to supply themselves abundantly with food-material at the expense of the host, without any very great consumption of vital energy, and thus renders unnecessary the re-invigoration of the protoplasm, which is the main object of sexual reproduction.

Life-history of Æcidium bellidis DC.*—C. B. Plowright has experimented on the *Æcidium* of the common daisy, and considers that it is not a mere variety of *Æcidium compositarum* Mart., but a true hetercœcismal Uredine, differing from its allies in the time that it appears.

Structure and Affinity of Sphæria pocula Schweinitz.†—Dr. M. C. Cooke describes the structure of this species, and shows that it must be relegated to the genus *Polyporus*, to which indeed it was formerly referred by Berkeley and Curtis, though the fact appears subsequently to have been forgotten.

Sphæroplea.‡—Under the designation var. *crassisepta* E. Heinricher describes a var. of *Sphæroplea annulina* with thicker septa than the ordinary form. Hæmatoxylin revealed the presence of a number of nuclei in the cells, sometimes as many as 60, viz. from 1–4 in connection with each ring of protoplasm. In the female cells a portion of the protoplasm collects round each nucleus to form an oosphere, the number of which therefore corresponds to the number of nuclei. The formation of antherozoids is accompanied by a great and rapid multiplication of nuclei, one nucleus being finally contained in each antherozoid. The oospores germinated in the dark, producing swarm-spores, from which new individuals sprung, but this latter germination was dependent on the presence of light.

New Parasite on the Silver-fir.§—Under the name *Trichosphæria parasitica*, R. Hartig describes a parasitic fungus which has been for some years very destructive to the pine-forests in the Neuburger forest. The colourless mycelium attacks the young branches and the leaves, covering the lower side with a weft of threads, and forming blueish white cushions on both sides of the leaves, on which the perithecia appear in autumn. The black globular perithecia are covered in the upper part with numerous long hairs, and have a diameter of 0·1–0·25 mm., or of 7 mm. including the hairs. The asci are about 8·0 μ in length, and completely disappear after the ripening of the spores. The spores are smoke-coloured, usually 4-locular, straight, or somewhat curved, and from 15–20 μ long. The formation of the asci is preceded by that of very small rod-shaped cells, possibly spermatia.

* Journ. Linn. Soc. Lond.—Bot., xx. (1884) pp. 511–2.

† Ibid., pp. 508–11 (1 pl.).

‡ Ber. Deutsch. Bot. Gesell., i. (1883) pp. 433–50 (1 pl.). Cf. this Journal, iii. (1883) p. 888.

§ SB. Bot. Verein München, No. 13, 1883. See Bot. Centralbl., xviii. (1884) p. 62.

Micrococcus prodigiosus within the Shell of an Egg.*—F. Ludwig describes a hen's egg the albumen of which was throughout of a rose-red colour. The absorption-spectrum agreed altogether with that of the colouring matter of *Micrococcus* (*Monas*) *prodigiosus*. The fungus must certainly have been present in the albumen when in a raw state.

Photogenous Micrococcus.†—F. Ludwig has identified the cause of phosphorescence in fish with that of the less common phosphorescence of the flesh of animals used for food, especially swine. It is due to a mucilaginous substance which can be readily wiped off, consisting of micrococci in a state of active motion and division, the characteristic form and arrangement of which are very readily shown by pigments, especially gentian-violet. The zoogloea-colonies are then seen to consist of sharply defined, roundish, densely crowded cells, sometimes isolated, more often associated in beautiful moniliform threads or compact colonies. The diameter of the cells is about 0·5–1 μ. To this organism Ludwig gives the name *Micrococcus Pflügeri*. It can be readily transferred from the haddock or other fish on which it is commonly found, to the flesh of oxen, calves, sheep, swine, &c., producing in it the well-known phosphorescence; it occurs also naturally on crustacea, star-fish, &c.

On the surface of the sea is sometimes found a phosphorescent slime, consisting largely of decaying organic matter, the phosphorescence of which is not due to *Noctiluca* or other animals of that kind; Ludwig attributes it also to this same species of *Micrococcus*.

Respiration of Saccharomyces.‡—M. Paumès has investigated this subject carefully, with the following results:—(1) The respiratory activity of the ferment (*S. cerevisiæ*) decreases as the temperature decreases; (2) in doses of from 1–2 per cent. ether has scarcely any effect on the respiration; (3) in doses of from 3–6 per cent. ether diminishes and even entirely stops the respiration; (4) even by these doses the plant is not killed.

Bacillus of Cholera.§—R. Koch has presented to the German Government six reports on the cause of cholera-epidemic, as the result of investigations on the excreta and on the dead bodies themselves of cholera patients in Egypt and in India, and on the inoculation of other animals with the germs. The internal organs, lungs, liver, spleen, kidneys, &c., as well as the ejecta, were found to swarm with microbia of a great variety of kinds; in all cases was found one definite kind of bacillus, resembling in size and form that of glanders. These were found in largest quantities in the tubular glands of the intestines, especially between the epithelium and the membrane of the gland. Experiments in inoculating other animals with this bacillus yielded only negative results.

* Zeitschr. f. Pilzfreunde, 1883, p. 176. See Bot. Centralbl., xviii. (1884) p. 161.

† Hedwigia, xxiii. (1884) pp. 33–7.

‡ Journ. Anat. et Physiol., xx. (1884) pp. 106–15.

§ 'Erster-sechster Ber. an den Staatssecretär des Innern über die Arb. zur Erforschung der Cholera-Epidemic, von R. Koch.' Alexandria-Calcutta, 1883–4.

Observations on Egyptian ophthalmia showed that two different diseases are ordinarily included under this name; one caused by a kind of bacterium resembling the micrococci of gonorrhœa, the other and less severe one by a very minute bacillus.

The experiments carried on in India determined the presence in the intestines, in all cases of cholera, of the same bacillus as that found in Egypt; and this Dr. Koch has been able to isolate and to cultivate. It then furnished characters in its form and mode of growth in nutrient gelatine, by which it is at once distinguished with certainty from all other known bacilli. This particular form was also never found in the intestines or in the ejecta of those not suffering from cholera. Experiments on the infection with it of other animals had not, up to the time of the publication of these reports, been completely successful.

The cholera-bacillus is not quite straight, like most other bacilli, but is somewhat curved, in the manner of a comma, or even nearly semicircular. In cultivation there often arise S-shaped figures, and shorter or longer slightly wavy lines. They are endowed with active spontaneous motion. They can be best observed in a drop of nutrient fluid attached to the cover-glass, which they are seen to swim through in all directions. In gelatine they form colourless colonies, which are at first close and have the appearance of small fragments of glass, but gradually spread through the nutrient fluid. They have a tendency to collect at the margin of the drop, where their peculiar movements can be well observed, and their comma-like form after treatment with anilin-solution.

As to the question whether their presence is simply due to the presence of the choleraic disease which promotes their growth and development, or whether they are themselves the cause of cholera, Dr. Koch is very strongly of opinion that the latter is the true explanation, since they are never found either in the organs or the ejecta, except in the case of patients who have either died of or are suffering from cholera. They are also found only in that organ which is the seat of the disease, viz. the intestines. In the first feculent ejecta, the bacilli occur only in small quantities; while in the later liquid odourless ejecta, they occur in enormous quantities, all other kinds of bacteria being almost entirely absent; they diminish in number as the excreta become more feculent, and have entirely disappeared when the patient is completely restored to health. Their abundance appears to correspond to the degree of inflammation of the mucous membrane of the intestines, attaining their maximum when this is of a bright-red colour, and the contents a colourless odourless fluid. When the contents become offensive from effusion of blood the bacilli decrease in number and are found only in the vesicular glands and their neighbourhood. Where death results from a secondary complaint following cholera, they are altogether wanting. Their behaviour therefore closely resembles that of all other pathogenous bacteria, their development being proportional to the severity of the disease.

Virus of Anthrax.*—In a preliminary communication, K. Osol describes some experiments, performed in the Pathological Institute of Dorpat, by which he claims to have proved that the bacilli which occur in anthrax are only to be regarded as the secondary products of a chemical virus.

Recounting the previous observations of Professor Semner and of Rosenberger, who claim to have shown the same thing in septicæmia; he states that he himself, in "numerous experiments," thoroughly sterilized, by prolonged boiling, virulent anthrax blood, diluted with an equal bulk of water, which was filtered; the residue again treated with water, boiled and filtered; the filtrate from both, to insure sterilization, was then boiled for two hours on three successive days. Of this concentrated viscid anthrax virus, "large quantities" were injected subcutaneously into rabbits and mice, with carefully disinfected syringes; cultivations of sterilized bouillon were at the same time inoculated each with "one drop" of the same superheated virus; and at the same time control-animals inoculated with *small quantities* of the same, to demonstrate the absence of micro-organisms. As an additional precaution, blood of healthy animals was treated in the same manner as the anthrax blood, and similarly injected in large quantities into rabbits and mice.

The animals inoculated with superheated anthrax blood died in from 3 to 6 days; in about a fourth of the cases typical anthrax bacilli were found in the blood and organs; in the other cases, numerous micrococci, as previously found in anthrax blood by Semner in 1871, and Bollinger in 1872, and shown by them to be a phase of development of the typical bacilli, which has been quite recently confirmed by Archangelski. The blood of animals killed by inoculation with the superheated anthrax virus, when inoculated into sterilized cultivating fluids, developed typical bacilli. Rabbits and mice inoculated with it died of pronounced anthrax, in general with numerous bacilli in the blood, or, in their place, micrococci and "diplococci," which, cultivated, developed to anthrax bacilli. The blood of these animals similarly was fatally infective.

In the control experiments, while animals inoculated with "small quantities" of superheated virus remained perfectly unaffected, cultivations inoculated with similar quantities continued sterile; hence the author claims to have proved that in anthrax blood there is a specific chemical poison, soluble in water, not volatile, of undetermined composition, which, inoculated into other animals, so affects the tissues of the organism that the innocuous microparasites normally present therein, develope under its influence, in from 3 to 6 days, to typical anthrax bacilli in some cases, and in others to an earlier form of the same.

The control-animals inoculated with superheated normal blood were unaffected, save by a slight pyrexia. The author, as he states, from these experiments, does not conclude that the bacilli have no significance or action in anthrax, but, on the contrary, that they alone

* Centralbl. f. d. Med. Wiss., 1884, pp. 401–4.

develope the anthrax virus in the living organism; though they are not the primary but the secondary factor, and derive their virulence, in the first instance, from the action of an unorganized chemical poison.

These conclusions are somewhat out of date at the present time, and misleading. It has been proved to demonstration that in the case of anthrax, the organism does, *per se*, constitute the active contagium. The results obtained by Professor Rosenberger, referred to, have been shown* to have been due to *imperfect sterilization*. In those here described, the absence of infection with small quantities of the superheated virus, and its occurrence with large quantities, shows evidence of the same phenomena; some germs or spores of the bacilli survived the boiling, but these were too few in number to be infectious in every small portion of the fluid, though they were so in large quantities. Were a chemical poison, of which comparatively large quantities are requisite, as asserted, the primary factor in infection, the micro-organisms alone could never be active in unusual quantities, viz. in the 100-millionth of a drop (minim) as has been shown to be the case. The final conclusion of the author here is an obvious paradox, viz. that the micro-organism is at once both cause and effect; it alone produces the virus—a soluble chemical poison—and is produced by it.

Attenuation of Virus in Cultivations by Compressed Oxygen.† —Experiments were made by M. Chauveau with compressed oxygen on the bacilli of anthrax, to ascertain whether their virulence could be modified by its graduated action, as by that of heat and other agents; with the result, at first, that in the case of guinea-pigs the cultivations of the organism exposed to its influence either became more actively virulent at moderate pressures, or at high tension completely inactive; but with sheep, by the action of the agent, the cultivations are modified in their virulence, so that it is not increased by moderate pressure as with guinea-pigs, but on the contrary decreased; and at a point short of that which stops all development of the microbe, spores are formed, which, though still fatal to guinea-pigs, are innocuous to sheep.

At this stage of attenuation, however, they produce a temporary affection, more or less pronounced, in all the sheep inoculated, which passes off within a few days, and the animals are found to have acquired immunity from subsequent infection with the most virulent material; and that by the single inoculation.

This modification of virus is transmissible to cultivations of the second generation, kept at 36–37° C. under normal pressure.

It is, too, very remarkable here, that though usually the blood of guinea-pigs which have died of anthrax is fatally infective to sheep, yet in the case of the former the blood of animals that have succumbed to inoculation with cultivations modified by pressure, is innocuous to the latter, and moreover confers on them immunity from future infection.

Further, these cultivations are so surely attenuated that no single

* Proc. Roy. Soc., xxxiv. (1882) p. 150.
† Comptes Rendus, xcviii. (1884) pp. 1232–5.

animal is killed by them, and the protection they confer is complete, whilst they preserve their properties for several months, and are as effectual with oxen as with sheep.

Cultivation of the virus of other diseases is equally modified by compressed oxygen, as is notably that of swine fever (rouget).

In conclusion, the author trusts that this method of attenuating virus, as yet only tried on a small scale in laboratory experiments, may be rendered generally available in practice, with the immense advantages it offers of (1) immunity conferred by a single inoculation, with (2) perfect safety, and (3) the possibility of using the modified cultivations a considerable time after their preparation.

Rabies.*—L. Pasteur, with the assistance of MM. Chamberland and Roux, has a further † communication on this important subject.

1. If rabic virus is passed from a dog to a monkey, and then from one to other monkeys, it gradually becomes weaker. If it is then injected into a dog, rabbit, or guinea-pig, it remains in this attenuated condition.

2. The virulence of the poison is increased when it is passed from rabbit to rabbit, or from guinea-pig to guinea-pig. If in this "exalted" condition it is passed on to a dog it gives a rabies which is always mortal in effect.

3. Although one can thus increase the virulence of the poison by passing it from one to another rabbit, it is necessary to do so several times if one is making use of a virus which has been attenuated by a monkey.

Thanks to these observations Pasteur has been able to preserve an organism from the effects of more active virus by the use of that which is less so. Here is an example:—Virus, made more powerful by passage through several rabbits, is inoculated into a dog, but as it is inoculated into the dog at every stage of the experiments on the rabbits, the result is that the dog becomes entirely refractory to the poison of rabies.

Pasteur proposes to make the following experiments, of which the first is the most decisive. He will take twenty of his "refractory" dogs and twenty that have not been inoculated; he will let all be bitten by a "mad dog," and he prophesies that his twenty will escape the effects, while the other twenty will exhibit the influences of the poison. A similar set of two twenties will be trepanned by the virus of dogs *à rage des rues*; the twenty vaccinated dogs will resist the poison, the others will die, either mad or paralysed. In a footnote the author points out that of the twenty non-vaccinated dogs, or, as he calls them, witnesses, all will not exhibit the effects of the poison to the same extent, for rabies does not always follow on the bite of a mad dog.

Bacteria in Canals and Rivers.‡—The much-discussed question as to the purification of water in rivers "by itself," that is, by the mere

* Comptes Rendus, xcviii. (1884) pp. 1229-31.
† See this Journal, *ante*, p. 430.
‡ Nature, xxix. (1884) p. 557.

fact of its motion, seems to have entered into a new phase. Dr. Pehl, at St. Petersburg, has recently made a series of bacterioscopic measurements on the waters of the capital, which are summed up in the last issue of the 'Journal of the Russian Chemical Society.' The water of the Neva itself appears to be very poor in bacteria, namely 300 germs in a cubic centimetre. After heavy rains this number rises to 4500, and to 6500 during the thawing of the river. The canals of St. Petersburg, on the contrary, are infested with bacteria, their number reaching 110,000 in a cubic centimetre, even during good weather. The same is true in regard to the conduits of water for the supply of the city. While its chemical composition hardly differs from that of the Neva (by which they are supplied), the number of bacteria reaches 70,000, against 300 in the water taken directly from the river; and the worst water was found in the chief conduit, although all details of its construction are the same as in the secondary conduits. Dr. Pehl explains this anomaly by the rapidity of the motion of water, and he has made direct experiments in order to ascertain that. In fact, when water was brought into rapid motion for an hour, by means of a centrifugal machine, the number of developing germs was reduced by 90 per cent. Further experiments will show if this destruction of germs is due to the motion of the mass of water, or to molecular motion. The germs, among which Dr. Pehl distinguishes eight species, are not killed by immersion in snow. As the snow begins to fall it brings down a great number of germs, which number rapidly diminishes (from 312 to 52 after a three hours' fall of snow, on January 21st, 1884), while their number on the surface of the snow increases, perhaps in consequence of the evaporation of snow or of the condensation of vapour on its surface.

Bacteria from Coloured Fishes' Eggs.*—Dr. Peter has investigated the causes of various colouring of the eggs of *Coregonus Wartmanni*, red, blue, and yellowish-brown, and finds it to be due to the presence of bacteria, which frequently entirely filled up the interior of the egg. The colour itself was due to drops of oil; the bacteria themselves were always colourless, and of the following kinds:—(1) slender smooth motile rods with short segments; (2) thicker motile rods; (3) very thick, straight, smooth, motionless rods (rare); (4) very slender, straight, smooth, motionless filaments; (5) micrococci. There was also not unfrequently a *Saprolegnia* present. These bacteria were cultivated in a large number of different nutrient fluids, when all transitions from them to a spirillum form appeared; as also a transition from the leptothrix form No. 4, to a spirillum. A transformation appears to take place of ordinary bacteria into those which are the cause of the colouring of the eggs.

Bacteria connected genetically with Algæ.†—H. Zukal has continued his investigations ‡ as to the genetic connection between

* Ber. Bot. Verein München, Sept. 19, 1883. See Bot. Centralbl., xviii. (1884) p. 92.

† Oesterr. Bot. Zeitschr., xxxiv. (1884) pp. 7-12, 49-51.

‡ See this Journal, iii. (1883) p. 400.

Drilosiphon and *Leptothrix*, from which, in certain circumstances, bacteria are produced. The filaments of *Leptothrix muralis*, which is very common in greenhouses, forming a gelatinous deposit on the walls, are usually of a light yellow colour; but when, as is frequently the case, they grow among the stems and leaves of mosses, they gradually become green. It must therefore be assumed that there is always in this species of *Leptothrix* a certain amount of green colouring matter,—another illustration of the difficulty of drawing an exact line of demarcation between the Schizomycetes and the Schizophyceæ. It agrees with ordinary Schizomycetes in the capacity for assuming bacterium, bacillus, coccus, and vibrio-forms; and this sometimes takes place even with filaments which are distinctly green.

When a piece of pure leptothrix-jelly is cultivated under water in a glass cell, hormogonia are soon separated, the time of their appearance depending on the temperature of the water. These either again develope into filaments, or pass into the bacterium form or, finally, into the swarming condition. It is usually only the outside filaments which project from the jelly that develope into hormogonia, which either break through the mucilaginous sheath or escape through its open end; on their escape they frequently display movements of circumnutation, due to the contraction of the protoplasm and not to the presence of cilia; the vibrio-form appears, however, to possess cilia, though the author was not able to determine their presence with certainty. The vibrio-form is developed only from a few of the filaments at the margin of the jelly, presenting thus a striking contrast to the true Schizomycetes, in which both the vibrio and spirillum form appear suddenly in large quantities. The bacterium form of *L. muralis* exhibits an evident segmentation, especially after the application of dilute hydrochloric acid or potassium acetate. The hormogonia, when they do not grow into filaments, usually break up into bacteria, which then excrete a thick gelatinous envelope, and swim on the surface of the culture-fluid, a zooglœa family being slowly formed in this way. Less often the bacillus and spirillum forms develope zooglœa colonies. Occasionally, by cell-division within the jelly, the zooglœa acquires the habit of a palmella or merismopædia.

The presence of phycochrome is indicated by the motile hormogonia always collecting on the illuminated side of the vessel. Under certain conditions the bacteria swarm out of the zooglœa-jelly, leaving their membrane behind; the cell-contents arrange themselves in a direction at right angles to the original one, and may develope into the bacillus, leptothrix, or spirillum form, then dividing into bacteria, &c.; but in all the forms the representatives of the last generation are always smaller than the preceding one, finally reaching the limits of vision with the best immersion system.

In addition to the forms above described, *Leptothrix muralis* much less often developes cocci, arranged in a moniliform string, often interrupted by a large strongly refringent cell. Filaments are sometimes found which are segmented above into cocci, below into bacteria.

The formation of cocci indicates a regression to the nostoc form, which is also met with in the history of development of *Drilosiphon*. Resting spores are formed here and there along with the cocci, from 1–1·8 μ in diam.; and these occur also in the bacterium and vibrio forms, in very long threads occasionally two.

The author concluded, as the result of experiments, that *Leptothrix muralis* has no power of inducing fermentation or putrefaction. The presence of free oxygen is absolutely necessary for its growth. It is best cultivated in water containing traces of iron, lime, and potash salts. It is probably capable of carrying on an independent existence; but the presence of vigorous tufts of moss is apparently favourable to its growth.

The micro-conditions of the three principal forms of *Leptothrix muralis;* the leptothrix form with its hormogonia, the nostoc form, and the glœocapsa or palmella form, are morphologically altogether equivalent to true bacteria, but physiologically they are as widely removed from them as any green plant from a non-chlorophyllaceous saprophyte.

Action of Oxygen on Low Organisms.*—F. Hoppe-Seyler has constructed an apparatus for the purpose of testing the influence on the development of the lowest forms of animal life of an abundant or restricted supply of oxygen. He finds that in the presence of free oxygen the only certainly demonstrable products of the decomposition of fluids containing albuminous substances are carbonic acid, ammonia, and water. If the fluid is saturated with oxygen, neither hydrogen nor marsh-gas makes its appearance; the ordinary products of decomposition, indol and skatol, are not formed at all, leucin and tyrosin only temporarily. Microscopic examination shows that when decomposition takes place in the presence of abundant oxygen, the Schizomycetes are formed in much greater quantities than when the supply of oxygen is small. The Schizomycetes and Saccharomycetes behave in just the same way, from a chemical point of view, as all other vegetable organisms, when supplied with abundance of oxygen; they absorb oxygen, and give off carbonic acid, water, and ammonia, or some nitrogenous substance nearly allied to it. In the absence of oxygen all decomposing organisms display fermentation-phenomena; but while the Schizomycetes and Saccharomycetes can remain in this condition for a considerable time, all other organisms perish rapidly in the absence of oxygen. Certain Schizomycetes can sustain the absence of oxygen for a considerable time, especially the one or more species which split up cellulose into CO_2, CH_4, and H_2; but the author altogether disbelieves the theory that there are organisms which can exist only in the absence of oxygen.

Biology of the Myxomycetes.†—E. Stahl has made a long series of experiments on the cause of the movements of the plasmodia of the Myxomycetes, especially of *Æthalium septicum*. By causing one end

* Zeitschr. f. Physiol. Chemie, viii. (1884) p. 214. See Naturforscher, xvii. (1884) p. 116.

† Bot. Ztg., xlii. (1884) pp. 145-56, 161–76, 187–91.

of a piece of blotting-paper, the other end of which dips into water, to come into contact with tan containing plasmodia of the *Æthalium*, he found the latter to display the phenomenon of rheotropism,* i. e. they move to meet the current of water, travelling in a horizontal or even in a vertical upward direction. The same was observed with the plasmodia of a small species of *Physarum*. The plasmodia display not only rheotropism, but also hydrotropism, i. e. movements regulated by the distribution of water in the substratum, when this water is not in motion. During the greater part of the period of development they display positive hydrotropism, or are attracted towards the source of water. They are indeed very dependent on water for their development. On a uniformly moist substratum in an atmosphere saturated with moisture, they spread uniformly in all directions; while in a dry air, when the substratum is gradually drying, they contract, and collect in the dampest spots. Negative hydrotropism does, however, also occur, where the sporangia bend away from the damp spots and stand erect; this was observed, but only rarely, in sporangia of *Physarum*, *Didymium*, and *Æthalium*.

Various chemical substances, such as crystals of sodium chloride, nitre, cane-sugar, grape-sugar, drops of glycerine, &c., exercise a repellent effect on the plasmodia. On the other hand an infusion of tan produced an opposite attractive result; and to this property of moving towards the spots where the supply of nutriment is most abundant Stahl gives the name *trophotropism*. The same substance may have opposite influences of attraction or repulsion according to the degree of concentration of the solution.

As regards heliotropism, the author adds nothing to the facts already known, that plasmodia move from illuminated spots to those that are in shade. He was unable to determine satisfactorily their relation to geotropism; the vertical position of the fructifications of Myxomycetes appears to be due rather to hydrotropism than to geotropism.

With respect to the effect of heat, if *Æthalium* is exposed on the two sides to unequal temperatures, an evident motion takes place towards the warmer side.

Lichenes.

Cephalodia of Lichens.†—Pursuing this subject, K. B. J. Forssell states that the algæ found in connection with cephalodia belong to all the groups of Phycochromaceæ, including the following families: —Nostocaceæ, Sirosiphoneæ, Scytonemaceæ, Chroococcaceæ, and Oscillariaceæ, the first being the most largely represented. The *Nostoc* cells take up very different positions in relation to the gonidial layer of the thallus, belonging to the different kinds of cephalodia already described. Occasionally several species of algæ are found in the same cephalodium.

The development of cephalodia is always the result of the mutual

* See this Journal, *ante*, p. 413.

† Flora, lxvii. (1884) pp. 33–46, 58–63, 177–87. Cf. this Journal, *ante*, p. 100.

action of hyphæ and algal cells; it is not a true parasitism, since the algæ are not destroyed or weakened by the fungal hyphæ; nor can it be regarded as a true example of hypertrophy of the algal cells. There is no struggle for existence between algæ and hyphæ. The author was unable to detect the mode in which the algal cells penetrate into the thallus, but each seems to impart nourishment to the other.

The author regards cephalodia as always the result of an accidental meeting of alga and lichen, the former constituent always belonging to a type of very wide distribution; but there must also always be some power of adaptation of one to the other; some forms of lichen, as *Cladonia*, appear never to form cephalodia. If Schwendener's hypothesis is regarded as one of mutual symbiosis of algæ and fungi, rather than as one of parasitism, then the occurrence of cephalodia supports it rather than otherwise.

Thallus of Lecanora hypnum.*—K. B. J. Forssell describes the somewhat peculiar structure of the thallus of this lichen. It consists of an incrustation of small yellowish-brown rounded granular scales, which do not form a continuous layer, but the whole lichen consists of a complex of individuals more or less cohering in their growth. The scales are of two kinds, one with yellow-green, the other with blue-green gonidia. The author is doubtful whether the latter are to be regarded as cephalodia, or as belonging to a different lichen-species, *Pannaria pezizoides*. Apothecia occur, on the under side of which are sometimes cephalodia containing cells of a *Nostoc*.

Algæ.

Systematic Position of Ulvaceæ.†—The third part of J. G. Agardh's series of Monographs of Algæ is devoted to the Ulvaceæ. Differing from Berthold's view,‡ he places the genera *Bangia* and *Porphyra* among the Ulvaceæ, and not among the Florideæ. In this he relies chiefly on the difference of the reproductive organs in the Ulvaceæ and Florideæ, the former possessing true zoospores, the Florideæ antheridia, cystocarps, and tetraspores. The quaternate division of the cells in the two genera in question he regards as showing an affinity not so much with the tetraspores of Florideæ, as with the mode of division in *Prasiola*, *Tetraspora*, *Palmella*, *Monostroma*, and some species of *Ulva* and *Enteromorpha*. There is also a very material difference in their physiological value, the octospores of *Porphyra* being regarded as sexual, the tetraspores of the Florideæ as non-sexual. There is at present a very considerable divergence between the description by different writers of the organs of reproduction in *Bangia* and *Porphyra*.

The Ulvaceæ are divided by Agardh into eleven genera:—*Goniotrichum*, *Erythrotrichia*, *Bangia*, *Porphyra*, *Prasiola*, *Mastodia*, *Mono-*

* Flora, lxvii. (1884) pp. 187-93.

† Agardh, J. G., 'Til Algernes Systematik:' Lunds Arsskrift, xix. (4 pls.) (Latin). See Nature, xxix. (1884) p. 340.

‡ See this Journal, iii. (1883) p. 408.

stroma, *Ilea*, *Enteromorpha*, *Ulva*, and *Zetterstedtia*. Of these, *Mastodia* and *Zetterstedtia* are natives of the southern ocean; *Ilea* is represented by a single species, *I. fulvescens*, growing at the mouths of some Swedish rivers.

Newly-found Antheridia of Florideæ.*—T. H. Buffham briefly sums up what is known concerning the reproduction of the Florideæ, and gives more particular descriptions of the antheridia of species not figured by Harvey.

In *Callithamnion tetricum* the antheridia appear to be almost terminal, and the principal portion of the mass is on the inner face of the ramulus, which in the specimen figured is bent down by its weight. *Call. byssoideum* has antheridia that are quite hyaline, with the exception of the cellules forming the axis. The antherozoids are very elongated, and their attachment can scarcely be made out. In *Call. Turneri* the antheridia cluster thickly on the ramuli, and are of ellipsoidal form, colourless, and filled with antherozoids. The antheridia of *Call. plumula* are ramose, and occur in clusters, all rising from one cell of the ramulus.

In *Griffithsia corallina* the antheridia cluster round the filament at the junction of two cells.

Figures of the foregoing, as well as of the antheridia of *Ptilota elegans*, *Ceramium diaphanum*, and *C. strictum* are given by the author.

New Unicellular Algæ.†—P. Richter describes the following new species of Algæ (or Protophyta):—*Protococcus gemmosus*, in greenhouses, allied to *P. cinnamomeus*; *Dictyosphærium globosum*; *Aphanocapsa Naegelii*, in greenhouses; *Aphanothece nidulans*, an extremely minute species, in greenhouses, along with *Protococcus grumosus*; *Oscillaria scandens*, also in greenhouses, possesses a strong smell, somewhat resembling patchouli; *Scytonema Hansgirgianum*, in similar situations, allied to *S. Hofmanni*; *Nostoc Wolluyanum*.

The author states further that his *Aphanothece caldariorum* is the bacillus-form of *Glaucothrix gracillima* Zopf, and is probably identical with *Aphanocapsa nebulosa* A. Br. and *Glœothece inconspicua* A. Br.

Structure of Diatoms.‡—Count Castracane gives a very useful epitome of the chief points in the structure and different modes of reproduction of diatoms.

Belgian Diatoms.§—Dr. H. van Heurck has published the first two sets (including fifty species) of slides illustrating his Synopsis of Belgian Diatoms, determined and described by A. Grunow. The specimens are, for the most part, preserved in the fluid composed and described by van Heurck, compounded of styrax and liquidambar, which has a higher index of refraction than Canada balsam; || a few in solution of phosphorus.

* Journ. Quekett Micr. Club, i. (1884) pp. 337–44 (3 pls.).

† Hedwigia, xxiii. (1884) pp. 65–9.

‡ Castracane, Conte Ab. Francesco, 'Generalità su le Diatomee,' 12 pp. Roma, 1884.

§ Van Heurck, H., 'Types du Synopsis des Diatomées de Belgique,' Série i. et ii. Anvers, 1883.

|| *Infra*, p. 655.

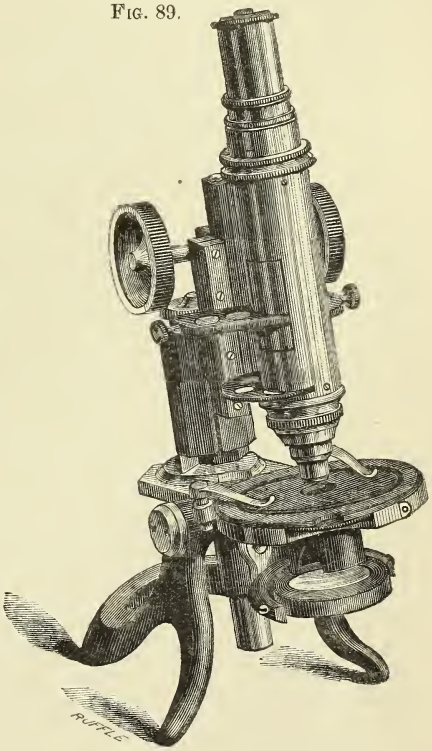
Diatomaceæ from the Island of Socotra.*—F. Kitton gives a list of twenty-two fresh-water species from the Island of Socotra. Amongst these are a new species of *Cerataulus* (*C. Soctrensis*), which is the first fresh-water representative of the genus, and *Fragilaria Ungeriana* Grun., which has previously been found in only two localities—Cyprus and Belgaum (India).

MICROSCOPY.

a. Instruments, Accessories, &c.

Microscope with Amplifiers.—Fig. 89 shows two methods of applying a series of amplifiers to the Microscope:—(1) A disk containing four apertures is mounted above the nose-piece to rotate so as to bring the apertures successively into the optic axis. One aperture is blank for normal examinations; and the others are provided with biconcave lenses of 3 in., 4 in., and 5 in. negative focus respectively. This application of amplifiers was exhibited at the Society several years ago, but we have not succeeded in tracing the name of the exhibitor. (2) Mr. J. Mayall, jun., suggests that the amplifiers should be mounted in a plate (shown in the fig.) sliding through the body-tube, and with means of raising or lowering it within the body-tube so that the best position with each objective may be found experimentally.

Fig. 89.



The use of such amplifiers involves a slight deterioration of the quality of the image, but in many cases this would be more than compensated by the increase in the magnification and in the working distance.

Bausch's Binocular Microscope.†—The following is E. Bausch's specification of his "Binocular Microscope":—

"My invention relates to the class of Microscopes in which part of the rays of light emanating from the object and passing through

* Journ. Linn. Soc. Lond.—Bot., xx. (1884) pp. 513-5 (1 pl.).

† Specification of U.S.A. Patent No. 293,217, dated February 12th, 1884.

the objective are divided by a doubly reflecting prism, known as the 'Wenham prism,' so that one-half of the rays pass to an auxiliary eye-piece mounted in a branch tube applied to the side of the main tube.

In Microscopes of this class the prism has heretofore been mounted in a box arranged to slide laterally in the lower part of the Microscope-body, so that it could be moved into and out of its place by sliding the box, and any imperfection in the bearings of the box, which are necessarily narrow, allowed the box to move laterally, thereby impairing the effectiveness of the instrument. Another serious objection to the common method of mounting the prism is, that the size of tubes in Microscopes being limited, and the box being contained entirely in the tube or nose-piece, the movement of the box and size of the prism are correspondingly limited. This being the case, a large proportion of the rays which are transmitted by modern objectives are prevented from passing to the eye-piece, so that it has frequently been found necessary to remove the nose-piece containing the ordinary prism-box and replace it by another nose-piece which had no obstruction when the full effectiveness of the objective was desired.

My invention is designed to obviate these difficulties by providing a prism-holder with a long cylindrical bearing, which is readily made and practically indestructible by wear, and which admits of either binocular or monocular arrangement of the Microscope with the full effect of either method of vision.

It consists of a prism-carrying arm fixed to the end of a spindle extending through a sleeve passing through the side of the Microscope-body, the spindle being provided with a milled head, by which it is turned, and with a stop-pin, for limiting its motion.

Fig. 90 is a vertical section on the line *x x* in fig. 91 of a portion of a Microscope-body, showing my improvement applied. Fig. 91 is a plan view, partly in section.

The body of the Microscope is provided with a nose-piece A, threaded in the usual way at its lower end to receive an objective, and having sufficient depth to contain the prism-holder B. The prism-holder B consists of a metallic plate *a*, bent twice at right angles, and receiving between its parallel sides *b c* the prism C. The side *c* of the holder B is prolonged, forming an arm *c'* which is secured in any suitable manner to the end of a spindle D. In the present case it is fitted to a shoulder on the spindle and fastened by means of a small nut *d* fitted to the threaded end of the spindle. The spindle D is fitted to a sleeve E, passing through the side of the nose-piece A, so that it may turn therein without lateral or longitudinal motion. To insure the perfect bearing of the spindle D in the sleeve E the sleeve has a longitudinal slit *e*, which permits it to adapt itself to the spindle by springing and to create the small amount of friction necessary to retain the prism-holder in any position. The outer end of the spindle D is provided with a milled head F, by which the prism may be moved into or out of the field, and a pin *f*, projecting from the spindle through a slot *g* in the sleeve E, limits the motion of the prism-holder in either direction. The prism-holder B is arranged relative to the main and auxiliary tubes of the Microscope

so that it will swing in a plane lying in the axes of the two tubes, and when it is swung down into the position shown in full lines in the drawings the prism intercepts one-half of the rays passing through the objective and diverts them to the auxiliary tube. When

Fig. 90.

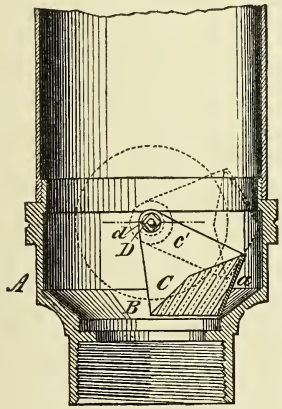
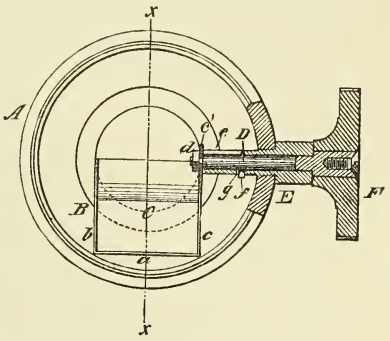


Fig. 91.



the Microscope is used for monocular vision, the prism is turned out of the field, as indicated by dotted lines in fig. 90.

Having thus described my invention, what I claim as new, and desire to secure by letters patent, is—

1. In a binocular Microscope, a swinging prism-holder adapted to support the prism within the body of the Microscope either in or out of the field of vision, as herein specified.

2. The combination, with the doubly reflecting prism of a binocular Microscope, of a prism-supporting arm and spindle attached thereto, and extending outward through the Microscope-body, as described.

3. The combination, in a binocular Microscope, of the prism C, prism-holder B, spindle D, provided with the stop-pin *f*, and the slotted sleeve E, as herein specified."

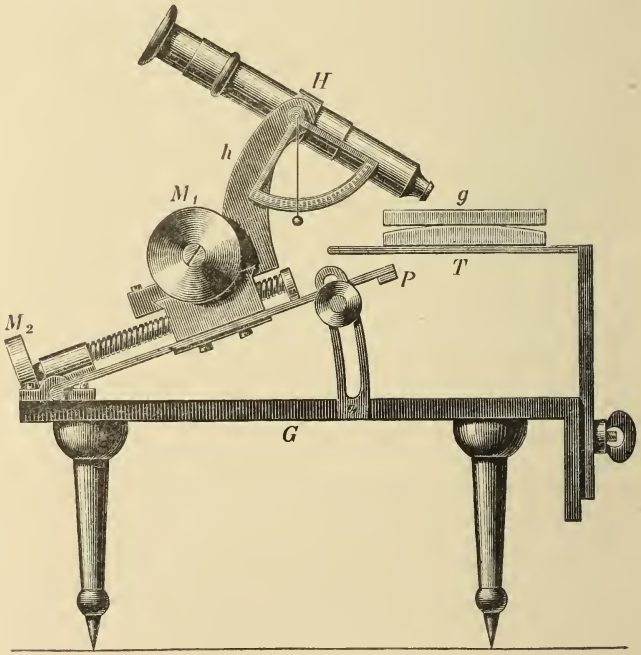
Sohncke's Microscope for Observing Newton's Rings.*—This instrument (fig. 92) is a device of Dr. L. Sohncke for examining Newton's rings, and it is claimed that it fulfils all the conditions in regard to variety of movements (and their measurement) necessary in such an instrument.

The microscope-tube (provided with cross threads and magnifying 20 to 25 times) slides in a short socket H, the former having a scale in half-millimetres (with a nonius on H) for allowing the exact position to be read off. The socket, with the Microscope, can be turned on a horizontal axis, fixed in the front part of two brass

* Zeitschr. f. Instrumentenk., i. (1881) pp. 55–8 (1 fig.).

shoulders *h*, rising from a common base plate. On one side the axis carries a quadrant turning with the Microscope, and having one arm parallel with the optic axis of the Microscope. A plumb line gives the angle on the quadrant. On the other side of the axis is a screw-nut to clamp it in any desired position. The brass base plate to which the shoulders *h* are attached, slides by means of a screw M_1 in a second piece shown in the figure. The motion is at right angles to the plane of incidence of the light falling on the object, i. e. from right to left (or *vice versâ*) as the observer would stand in using the instrument. The second piece is again part of another slide, which

Fig. 92.



is moved backwards and forwards by the screw M_2; the motion here is at right angles to that of the first slide, and therefore parallel to the plane of incidence. The extent of these two movements is read off on two millimetre scales on the guides of the slides, and the screw heads are divided for reading fractional parts of mm. The heavy iron base G of the whole instrument rests upon three feet, and the plane and convex glasses *g* are laid upon a small stage T attached to the front of the instrument, and capable of being raised and lowered above G as required.

Although the apparatus in this form may be thought to fulfil all requirements, Dr. Sohncke considered it especially necessary to add an additional contrivance for indicating, without further measurement, the most characteristic phenomenon in the position of Newton's rings, viz. that those ring-points which are in the plane of incidence passing through the centre of the rings, all lie in a straight line which rises obliquely towards the light. The greatest inclination of this "fundamental line" towards the horizon is 19° 28′. If we have an arrangement by which the Microscope with any angle of incidence can be given a movement parallel to the "fundamental line," then when any one ring (in the central plane of incidence) is clearly seen by proper focusing of the Microscope, all the rings in succession will also be clearly seen by the movement in question; whilst if the Microscope were moved horizontally, they would very soon be out of focus. This requirement is carried out in the present instrument by the guides of the lower slide being fixed, not upon the horizontal base G, but upon the plate P, which is movable on an axis at right angles to the plane of incidence, and can be fixed at any required inclination between 0° and 20°. That the object may not be disturbed by the inclination of the plate, it is cut out somewhat in the shape of a horse-shoe. To use this arrangement the plate P must be placed at the angle ω of the "fundamental line" for the particular angle of incidence θ. The value of ω is obtained from the formula:—

$$tg\,\omega = \frac{\sin\theta \,.\, \cos\theta}{1 + \cos^2\theta}.$$

The Microscope is then to be placed at the required angle of incidence. In order to do this direct, a plumb line, instead of an index, is used for reading off the "angle" on the quadrant, as an index would join in the inclination of the plane P. The lower slide has now only to be moved parallel to the plane of incidence, by means of the screw M_2, in order to see all the rings pass across the field in complete distinctness.

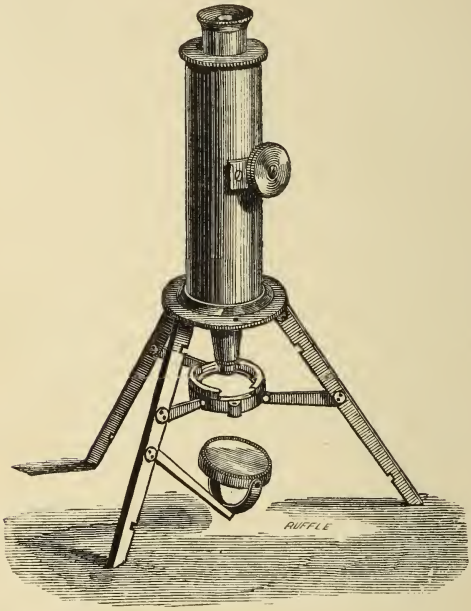
Dr. J. H. L. Flögel describes* a method of determining the thickness of diatoms by the examination of the Newton rings formed when they are illuminated by reflected light from a Lieberkühn. It consists simply in tilting the slide at an angle, the light being admitted to the Lieberkühn through a small excentric aperture in the diaphragm, reaching the objective only after reflection from the preparation.

Harris & Son's Portable Microscope.—This (figs. 93 and 94) is a somewhat ancient form, probably fifty years old, but is arranged on an ingenious plan to secure portability. When set up for use it takes the form shown in fig. 93. By unscrewing the tube, and screwing it into the lower side of the ring which holds it, and closing the tripod legs together, it is reduced to the form shown in fig. 94.

* Arch. f. Mikr. Anat., vi. (1870) pp. 472–514.

The subsidiary leg, which carries the mirror, folds against the leg of the tripod to which it is attached. The stage is removable, leaving

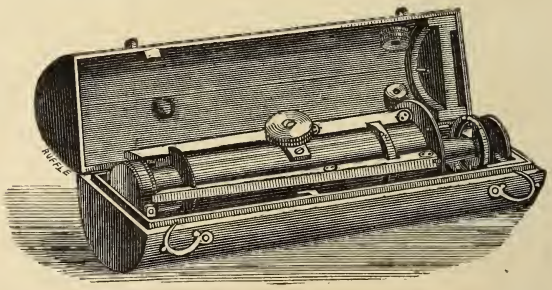
Fig. 93.



a ring, which is attached by three supports to the tripod, and rises and falls somewhat as the tripod legs are shut or opened.

The instrument is hardly so convenient as the modern forms which

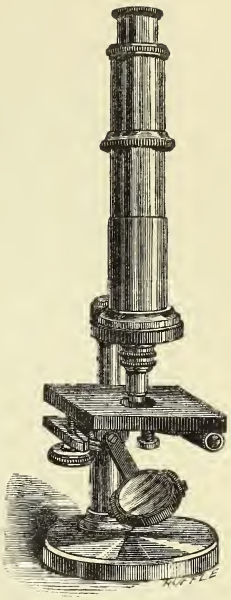
Fig. 94.



have been devised in such profusion, but it is interesting as being a very early progenitor of this class of instrument.

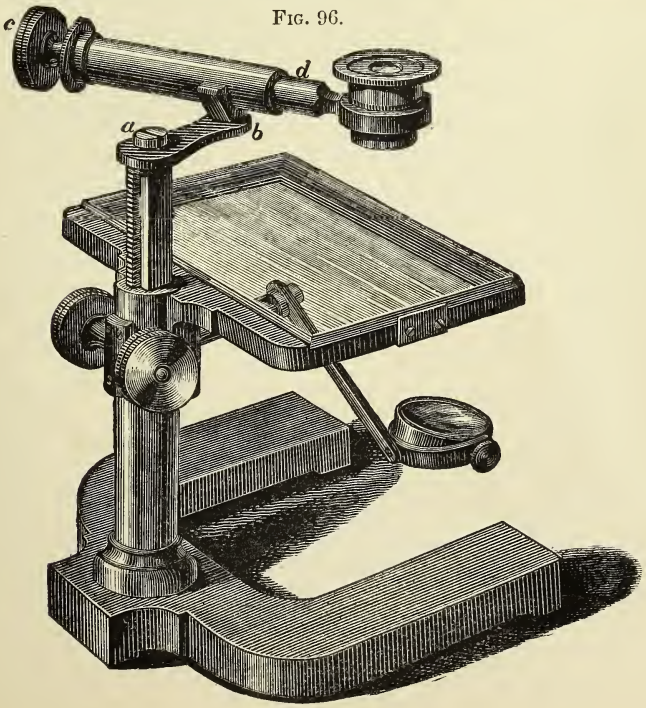
Seibert's No. 8 Microscope.—The Microscope No. 8 in Seibert and Kraft's Catalogue (fig. 95) has a fine adjustment similar in principle to those described Vol. III. (1880) p. 882, though carried out in a different manner. Here the stage is supported on a horse-shoe-shaped frame, and is pivoted to one of the projecting arms. A screw passing through the opposite arm raises the stage at the end and as the screw is withdrawn a spiral spring presses the stage back again.

Fig. 95.



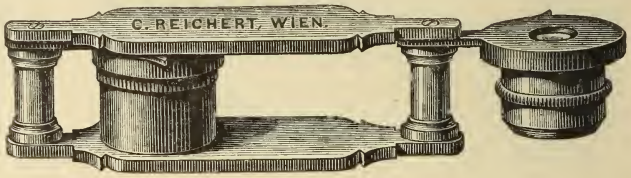
Reichert's Large Dissecting Microscope and Hand Magnifiers.—C. Reichert's large dissecting Microscope (fig. 96) is of exceptional size for the examination of sections of brain and similar large objects. The stage is entirely of glass, and is 11·5 cm. wide and 18 cm. long. The mirror can be moved forwards and to both sides. The preparation is intended to be fixed while the lens is capable of being moved over it in all directions. The arm *a b* can be rotated on *a*, and the lens-carrier *c d* can also be rotated at *b*. By turning the milled head *c* the inner tube *d* which carries the lens is pushed forward or withdrawn again.

Fig. 96.



Herr Reichert also mounts two doublets of 10 and 20 power in a nickelled frame (fig. 97, natural size). When not in use they are

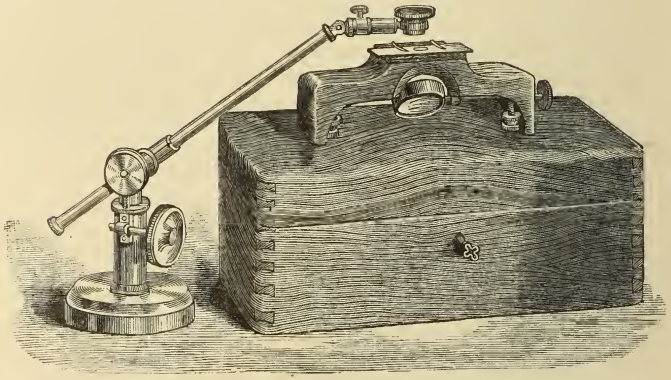
Fig. 97.



turned back within the frame, or for examining an object, brought out as shown in the fig.

Geneva Company's Dissecting Microscope.—This, fig. 98, consists of two parts, a support for the lenses and a stage and mirror.

Fig. 98.



The two are quite separate, a plan which gives more freedom of action than can be obtained in the ordinary form of dissecting Microscope.

The lens-support can be raised by a pinion acting on a rack on an inner tubular pillar. It can also be rotated in a horizontal plane on the top of the latter or in a vertical plane on the pivot clamped by the second (upper) milled-head.

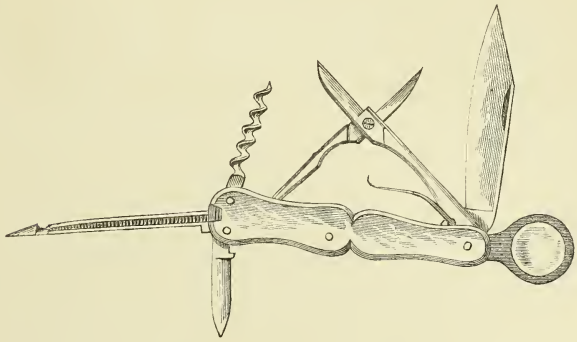
The stage has side rests for the hands and can be screwed to the top of the box holding the instrument. The mirror is rotated on its axis by the milled-head shown on the right. On one side there is an ordinary concave mirror and on the other a plane one of opal glass.

Drallim and Oliver's Microscope Knife.—The following is taken from the advertisement of this knife (fig. 99) :—

"It comprises a great variety of articles including a large dagger-blade, small penknife, pair of folding scissors, corkscrew, nail-trimmer and file, tortoise-shell toothpick and ear-scoop, nickel silver tweezers,

and last, but by no means least, a very powerful Microscope. We are not aware of any other knife manufactured which contains a Microscope of any description, and we anticipate an enormous demand in consequence. An ordinary pocket handkerchief submitted to the

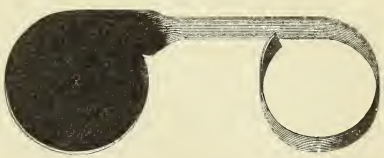
Fig. 99.



lens of this powerful glass, the texture appears nearly as coarse as a sack. Scientific students and merchants will find this invaluable to them, as the knife is of convenient size to be carried in the waistcoat pocket."

Ward's Eye-shade.*—Dr. R. H. Ward's device consists (fig. 100) of a circular disk of hard rubber or blackened metal, about $1\frac{1}{2}$ in. in diameter, an extension of which in the form of a band 1/2 in. wide crosses in front of the nose of the observer, but quite out of the way, and encircles the top of the draw-tube or compound body just below the ocular. As now used, this shade is made of hard rubber, which is of light weight, and suitably dark colour, is less likely than metal to scratch the brasswork with which it comes in contact, and is so elastic as to be applicable to a considerable variety of tubes. The same shade, for instance, can be used on tubes of from 1 to $1\frac{1}{4}$ in., or from 1/8 to $1\frac{3}{8}$, the best fit being of a size midway between the two extremes. Besides this easy range of adaptation, this eye-shade differs from those hitherto in use in its attachment to the body instead of the ocular, by which it is brought to an advantageous distance from the face, and is retained in position as long as the instrument is in use, instead of being removed with the ocular and requiring a fresh application every time that is changed. It is reversible by simply turning it over, and can thus be instantly transferred from the left

Fig. 100.



* Amer. Mon. Micr. Journ., v. (1884) pp. 82-3 (1 fig.).

to the right eye, according to the observer's custom of using either eye habitually or both in succession. It is equally applicable to stands whose construction does not admit of its being slipped over the tube from the top; the spring ring at the right of the figure being in such cases made partly open so as to spring on from the side.

Endomersion Objectives.*—Prof. K. W. Zenger claims to have found that perfect achromatism of telescope and Microscope objectives is possible by using a mixture of ethereal and fatty oils, the dispersive power of which for the different rays of the spectrum increases regularly. The disadvantages of the use of fluids are obviated by mixing with suitable salts of the fatty acid series by which nearly hard or gelatinous, vitreous, homogeneous, colourless, and transparent substances are obtained.

The following are extracts from two papers published by the author:—

The construction of achromatic objectives for telescopes, Microscopes, and photography has, from the beginning, presented great difficulties theoretically as well as practically. The dioptrical formulæ which give the equations for the achromatism and aplanatism of the objectives are so complicated that, up to the time of Fraunhofer and the younger Herschel, opticians were content with developing the conditions of achromatism and aplanatism in the axis. In this way, however, a perfect objective was theoretically not to be obtained, and therefore the best makers of that time were obliged to confine themselves to experimental trials.

Herschel and Fraunhofer first showed the way to a more accurate determination of the direction of the rays, and the former has given us a complete theory of telescope objectives, but for the much more difficult computation of Microscope objectives almost nothing has been done, and we to-day still look for a theory of these objectives.

The principal practical difficulty for all kinds of objectives lies in procuring suitable refracting media, because the flint and crown glass, hitherto exclusively used, deviate greatly from the conditions of perfect achromatism. Blair, at the end of the last century, showed the possibility of getting rid of all colour by the use of at least three refracting media, crown glass, oil of turpentine, and naphtha, which give contrary secondary spectra, the dispersive power of one being greater in the red, and of another in the violet part of the spectrum. In this way he succeeded in making an absolutely achromatic objective, the aperture of which was particularly large, namely, one-third of the focal length.

After Blair the matter was lost sight of until the second decade of the present century, when Barlow made an objective of crown glass and a biconcave lens filled with bisulphide of carbon on the dialytic principle. The achromatism of this was not, however, perfect, Blair's use of more than one fluid not having been attended to, and the question again fell into oblivion.

* SB. K. Böhm. Gesell. Wiss. Prag, 1881, pp. 479–92, 467–79 (reversed in order).

Prof. Zenger, in view of Blair's experiments, determined to see whether it would not be possible to find fluids which in combination with crown glass, would produce achromatic objectives. The conditions for absolute achromatism require that the partial dispersions should maintain the same relation in all parts of the spectrum for the two refracting media. Now mixtures of aromatic and fatty substances possess this property to a high degree of approximation, so that when combined as lenses with crown glass (a biconvex crown and a plano-concave fluid) all the different rays of the spectrum will be united and a perfection of achromatism will be produced not hitherto attained.

The question of course arises whether the fluids in consequence of striæ-formations, through rapid changes of temperature, may not originate a new element of optical imperfection. This is opposed to the author's experience of fluid achromatics in sunlight, either with the telescope or Microscope. He has succeeded in converting the ethereal and fatty oils which serve for the production of the refracting media, into the condition of vitreous bodies, or into a kind of gelatine in which striæ-formation is not as easily possible as in very mobile fluids.

By solutions of stearic, oleic, or palmitic acid, or mixtures of these, we can change benzol, castor-oil, poppy-oil and other similar ethereal and fatty oils into transparent gelatine, which is amorphous like glass, perfectly clear and does not flow out of the vessel if inverted. These substances are already used in the arts.

An immense scope for combination is thus opened in order, so to say, to produce kinds of glass of any desired refraction and dispersion, and consequently the optician is saved the trouble of undertaking changes of radius at great expense and loss of time. It is sufficient to make a suitable selection of the gelatine substance which is to be inclosed between a plane parallel plate and the biconvex lens, in order to solve the hitherto difficult problem of a perfect achromatic and aplanatic lens-combination.

The closing up of the fluid must be as hermetical as possible, in order to prevent any evaporation and chemical change in the course of time. There are ethereal and fatty oils which are transparent and very little changeable.

The problems as to lenses for telescopes, Microscopes, and photographic objectives are therefore, it is claimed, extraordinarily simplified through the use of "endomersion" objectives, which are thus named by the author in analogy with immersion objectives, because the fluid is between the lenses. On account of the fact that three radii are equal, while the fourth is infinitely great, he also calls them "symmetrical" endomersion objectives, a quality which embraces the most favourable conditions for brightness, sharpness, and flatness of field of view.

Formulæ and tables are given for the construction of endomersion objectives, and after considering more particularly the case of telescope objectives, those for the Microscope are dealt with, in which case the plane side of the concave fluid lens should be turned to the object.

Such an objective is then somewhat over-corrected, and thus exactly suited for a Microscope objective, because in the case of a single lens the over-correction can be removed by the Huyghenian ocular, while with doublets and triplets, the lens can be corrected or over-corrected to the desired amount, the residue being removed by the ocular as is commonly done by the Lister method.

When the necessary calculation for a given mean refractive and dispersive relation, such as from quartz to a fluid, is once made for a fixed large angle of aperture and a given thickness of the lens, it is easily seen what alterations a change in the refraction of the less refracting lens requires, according to the crown glass used, and we can correct the objective accordingly.

An objective, composed of three achromatics, whose curves were calculated for parallel rays (according to the formulæ and tables of the author) gave such satisfactory results that further detailed calculation is only required for exceptionally large angles of aperture.

The performance of a triplet of 8 mm. equivalent focus composed of three symmetrical endomersion lenses consisting of crown glass and a mixture of fatty and aromatic substances, gave perfect achromatism, for when achromatic eye-pieces (by Schröder) were used which magnified 9, 18, 36, and 72 times, there was even with the last, in bright lamplight and sunlight, scarcely a trace of colour on diatoms or on a Zeiss's silver grating, whilst all the objectives at hand * showed all the colours of the spectrum with such enormous eye-piece power.

With some of these objectives, however, the aplanatism was more perfect than others, which can probably be accounted for by slightly imperfect centering of the three lenses, and also by the defective quality of the plane-parallel plates, in place of which, later on, concave lenses of great focal length were used.

In direct light, with an angle of aperture of only 56°, all the more easy diatoms of Möller's plates were resolved, and of the more difficult the following:—*Rhabdonema arcuatum* and *R. adriaticum*, *Achnanthes subsessilis*, *Scoliopleura convexa* (the images appear black upon white).

With oblique light:—*Nitzschia circumsata*, *Navicula divergens*, *N. minor*, *Gomphonema geminatum*, *Melosira Borrerii*, *Symbolophora Trinitatis*, *Odontodiscus subtilis*, *Hyalodiscus stelliger*, and *H. subtilis* could not be quite resolved, as they were on the limits of the unresolvable with the aperture. *Grammatophora marina* and *Pleurosigma angulatum* were not resolved.

A double symmetrical endomersion objective, combined after the manner of Steinheil's "Symmetric Aplanaten," gave no trace of a difference of the chemical and visual foci, and therefore such an objective, which can be constructed from quartz and a very transparent fluid, is of practical importance for photography.

The usual contrivance is not necessary for obtaining sharp photographs of diatoms, which will even bear well a power of 30 times as

* Objectives by Schneider of Berlin, 1″ to $\frac{1}{9}$″ dry, and $\frac{1}{9}$–$\frac{1}{11}$ (*sic*) immersion, by Zeiss 1 *n* (A) and Hartnack, as well as Reichert of Vienna.

microscopic objects, furnishing the best proof of the coincidence of the optic and actinic foci. The eye-piece is removed and the camera placed in position, without having to make use in any way of coloured or subdued light for the illumination.

In an abstract* of Prof. Zenger's papers by G. Fischer, he expresses the apprehension that the unavoidable changes of temperature to which the lenses would necessarily be subject would be likely to impair their efficiency, and adheres to his own view that absolute achromatism will in all probability only be obtained by the discovery of more favourable kinds of glass.

Prof. Zenger subsequently wrote† to Herr Fischer that Merz's crown glass is still much wanting as regards refraction and dispersion; in his view crown and flint never give a rational dispersion, although flint containing different quantities of lead approximates to it. Incomparably better is the achromatism obtained by his fluid lenses, which are as much in advance of the best achromatics of the present time as these latter are in advance of the non-achromatics. The analogy of the eye, which formerly led to the discovery of partial achromatism, prompted him to try and obtain *absolute* achromatism by imitation of the gelatinous fluids of the eye, that is by mixing two, three, and four different fluids. In this he has succeeded; two or three fluids, oil and balsam mixed, give, compared with crown glass or quartz, quite rational spectra; that is constant ratio of the partial dispersions. A constant dispersion-quotient can be obtained for the whole length of the spectrum within 0·002 to 0·004, therefore much better achromatism than with the best of Merz's systems, in which the quotients differ from 0·004 to 0·026.

Finally he points out that the experiences of photography suffice to show how much the best productions of the first modern opticians fail in collecting all the rays to one focus. He, on the contrary, is able with his fluid system to obtain micro- and astrophotographs without the interposition of coloured glasses or adjustment-correction, just as if his lenses were mirrors; consequently, all rays, chemical and optical, are united in one focal point.

Prof. Safarik has pointed out‡ to Herr Fischer that whilst with Zenger's objectives perfect achromatism is undoubtedly almost attainable, yet it is very doubtful whether *aplanatism* (removal of spherical aberration) is also attainable. With Merz the diminution of the dispersion-relation necessarily entails a lengthening of the focus, the reverse of what opticians have hitherto striven to obtain. "Whether," adds Herr Fischer, "Zenger's system, the three-lens system (Merz's), the improved Herschel-Fraunhofer system with more perfect kinds of glass, Plössl-Littrow's, or an entirely new system, attains the desired end, this much may, I consider, be confidently expected, that sooner or later a considerable improvement of the achromatism, and with it of the optical capacity of the Microscope and telescope, will be assured. In conclusion, I gladly avail myself of the opportunity of bringing

* Central-Ztg. f. Optik u. Mech., iv. (1883) pp. 254–6.
† Ibid., p. 267.
‡ Ibid.

forward the opinion of so competent a judge as Dr. L. Dippel,* against that of Prof. Merkel, who has objected to Merz's object-glasses that they get dim from being too soft. Dr. Dippel writes: 'I have lately become more closely acquainted with Merz's objectives, 1/3, 1/9, 1/12, 1/18, and 1/24 in., and have convinced myself that the objection made to them by Prof. Merkel of their being affected by the air is not well founded.'"

Selection of a Series of Objectives.—At p. 449 (last line but one) a misprint occurs of 200° instead of 120° as in Dr. Carpenter's original text.

Correction-Adjustment for Homogeneous-Immersion Objectives.† —Dr. W. B. Carpenter's views on this somewhat vexed question are explained in his article "Microscope' in the 'Encyclopædia Britannica.'

After pointing out that with homogeneous-immersion objectives the microscopist can feel assured that he has such a view of his object as only the most perfect correction of an air-objective can afford, Dr. Carpenter continues as follows: "This is a matter of no small importance, for while in looking at a known object the practised microscopist can so adjust his air-objective to the thickness of its cover-glass as to bring out its best performance, he cannot be sure, in regard to an unknown object, what appearance it ought to present, and may be led by improper cover-correction to an erroneous conception of its structure.

"It has been recently argued that, as the slightest variation in the refractive index of either the immersion fluid or the cover-glass, a change of eye-pieces, or the least alteration in the length of the body—in a word, any circumstances differing in the slightest degree from those under which the objective was corrected—must affect the performance of homogeneous-immersion objectives of the highest class, they should still be made adjustable. The truth of this contention can, no doubt, be proved, not only theoretically, but practically, the introduction of the adjustment enabling an experienced manipulator to attain the highest degree of perfection in the exhibition of many mounted objects, which cannot be so well shown with objectives in fixed settings. But it may well be questioned whether it is likely to do the same service in the hands of an ordinary working histologist, and whether the scientific investigator will not find it preferable, when using these objectives, to accept what their maker has fixed as their point of best performance. The principal source of error in his employment of them lies in the thickness of the optical section of the object; for the rays proceeding from its deeper plane, having to pass through a medium intervening between that plane and the cover-glass, whose refractive and dispersive indices differ from those of the glass and immersion fluid, cannot be brought to so accurate a focus as those proceeding from the plane immediately beneath the cover-glass. The remedy for this, however, seems to be rather in

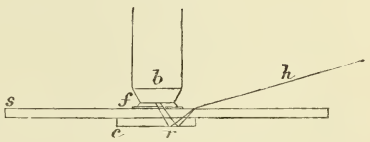
* 'Das Mikroskop,' 2nd ed., 1883, p. 460.

† Encyclopædia Britannica, 9th ed., xvi. (1883) p. 265.

making the preparation as thin as possible than in the introduction of what is likely, in any but the most skilful and experienced hands, to prove a new source of error. Every one who has examined muscular fibre, for example, under a dry objective of very high power and large aperture, well knows that so great an alteration is produced in its aspect by the slightest change in either the focal adjustment or the cover-correction that it is impossible to say with certainty what are the appearances which give the most correct optical expression of its structure. This being a matter of judgment on the part of each observer, it seems obvious that the nearest approach to a correct view will be probably given by the focal adjustment of the best homogeneous immersion-objectives, in fixed settings, to the plane of the preparation immediately beneath the cover-glass."

Lighton's Immersion Illuminator.*—This device of W. Lighton (fig. 101) consists of a small disk of silvered plate-glass *c*, about 1/8 in. thick, which is cemented by glycerin or some homogeneous-immersion medium to the under surface of the glass slide *s*, *r* being the silvered surface of the disk, *b* the immersion objective, and *f* the thin glass cover. The ray *h* from the mirror or condenser above the stage will enter the slide, and thence be refracted to the silvered surface of the illuminator *r*, whence it is reflected at a corresponding angle to the object in the focus of the objective. A shield to prevent unnecessary light from entering the objective can be made of any material at hand by taking a strip 1 in. long and 3/4 in. wide, and turning up one end. A hole of not more than 3/16 in. in diameter should be made at the angle. The shield should be placed on the upper surface of the slide so that the hole will cover the point where the light from the mirror enters the glass. "With this illuminator Möller's balsam test-plate is resolved with ease, with suitable objectives. Diatoms mounted dry are shown in a manner far surpassing that by the usual arrangement of mirror, particularly with large angle dry objectives."

Fig. 101.



Illumination by Daylight and Artificial Light—Paraboloids and Lieberkühns.†—E. M. Nelson finds daylight effective for low powers up to 2/3 in., and with condenser up to 1/6 in. Direct sunlight involves the use of a heliostat, otherwise the continued adjustment of the mirror is irksome. Where strong resolving power is needed, oblique pencils of sunlight from the heliostat outrival any other illumination; but much care is necessary not to injure the sight, and on the whole, he cannot recommend its general use except for photographing. Diffused daylight is too uncertain and too variable for accurate testing of objectives. It is not possible to get with diffused daylight the absolutely best image that an objective will produce.

* Amer. Mon. Micr. Journ., v. (1884) pp. 102-3 (1 fig.).
† Engl. Mech., xxxix. (1884) p. 48.

A really critical image could only be seen with artificial light, and with a good condenser and diaphragms. He does not mean to say that no good work can be done with diffused daylight, for excellent work is done with low or medium powers; but he insists that it is not possible to do any such critical work as testing objectives by daylight as thoroughly as it can be done by artificial light. With daylight and mirror only there is milkiness and "glaze." The milkiness can be got rid of by a diaphragm, and the "glaze" by using a ground glass behind the object. Unless a condenser is used there will always be found a falling off in the quality of the image with all powers higher than 2/3 in. From long experience in working with the Microscope, he feels justified in asserting that on the whole daylight is more trying to the sight than lamplight.

The oxy-hydrogen light may be serviceable for resolving such tests as Nobert's lines, but the incandescence lamp he regards as entirely a failure for microscopical purposes. "This is at once obvious upon the consideration that the finest images seen are got by viewing objects, as it were, *in the image of the source of light.* All critical images of transparent objects viewed by direct transmitted light require first that the source of light should be pictured by the condenser exactly in the plane of the object, the object then serves to interrupt the image of the source of light. The observer has simply to arrange the lamp, condenser, and diaphragms so as to produce the most perfect image of the source of light of the required size in the plane of the object, the objective will then have fair play. The size of the image of the lamp flame can be controlled by distancing the lamp. There is no other secret in the matter. With the incandescent lamp the image produced by the condenser represents the mere carbon thread, on which no object could be seen projected; in order to obtain some extent of brightly luminous field, the condenser must be put out of focus, then the intensity of the light is so reduced that the observer would simply discard the incandescence, finding it far less serviceable than a shilling paraffin lamp."

He entirely condemns the use of paraboloids for dark-ground illumination, as properly adjusted central stops with the condenser will give by far the best dark-ground illumination. For opaque objects he considers nothing has been devised so good as Lieberkühns, and objects ought as far as practicable to be mounted for use with Lieberkühns, and not covered up with paper. If the side illuminator is used it should be attached to a fixed part of the stand, not to the body-tube or stage.

With the preceding remarks may be contrasted the view of Prof. Abbe (*in litt.*) that it is quite immaterial, from a theoretical point of view, whether an illuminator has or has not spherical aberration. The effect of illumination does not depend upon the projection of a *sharp image* of the source of light upon the object, nor even on the projection of any image at all. The only object of projecting an image of the source of light *approximately* at the plane of the object is in order that a uniform illumination of a given area

of the object (the field of vision) may be obtained by means of a small source of light. This object is attained notwithstanding considerable aberrations, and it is the better obtained the greater the focal length of the illuminating system. A lens of 3/4 in. curvature is therefore less advantageous than one of 1 in.

The general view of English microscopists is undoubtedly in favour of the superiority of an achromatic condenser over any non-achromatic arrangement. With the latter, confused pencils of light are produced by the spherical aberration, which seriously impair the images of fine structures, whilst with the former, "the most delicate objects are seen with a clearness and sharpness of detail quite unknown to those microscopists whose experience has been confined to the use of non-achromatic condensers." *

Bausch's New Condenser.†—E. Bausch describes a new condenser (figs. 102 and 103), similar to that of Prof. Abbe, the formula upon

Fig. 102.

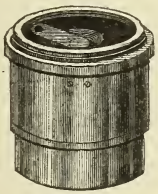
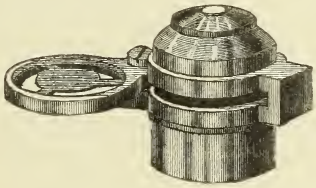


Fig. 103.



which it is constructed being, however, a modification of that used in Bausch's Immersion Illuminator. The posterior system is as large as the substage-ring will allow, and will transmit and condense all the rays which pass through this from the mirror. Its numerical aperture is about 1·42.

There are two styles of mounting, fig. 103 shows the substage adapter and condenser with a swinging diaphragm ring between them. This ring receives the various stops, which may be changed without disturbing the condenser. Fig. 102 is intended to give the different degrees of oblique illumination, from central to that of the utmost possible limit. It is provided with a circular opening, 1/4 in. in diameter, which may be decreased if desired, and which is caused to move slowly from the centre to the edge of the mounting by turning the outside milled edge.

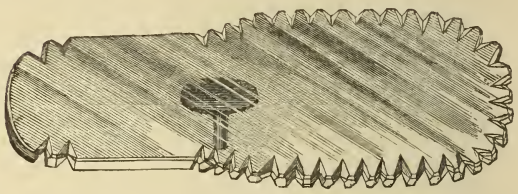
Both of these mountings are adapted to substages attached either to the substage bar, or fixed to the bottom of the stage. The condenser is also furnished with plain substage adapter only.

Glass Frog-plate.—This (fig. 104, designer unknown) is a simplification of the ordinary frog-plate. The general form of the

* Swift's 'The Microscope,' 1883, p. 43.
† The Microscope, iv. (1884) pp. 105-6 (2 figs.).

old brass plates is retained, but in place of brass glass is used, the edges of which are serrated for the string. The brass pin is at

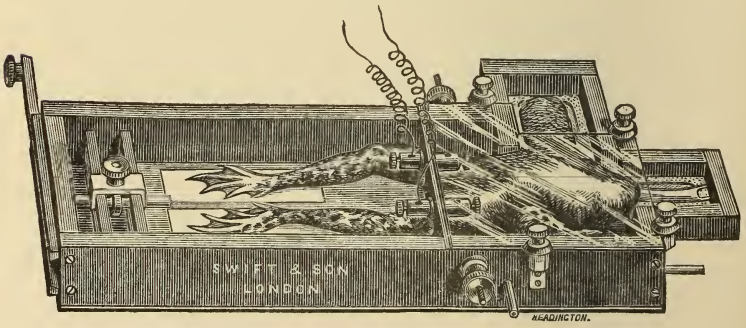
Fig. 104.



present only cemented to the plate; it would be better if it passed through it.

Groves and Cash's Frog-trough for Microscopical and Physiological Observations.—Some years since Mr. J. W. Groves devised a simple guttapercha trough, in which circulation in the webs of frogs could be observed for a considerable time without the web becoming dry. This was effected by keeping the feet of the frog entirely covered with water, into which the objective (protected by a watertight cap closed below by a piece of thin glass) could be lowered after the fashion of Mr. Stephenson's submersion objective. This contrivance he and Dr. Theodore Cash have considerably improved. The trough (fig. 105) is long enough to admit a full-sized frog; in

Fig. 105.



the bottom, which is lined with cork, are two windows of glass, through which light may be transmitted to the webs of the feet. At the anterior end is a projection, with a cork bottom and glass window for the examination of the tongue, and another similar projection at the side for the observation of the mesentery or lungs. The trough is made of vulcanite, and is watertight, but at the posterior end is a sliding piece by which that end can be opened and a thread passed through to the lever of a myograph. In convenient situations are binding screws for the connection of wires from a coil or battery.

Either or both of the projecting portions of the trough can be shut off from the main receptacle by sliding hatches (not shown in the fig.) if necessary, and the part containing the body of the frog can be covered with glass or a vulcanite lid. Should it be desired to observe the effect of gases or of heat or cold, the required gases or warm or cool air may be conducted through the body chamber by means of the two small tubes seen projecting from the front and sides respectively.

The frog to be observed is placed either ventrally or dorsally as may be required, and is held by means of loops of thread passed round the arms and then led through screw-eyes and clamped up. The thighs are held by a pair of stocks, which, by means of a sliding upper half, can be adjusted accurately to the limbs without causing constriction; and the webs are spread out by pinning loops of thread tied to the toes.

Visibility of Ruled Lines.*—C. Fasoldt writes, in regard to the note by Professor W. A. Rogers, which appears at p. 439 of vol. iii. (1883), that "there are some statements which do not agree with my experience. I find that lines properly ruled on glass are similar to graven lines; they are smooth, clean cut, having a definite shape and depth. Such lines are always visible in the Microscope, and central or oblique light will show the bottom of each cut as a dark or coloured line, plainly visible, and requiring no graphite or other foreign substance to indicate it. The Microscope is the test for a properly ruled line. The mechanical elements (pressure, &c.) entering into the process of ruling are not at all evidences that lines have been properly ruled. The slightest accident to the point of the cutter, or the surface of the glass not being perfectly clean, will spoil a line; that is, produce a scratch which cannot be satisfactorily illuminated in any light. Well-ruled bands of lines, 70,000 or 80,000 to the inch, are visible in the Microscope with central light; and with a Smith vertical illuminator (giving central light), I have seen 100,000 lines to the inch. As these individual lines have a width of about 1/200,000 of an inch only, it follows that the difficulty is not to see such a narrow line, but to eliminate the diffractions which tend to blur the image in the Microscope, and so prevent the resolution or separation of the lines in a band of them."

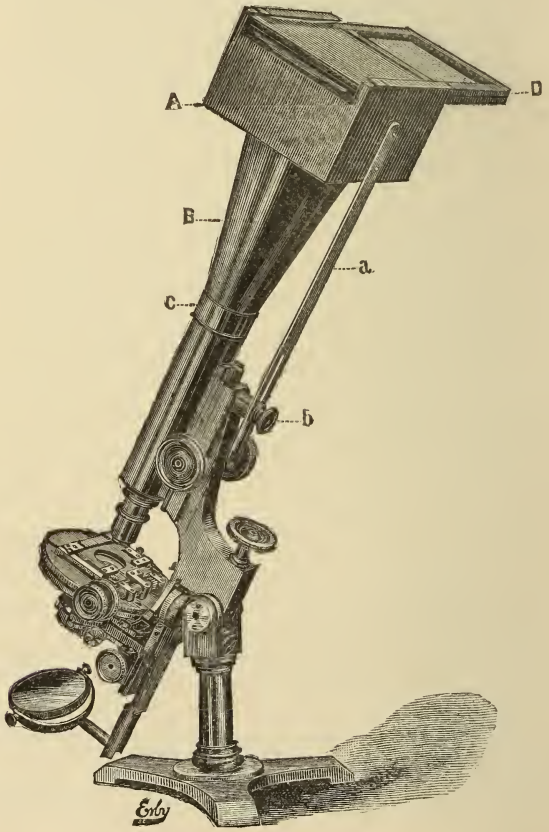
Mercer's Photomicrographic Camera.†—Dr. F. W. Mercer has devised the camera shown in fig. 106. It consists of a box of light wood A, a cone of light metal B, a tube which takes the place of the ordinary draw-tube of the Microscope, C, and the frame carrying the ground glass and plate-holder, D. The tube C is fitted to the cone B, so that it may be withdrawn for the insertion of an eye-piece or amplifier. To the box A is attached a brass strap *a*, the lower end being slotted to admit the passage of a binding screw secured to a button *b*, fastened to the arm of the stand. As soon as the object is coarsely focused upon the ground glass the cone and its tube are

* Scientific American, xlviii. (1883) p. 341.

† 'Photography' (Chicago), i. (1884) pp. 9–10 (1 fig.).

raised slightly, say about a quarter of an inch from the body of the Microscope, and the binding screw is then tightened, securing the weight of the camera, &c., upon the arm of the instrument, thus removing any undue pressure upon the rack and pinion, or fine movement of the tube, during future manipulation. The fine focusing

Fig. 106.



when completed leaves nothing to be done but to push the ground-glass frame on till it is replaced by the plate-holder, when the picture may be made.

The features claimed for this apparatus are: "Its great portability, measuring when the draw-tube has been removed from the cone, $4\frac{1}{4} \times 4\frac{1}{4} \times 9$ in.; its ready application to the Microscope in any position from the vertical to the horizontal, requiring but a few minutes for its adjustment without changing the position or light, at least for moderate powers; its special fitness for the amateur, being

moderate in first cost and inexpensive in use from the size of the plate used. Though the plate is small, $3\frac{1}{4} \times 4$ in. (lantern size), it is very useful and will meet most of the needs of the amateur workers for whose convenience the instrument is intended.

There is a class of work of which this little camera is incapable, and in introducing it to the notice of microscopists, it is not intended to convey the impression that it will supersede other means where skilled hands and elaborate apparatus are absolutely necessary. To those who have but an hour or two of an evening for observation with the Microscope, this camera may prove of service in securing a photograph quickly at the work-table.

The box above the cone might be dispensed with, and the slide carrying the ground glass attached directly to the large end of the cone. The advantage in having the box is the shutter, which may be fitted to its interior for excluding light from the plate at the moment of completing the exposure, a preferable means to that of placing a piece of black paper between the objective and the source of light. Instead of having the ground glass and plate-carrier in one frame, it might be desirable for some to have them separate, having more than one plate-holder. The apparatus can at a trifling cost be attached to most stands, and when properly made should not exceed, including ground glass and plate-holder, seven or eight ounces in weight."

Photographing Bacillus tuberculosis.*—M. Defrenne describes the process which he adopts to photograph this *Bacillus* with a Tolles' 1/10 in. (hom. imm.), without eye-piece, using extra rapid bromo-gelatine plates, developed with ferro-oxalate, a petroleum lamp being employed for illumination.

If, he says, the determination of the actinic focus of objectives constitutes, so to say, the chief difficulty in photographing ordinary microscopic preparations, it is no longer so when we deal with organisms so infinitesimally small as the bacilli of tuberculosis. Here arises a difficulty of quite another kind, which at first seemed insurmountable: the staining of the bacilli by means of fuchsin. This agent, even when it is employed in thick layers, is somewhat actinic, and it becomes the more so as the object stained is smaller or more transparent. These two circumstances are combined in the highest degree in the organisms in question. Thus at the beginning the plates exposed were either uniformly acted on or the image was so faint and so little differentiated after development that they were worthless for proofs on glass or on paper.

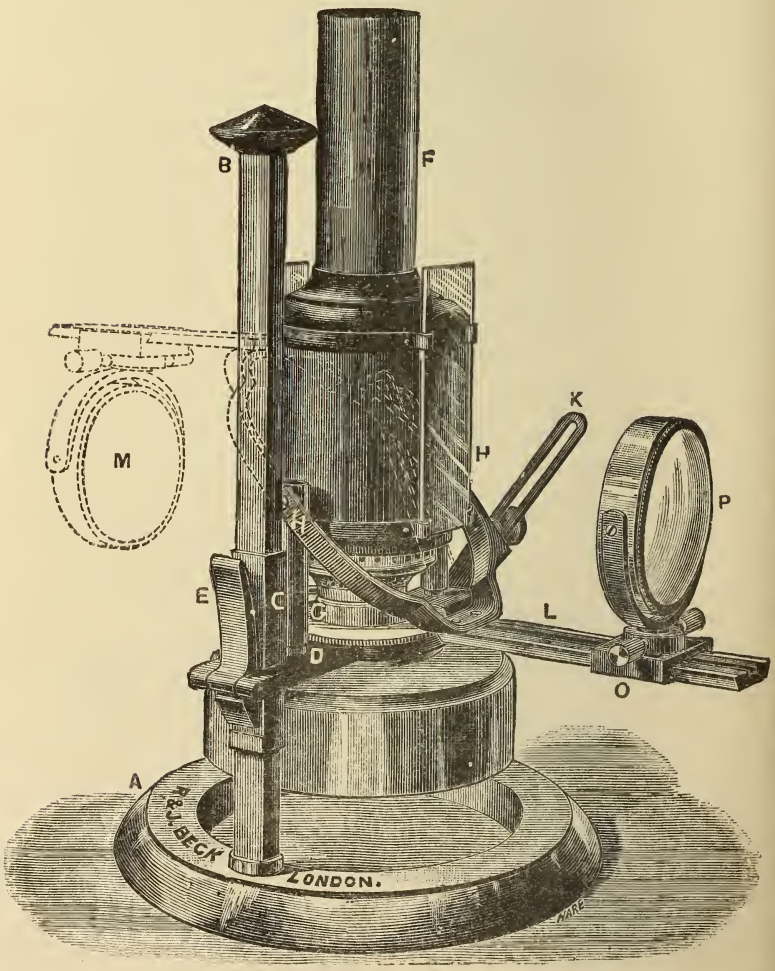
These negative results suggested the abandonment of the attempt, when the idea was suggested of having recourse to the use of a *compensating glass* of a colour complementary to red (that is green), placed between the objective and the sensitized plate. By thus filtering the image formed by the objective, the red rays, the only ones passing through the bacilli, are absorbed, if not wholly, at least in great part. The microbes therefore appear nearly black on the plate, and make

* Bull. Soc. Belg. Micr., x. (1884) pp. 128–32.

a much slower impression than the rest of the preparation, which gives free passage to all the green rays. More contrast is thus obtained and a very distinct photograph produced.

Beck's "Complete" Lamp.—For pathological and physiological investigation, as also for many other branches of microscopical

Fig. 107.



research, a lamp more delicate in its adjustments and giving a greater control over the light than those ordinarily in use is requisite, and Messrs. Beck have therefore constructed a lamp whereby more

perfect illumination of both opaque and transparent objects can be obtained.

The base A (fig. 107) consists of a heavy ring, into which a square brass rod B is screwed. The square rod carries a socket C with an arm D, to which the lamp is attached. This socket fits the square rod loosely, but is kept in any position by a lever E, which is pressed firmly against the square rod by a strong spring. If the lever and the opposite side of the socket are taken between the thumb and finger, the pressure of the lever on the bar is removed, and the lamp can be raised or lowered to the desired position, when by releasing the hold the lamp is at once clamped.

On each side of the burner, and attached to the arm D, is an upright rod G, to one of which the chimney is fixed, independent of the reservoir of the lamp, but fitting closely over the burner, thus enabling the observer to revolve the burner and reservoir, and obtain either a thin intense light or a broad and diffused one, without altering the position of the chimney. The chimney F is made of thin brass, with two openings opposite to each other, into which slide 3×1 glass slips of either white, blue, or opal glass, the latter serving as a reflector.

The reservoir, although holding enough oil to burn for several hours, is made very flat, and drops into the annular base, thereby bringing the flame of the lamp within 3 inches of the table, rendering it much more serviceable for direct illumination (without the mirror) and for other purposes.

A semicircle swings from the two uprights G, to which it is attached by the pins H, placed level with the middle of the flame; to this semicircle is fixed a dovetailed bar L, carrying a sliding fitting O, which bears a Herschel condenser P.

This condenser, swinging with the middle of the flame as a centre, is always at the same distance from it; and thus, when once focused, needs no further alteration for any change in the inclination of the beam of light. The condenser is fixed at any inclination by a milled head working in a slotted piece of brass K, fixed to the arm D.

When used for transparent illumination, the condenser is not required below the horizontal position; but when the lamp is required for the illumination of opaque objects, the chimney having been temporarily removed and the milled head fixing the condenser arm having been loosened, the arm with the condenser can be thrown over the lamp, as shown in the illustration at M, and the chimney being replaced, the light, which now comes through the opposite opening of the chimney, can be condensed at a large angle below the horizontal.

James' 'Aids to Practical Physiology.'*—It is beyond our comprehension how this extraordinary book could ever have been written by an author entitled to add M.R.C.S. to his name, or published as a volume of 'Students' Aids Series' by such publishers as those whose

* J. Brindley James, M.R.C.S., 'Aids to Practical Physiology,' 8vo, London (Baillière, Tindall, & Cox), 1884, viii. and 60 pp.

names are attached to the title-page, which moreover bears the motto "Mens sana in corpore sano." That we do not criticize it without reason will be seen by the following extract which is prefaced by the statement that it contains a "few practical hints which we trust may "powerfully tend to facilitate the young experimentalist's labours." (The italics are ours.)

"The Microscrope (sic).—You cannot expect to get one of any valuable power (!) under five guineas. It should be of two powers, enabling you to use inch and quarter-inch glasses (!) The hole in the stage should have its *axis diametrically consistent (!) with that of the tube* of the instrument. *A stand is also needed* (!!) Object-glasses, denoted as one-fourth, one-fifth, one-sixth, are used for high powers, *one-half to two-fifths* (!) for low. An oil-immersion lens is now-a-days a necessary complement, and should be about one-twelfth. The simpler it is the better for a beginner (!) The same may be said of the eye-piece (!!) With respect to such other adjuncts as achromatic condensers, special stands, &c., these concern the accomplished microscopist rather than the tyro."

As it was obvious that the author was not at home in the optical branch of his subject, we turned to the description of a piece of apparatus with which the practical physiologist should necessarily be intimately acquainted—the Microtome. Will it be believed that it is described not as an instrument for cutting sections, but for freezing specimens! The author's own words are as follows: "The Micro-"tome. This useful device for freezing specimens is susceptible of "various forms of construction."

After these extracts it is superfluous to refer to the other minor blunders which disfigure the book, such as the description of Dr. Klein as "Kleän," the indiscriminate use of "bichromate of potash," "potass" and "potassium," and "potassic bichromate" for the same substance.

Postal Microscopical Society.—This society is now forming a section specially devoted to members of the medical profession (including students).

"A President."—Suggestion for making the 'Journal of Microscopy' the Journal of provincial and other Microscopical Societies.
Journ. of Micr., III. (1884) pp. 194–5.

"Amateur."—Bacteria and the Microscope.
[Elementary Inquiries.] *Engl. Mech.*, XXXIX. (1884) pp. 465–6.

American Society of Microscopists, Session of 1884.—Circulars of President J. D. Cox, and E. H. Griffith. *Micr. Bull.*, I. (1884) pp. 25 and 28.
Amer. Mon. Micr. Journ., V. (1884) pp. 117–8.
The Microscope, IV. (1884) p. 133.

Belfield, W. T.—Photo-micrography in Legal Cases. [*Post.*]
Photography (Chicago), I. (1884) pp. 54–9 (7 figs.).

Bradbury, W.—Papers relative to the theory of the Object-glass.
[Note introducing paper by Dr. C. S. Hastings, from 'Amer. Journ. Sci.,' detailing the method used by him to determine the optical properties of various kinds of glass and the alterations in the properties when the glass was subjected to different temperatures.]
Engl. Mech., XXXIX. (1884) pp. 420–1.

Bulloch, W. H.—The Congress Nose-piece.
[Further rejoinder to Prof. McCalla's claim of priority.]
Amer. Mon. Micr. Journ., V. (1884) pp. 119–20.

Carnoy, J. B.—La Biologie Cellulaire. Etude comparée de la cellule dans les deux Règnes. (Cellular Biology; a comparative study of the cell in the two kingdoms.) Fasc. I. 271 pp. and 141 figs. 8vo, Lierre, 1884.
[Part I. Microscopical Technics (pp. 37–167, 24 figs.). 1. On instruments and the laboratory of the microscopist or cytologist. 2. On objects and their preparation. 3. On the method to be followed in microscopical observations and cytological researches.]

Carpenter, W. B.—Article "Microscope" in the 'Encyclopædia Britannica,' 9th ed., XVI. 4to, Edinburgh, 1883. [*Cf. ante*, pp. 448 and 620.]

Cox, J. D.—See American.

„ „ Photographs showing the structure of Diatom shells.
Amer. Mon. Micr. Journ., V. (1884) p. 112.

D., E. T.—Graphic Microscopy. VI. Pupa of Locust, one day old. VII. Cluster Cups: *Æcidium quadrifidum*.
Sci.-Gossip, 1884, pp. 121–2 (1 pl.), 145-6 (1 pl.).

Defrenne.—Présentation d'une Microphotographie du *Bacillus tuberculosis*. (Exhibition of a photomicrograph of *Bacillus tuberculosis*.) With remarks by E. van Ermengem. [*Supra*, p. 627.]
Bull. Soc. Belg. Micr., X. (1884) pp. 128–32.

Dudley, Prof.—Microscopic Photography.
[Response to a toast.] *Photography* (Chicago), I. (1884) pp. 71–2.

Ermengem, E.—See Defrenne.

F.R.A.S.—Optical Recreations.
[Containing a note on the convex lens used as a magnifying glass.]
Knowledge, VI. (1884) pp. 46–7 (4 figs.).

Francotte, P.—Aspirateurs pour tenir constamment saturée d'air l'eau des récipients où l'on observe les animaux et les plantes aquatiques. (Aspirators for keeping saturated with air the water of receptacles for observing aquatic animals and plants.) [*Post.*] *Bull. Soc. Belg. Micr.*, X. (1884) pp. 141–3.

Giant Electric Microscope.
[Criticism of its defects.] *Journ. of Sci.*, VI. (1884) p. 370.

Gill, D.—Article "Micrometer" in 'Encyclopædia Britannica,' 9th ed., XVI., p. 248. 4to, Edinburgh, 1883.
[Contains "How to web a filar micrometer." *Post.*]

Gowen, F. H.—Resolution of *Amphipleura*.
[Direct sunlight above the stage. "The Microscope should be so placed that the light may fall on the circumference of the stratum of immersion fluid obliquely to the upper surface of the slide, and care should be taken to have one end of the frustule point towards the sun."]
Amer. Mon. Micr. Journ., V. (1884) p. 118.

„ „ Resolution by Central Light.
[Resolution of *A. pellucida* in balsam by sunlight with the mirror in a strictly central position. "The resolution was effected by light reflected within the slide from one of its convex edges, and that instead of being central the light was very oblique."]
Amer. Mon. Micr. Journ., V. (1884) pp. 118–9.

Griffith, E. H.—See American.

Hardy, J. D.—Microscopical drawing.
[Report of demonstration.] *Journ. Quek. Micr. Club*, I. (1884) pp. 360–1.

Hastings, C. S.—See Bradbury, W.

Hazlewood, F. T.—A home-made revolving table.
["I got a second-hand sewing-machine table . . . Then I took another table-top which was raised about 2 in. from the other by a moulding. On the top of the first table I put a piece of pine board 1 in. thick. Into this I put three small castors upside down. I bored three holes in the top of the other table, on radii, from a common centre. Then I put top No. 2 over top No. 1, so that the castors came over the surface about 1/4 in.

Through the centre of both tables I bored another hole. Then I took a steel saw-plate into which the teeth had not been cut. I had a hole bored in its centre, and two brass handles or pins put in opposite each other near the circumference. This plate is fastened by a pin with nuts on the table over the three castors. The table is perfect. I painted the steel plate. The drawer of the first table on the side serves for accessories. The whole thing cost less than five dollars. The finished table looks as though made for this purpose, and not for a sewing-machine."]

Amer. Mon. Micr. Journ., V. (1884) p. 94.

Herrick, S. B.—The Wonders of Plant Life under the Microscope. 248 pp. and 85 figs. 8vo, London, 1884.

Hertwig, O. — Die Verwendung des Sciopticons als eines Anatomischen Unterrichtsmittels. (The employment of the Sciopticon for anatomical instruction.)

[Exhibition of glass photograms and sections.]

SB. Jenaisch. Gesell. Med. & Naturwiss., 1883, p. 17.

Heurck, H. Van—[Protest against the review of his "Lumière électrique," by Stein, in 'Zeitschr. f. Wiss. Mikr.']

Journ. de Microgr., VIII. (1884) pp. 273–7.

Hitchcock, R.—The Postal Microscopical Club.

[Exhortation to put better slides in the boxes.]

Amer. Mon. Micr. Journ., V. (1884) pp. 113–4.

James, F. L.—The St. Louis Microscopical Society.

[Notification of its formation.] *The Microscope*, IV. (1884) pp. 129–30.

James, J. B.—Aids to Practical Physiology. viii. and 60 pp. 8vo, London, 1884. [*Supra*, p. 629.]

Lighton, W.—Immersion Illuminator. [*Supra*, p. 621.]

Amer. Mon. Micr. Journ., V. (1884) pp. 102–3 (1 fig.).

Möbius, K.—Rathschläge für den Bau und die innere Einrichtung zoologischer Museen. (Advice on the construction and internal arrangement of Zoological Museums.)

[Contains a reference to the "Microscopirzimmer."]

Zool. Anzeig., VII. (1884) pp. 378–83.

Müller, P.—Insectenfänger mit Lupe. (Insect-catcher with lens. *Post.*)

German Patent No. 25,806, 6th June, 1883. See *Zeitschr. f. Instrumentenk.*, IV. (1884) pp. 259 (1 fig.).

Nelson, E. M.—How to Work with the Microscope.

[Report of demonstration. See *ante*, pp. 447 and 464. The view originally expressed as to the decided preference to be given to the Ross form over the Jackson is modified. "In point of steadiness he did not think there was much to choose between them in first-class stands."]

Journ. Quek. Micr. Club, I. (1884) pp. 375–9.

" " The Health Exhibition.

[Description of Microscopes, Apparatus, &c., exhibited.]

Engl. Mech., XXXIX. (1884) pp. 437–9.

Rogers, W. A.—On a practical solution of the perfect screw problem.

[Describes the method by which it is claimed a perfect screw can be made on a common lathe, including a Microscope provided with Tolles' opaque illuminator attached to the carriage moved by the leading screw of the lathe.]

Engl. Mech., XXXIX. (1884) pp. 341–2.

Royal Microscopical Society: Notes as to the admission of ladies and rearrangement of the Cabinet. *Journ. of Sci.*, VI. (1884) p. 437.

Schneider, E.—Ueber eine Justirvorrichtung an einem Krystallgoniometer. (On an adjusting arrangement for a Crystal Goniometer.)

[Differential screw.]

Zeitschr. f. Instrumentenk., IV. (1884) pp. 242–4 (1 fig.).

Stein, S. T.—Das Mikroskop und die mikrographische Technik zum Zwecke photographischer Darstellung. (The Microscope and Microscopical Technic in Photographic representation.) Part II. of 'Das Licht im Dienste wissenschaftlicher Forschung,' 2nd ed., pp. i.–ix. and 151–322, figs. 168–302, pls. iii–vi. 8vo, Halle a. S., 1884.

Stowell, C. H.—Rochester meeting [of American Society of Microscopists]. *The Microscope*, IV. (1884) pp. 131–2.

Strasburger, E.—Das botanische Practicum. Anleitung zum Selbststudium der mikroskopischen Botanik für Anfänger und Fortgeschrittnen. (Practical Botany. Guide to the study of microscopical Botany for beginners and advanced students.) xxxvi. and 664 pp., and 182 figs. 8vo, Jena, 1884.

Talbot, R.—Das Scioptikon, Vervollkommneter Projectionsapparat für den Unterricht. 7th ed., vi. and 82 pp. 8vo, Berlin, 1884.
[Mainly a Catalogue of Photograms and microscopical preparations.]

Thurston, E.—The Microscope: its Construction and Manipulation. *Micr. News*, IV. (1884) pp. 150–2.

Waters, W. H.—Histological Notes for the use of Medical Students. vi. and 65 pp. 8vo, Manchester and London, 1884.
[The body-tube of the Microscope is (not aptly) styled the "telescope-tube"! and the concave mirror the "curved mirror."]

Wenham Button.
[To keep the Wenham button or the common hemispherical lens in position while examining temporary mounts, fix it with glycerin or immersion fluid to that surface of a slide on which has been turned a wax or an asphalt ring, the internal diameter of which corresponds to the diameter of the lens. Invert the slide, and it is ready for use.]
The Microscope, IV. (1884) p. 134.

β. Collecting, Mounting and Examining Objects, &c.

Methods of Investigating Animal Cells.*—Dr. A. Brass has devoted several years of close study to the structure and life of animal cells, and gives a detailed account of his methods. The following are some of the more important of these methods:—

1. *Protozoa.*—As most Protozoa move very rapidly when hungry, it is well to feed them before attempting to study them with the Microscope. If well fed with powdered pieces of plants, &c., they usually remain quiet after a short time, and begin to assimilate the food-material which they have appropriated. In this condition of comparative quiet they can be easily examined with high powers. For this purpose they may be placed under a cover-glass with a considerable quantity of water and a number of small green algæ to keep the water supplied with oxygen.

For higher powers Abbe's illuminating apparatus is extremely useful. In some cases it is desirable to have a completely one-sided illumination, and this is best effected by inserting beneath the illuminating apparatus a circular diaphragm-plate perforated with a slit 3 mm. wide that runs parallel to the edge of the plate. It is best to leave about 2 mm. between the slit and the edge of the

* Zeitschr. f. Wiss. Mikr., i. (1884) pp. 39–51. Cf. Amer. Natural., xviii. (1884) pp. 650–1.

plate. Several diaphragm-plates should be prepared in which the slit varies in extent from a half to a whole of a quadrant or more.

The following mixture, which is Meckel's fluid with the addition of a little acetic acid, is recommended above all other reagents as a preservative medium:

Chromic acid	1 part.
Platinum chloride	1 ,,
Acetic acid	1 ,,
Water	400–1000 parts.

Unicellular animals die very slowly in this mixture, and suffer very much less alteration in structure than when killed in osmic acid or picro-sulphuric acid.

A special method is required for Protozoa filled with opaque food-material. In many cases the nucleus and the structure of the cell-body are completely obscured by foreign bodies. The method adopted in such cases is as follows:—

(1) Placed in picro-sulphuric acid 3–4 minutes.

(2) Transferred to boiling hot water for a short time.

(3) Placed in water and a little ammonia added; this causes the contracted object to swell up to its original size and form.

(4) Neutralize the ammonia with a little acetic acid, and then

(5) Colour with borax-carmine or ammonia-carmine.

(6) Wash and examine in dilute glycerin.

The picro-sulphuric acid destroys the nutritive material; the ammonia dissolves any particles of fat that may be present; and thus the object becomes transparent as far as possible.

A concentrated solution of corrosive sublimate may also be used with success for killing Protozoa; but care must be taken to wash thoroughly.

Dr. Brass has obtained his best results without reagents or dyes.

Born's Method of Reconstructing Objects from Microscopic Sections.*—Dr. G. Born describes in detail a very ingenious method of constructing models of objects from serial sections. By the aid of the camera the outlines of the sections are transferred to wax plates, which are then cut out so as to correspond in outlines as well as dimensions to the sections equally magnified in all three directions. With plates thus prepared, it is only necessary to put them together in the proper order to obtain a complete model. The method is simple and extremely useful, especially in investigating objects with complex internal cavities. Born has made use of the method in studying different parts of the vertebrate head; Swirski, in elucidating the development of the shoulder-girdle of the pike; Stöhr, in tracing the development of the skull of Amphibia and Teleostei; and Uskow, in studying the development of the body-cavity, the diaphragm, &c.

* Arch. f. Mikr. Anat., xxii. (1883) pp. 584–99. Cf. Science, ii. (1883) p. 802, and Amer. Natural., xviii. (1884) pp. 446–8.

Born makes use of three rectangular tin boxes of equal sizes, each measuring 270 mm. × 230 mm. × 2½ mm. Sections should be made about 1/25 mm. thick (never thinner than 1/50 mm.). If we desire to construct a model of an object from serial sections 1/30 mm. thick, which shall be magnified 60 diameters, then the wax plates must be made 60 times as thick as the sections, i. e. 2 mm. thick.

The surface of a plate that could be made in a box of the above-named dimensions, contains 62,100 sq. mm.; and the volume of such a plate 2 mm. thick would therefore be 124·2 c.cm. The specific gravity of common raw beeswax amounts to ·96–·97. For use, it requires only to be melted and a little turpentine added to make it more flexible. Thus prepared, its specific gravity is about ·95; and this number has been found sufficiently accurate in all cases. The weight of the wax required to make one plate of the above size, will accordingly be 117·99 gr., or, in round numbers, 118 gr. The wax having been weighed and melted, the tin box is first filled 1½ cm. deep with boiling water, and then the melted wax poured upon the water. If the water and the wax are quite hot, the wax will generally spread evenly over the surface; if gaps remain, they can be filled out by the aid of a glass slide drawn over the wax. As soon as the plate has stiffened, and while it is still soft, it is well to cut it free from the walls of the tin box, as further cooling of the water and the box might cause it to split. By the time the water becomes tepid, the plate can be removed from the water to some flat support, and left till completely stiffened. Half a hundred plates may thus be prepared in the course of a few hours.

The outlines of the section are transferred to the plate in the following manner: a piece of blue paper is placed on the plate with the blue side turned towards the wax, and above this is placed a sheet of ordinary drawing paper. The outlines are drawn on the latter by the aid of a camera, and at the same time blue outlines are traced on the wax plate. The plate can then be laid on soft wood and cut out by the aid of a small knife. Thus a drawing and a model of each section are prepared. The plates thus prepared can be put together in the proper order, and fastened by the aid of a hot spatula applied to the edges.

Shrinking Back of Legs of Oribatidæ in Mounting.*—A. D. Michael suggests a mode of getting over the difficulty of the shrinking back, during the process of mounting, of the legs of species of *Oribata* and other genera which have special cavities for the reception of the legs. The process requires careful manipulation, but if well done is very successful. Place a very thin layer of balsam upon the slide upon which the specimen is to be soaked in oil of cloves; when this layer becomes sticky the specimen is placed upon it, dorsal surface downwards. The mounter must then extend the legs and stick them to the balsam, if they rise up they should be pressed down again with a hair; when they are all fast the body should be brushed over with the smallest possible quantity of oil of cloves to prevent its drying,

* 'British Oribatidæ' (Ray Society) 1884, pp. 104–5.

but without touching the legs. This brushing with oil of cloves must be repeated from time to time as it sinks into the body. When a creature is ready, which can only be learned by experience, a large drop of oil of cloves, not benzole, may be put on; when this has *thoroughly* dissolved the balsam, but not before, the specimen may be moved and mounted, or further soaked in oil of cloves.

Preparing the Liver of the Crustacea.*—For the study of fresh tissues J. Frenzel places a small piece of the organ on the slide, *in the blood of the individual from which it was taken;* or, *in sea-water diluted until the salt contained amounts to about* 1½–2 *per cent.* (one part distilled water and one part sea-water from the Bay of Naples). The so-called "physiological salt-solution" (3/4 per cent.) worked unfavourably, causing maceration.

Various fluids were employed for killing and hardening, partly for determining the effect of different reagents on the nuclei and the protoplasm, and partly for finding the best means of preparing the object for sectioning.

Very good preparations were obtained with *warm* alcohol from 70–90 per cent.; while direct immersion in absolute alcohol did not prove advantageous. This treatment gave good results for the cell-protoplasm, but destroyed the structure of the nuclei. Still better results were obtained for the cells (not for the nuclei) by adding a few drops of iodine to 70 per cent. alcohol.

The most satisfactory results were reached by immersing the object in a saturated aqueous solution of corrosive sublimate from ten to thirty minutes, then washing with water, and finally replacing the water gradually with alcohol.

Perenyi's fluid gave best results when combined with corrosive sublimate. The object was left from five to ten minutes in the first-named fluid, then transferred to the second and left for the same time.

While these methods were good for the Decapods, Amphipods, and Phronimidæ, the Isopods required a different treatment. With these, Kleinenberg's picro-sulphuric acid, diluted with an equal volume of water, and allowed to act 15–20 minutes, gave much better preparations than the sublimate solution.

Preparing Alcyonaria.†—In studying the mesenterial filaments of the Alcyonaria, E. B. Wilson obtained the best results in the following manner.

The animals were suddenly killed by momentary immersion in a mixture of 1 part strong acetic acid and 2 parts of a concentrated solution of corrosive sublimate in fresh water. After being quickly washed, they were transferred to a concentrated solution of sublimate in fresh water and left two or three hours; the internal cavities being injected with the solution, where this was possible. They were then thoroughly washed in running sea-water, then in distilled

* MT. Zool. Stat. Neapel, v. (1884) p. 51. Amer. Natural., xviii. (1884) pp. 556–7.

† MT. Zool. Stat. Neapel, v. (1884) p. 3.

water, and finally preserved in successive grades of alcohol. A weak solution of iodine in alcohol and sea-water also gives beautiful results, but is less certain in its action. For staining he used Grenacher's alum-carmine, borax-carmine, picro-carmine, and Kleinenberg's hæmatoxylin. Much the best results are obtained by the use of alum-carmine, but it must be used as quickly as possible, since the gelatinous tissue of the mesoderm is apt to shrink if the object be left too long in aqueous fluid. The tissues were decalcified with very weak nitric or hydrochloric acid in 90 per cent. alcohol. For maceration, the Hertwigs' well-known mixture of osmic and acetic acid gives good results.

Semper's Method of making Dried Preparations.*—B. Sharp redescribes this process.†

After hardening in chromic acid solution (¼–1 per cent.) and being repeatedly washed, the object is placed in alcohol, 30-40, 60–70, and 90–95 per cent. successively, and finally in absolute alcohol.

This stage of absolute alcohol is the most critical part of the whole process. *Absolutely* every particle of the water must be removed, and the secret of the whole process depends on this one point. If any water be left in the tissue, it will become spotted and eventually spoil. After all the water has been withdrawn by the absolute alcohol, by remaining in it for three days to a week, the object is placed in turpentine, the best that can be procured. In this it is allowed to remain until it becomes thoroughly saturated: with large objects it is best to change the turpentine once. Two or three days are required for this stage. When saturated, the object is quite stiff, and when the process is successful little or no contraction has taken place. The object is then placed in the air and protected carefully from the dust, and the turpentine allowed to evaporate. The object then soon presents a very beautiful appearance; it becomes white, resembling the whitest kid. It is light, stiff, and, on account of the resin it contains, is perfectly insect-proof. In annelids the iridescence is perfectly kept; hair and feather retain their original colours.

Method of Detecting the Continuity of Protoplasm in Vegetable Structures.‡—W. Gardiner makes the following observations on the various methods for observing the protoplasmic threads which pass from cell to cell.

During the earlier part of his work he used sulphuric acid in combination with Hoffmann's violet. This latter reagent, at the time of staining, colours equally protoplasm and cell-wall. If, however, the section be treated for some time with dilute glycerin, the staining of the cell-wall is removed, and the protoplasm alone remains clearly stained. A very useful reagent for the demonstration of sieve-tubes may be made by dissolving Hoffmann's violet in strong sulphuric acid. After treatment with this solution the sieve-tubes are well brought into view, and all lignified tissue assumes the usual

* Proc. Acad. Nat. Sci. Philad., 1884, pp. 24–7.
† See this Journal, i. (1881) p. 706.
‡ Arbeit. Bot. Inst. Würzburg, iii. (1884) pp. 53–60 (English).

gold-yellow tint, as after treatment with aniline chloride and hydrochloric acid.

In working with sulphuric acid the fresh material is first cut in water. A section having been taken up with a platinum spatula, and the excess of water removed by blotting-paper, a drop of strong sulphuric acid is placed upon it, and allowed to act for a short time, usually a few seconds. The section is then plunged into water and rapidly washed. After several washings it may be stained and mounted. As a staining reagent, either Hoffmann's violet or preferably Hoffmann's blue may be used. In the former case the section is quickly stained, washed in water, and then placed for twenty-four hours or more in dilute glycerin, which dissolves out a great portion of the dye from the stained cell-wall, and at the same time removes the peculiar staining of the pits, which, if allowed to remain, is apt to lead to very delusive results. The section is finally mounted in glycerin. When Hoffmann's blue is used, a moderate quantity of the dye is dissolved in a 50 per cent. solution of alcohol to which have been added a few drops of acetic acid. After staining, the sections are washed with water and mounted in glycerin. Or a sufficient quantity of the dye may be dissolved in a 50 per cent. solution of alcohol which has been saturated with picric acid, until the solution assumes a dark greenish-blue tint. To this solution Gardiner gives the name picric-Hoffmann's-blue. After staining, the sections are washed with water and mounted in glycerin as before; or, after treatment with alcohol, they may be cleared with oil of cloves and mounted in Canada balsam.

In Tangl's method, sections of endosperm were stained with iodine and mounted in chlor-zinc-iod. In such dry tissue as ripe endosperm cells the cell-walls do not turn blue, but merely remain stained with the ordinary yellow-brown due to iodine. The protoplasm, on the other hand, assumes a very dark brown coloration, and after some time there comes into view a series of striæ traversing the thickened cell-wall, which, from their coloration, and from the fact that their depth of staining varies *pari passu* with that of the protoplasm, are taken to be essentially protoplasmic in character. Although in cases where it can be applied this method is of great value, it is attended also with some disadvantages. Firstly, in tissues containing a higher percentage of water the walls assume the ordinary cellulose blue, which at once prevents the threads from being seen; and, secondly, on account of the extensive and varied staining properties of the iodine, the results obtained by it alone cannot be taken as entirely conclusive. But, where practicable, Tangl's method is of great use in giving at least an idea of the existence of the protoplasmic threads, and the staining of the threads with iodine is much more distinct than with any other reagent.

To obviate these difficulties Gardiner adopted the modification already described of dissolving Hoffmann's blue in a 50 per cent. solution of alcohol saturated with picric acid; and, on washing out, the threads were found to be well stained, the picric acid bodily carrying, as it were, the solution of the dye into the fine protoplasmic

strands. Picric acid has also another valuable property in tending to prevent the staining of cellulose by dyes which, although possessing an especial affinity for protoplasm, will stain the cell-wall also unless some such restraining reagent be used. The sections are first stained with iodine and mounted in chlor-zinc-iod. If the material is favourable, something may then be seen of the threads. After being exposed to the action of the chlor-zinc-iod for about 12 hours, the sections are well washed, stained with picric-Hoffmann's-blue, washed again in water, and finally mounted in glycerin, or, better still, placed in alcohol, first dilute and at length absolute, cleared with oil of cloves, and mounted in Canada balsam. In those cases where the tissue swells rapidly under the action of the reagent, as in the endosperm of *Strychnos nux-vomica*, *Bauhinia*, and *Tamus*, the action need not be so prolonged, and the excessive swelling must be prevented by the use of alcoholic iodine at the outset, and in a similar manner it may be washed with alcohol instead of with water, otherwise the threads will be so displaced or altered as to be almost or entirely invisible.

As regards the management of the reagents, and the length of time they must be allowed to act to obtain a satisfactory result, the manipulation must be varied to a certain extent to suit the requirements of the various kinds of tissue, according as it is thick- or thin-walled, easily swollen or only with difficulty. The use of sulphuric acid is attended with a much greater amount of difficulty; for if it is allowed to act for too short a time, the cell-wall will not be sufficiently swollen; while if the treatment is prolonged, the middle lamellæ of the walls are liable to swell and at the same time stain, and will then hinder all successful observation of the threads which may traverse their substance. Upon still further action the protoplasm itself commences to be attacked. With chlor-zinc-iod, on the other hand, where the action is much more regulated and gradual, but little precaution as to length of time need be observed. Besides the difficulty of regulating its action, there are still other and grave objections to the use of sulphuric acid. One of these is that, no matter how carefully the acid is added to the tissue, and no matter how quickly the washing in water is accomplished, there will be a very considerable evolution of heat attending the hydration of the acid, which is liable to accelerate its action and to cause very grave changes in such delicate structures as fine protoplasmic threads traversing the cell-wall. The folding up and general displacement of the tissue consequent upon the action of such a violent reagent also greatly increases the already existing complications which attend all observations connected with minute histology.

For these reasons, while sulphuric acid is a very valuable reagent, both for swelling up resistent tissues on which chlor-zinc-iod has but little action, and for demonstrating in an unusually clear way the remarkable manner in which the apices of the protoplasmic processes, entering the pits, cling to the pit-closing membrane, it is, on the whole, the less satisfactory of the two, and the phenomena resulting from its action can only be rightly interpreted in the light of the more certain results obtained by the use of chlor-zinc-iod. For all

tissues which will swell sufficiently under its action, the chlor-zinc-iod method may be regarded as perfectly satisfactory; after treatment with picric-Hoffmann's-blue and subsequent washing with water, nothing but protoplasmic structures will be stained. In clear instances where a thick closing membrane is plainly traversed by threads, it can be demonstrated with ease that, while the individual threads are well stained, the substance of the pit-membrane itself undergoes no coloration, even when the section has been exposed to the action of the dye for a long time. When the pits are smaller and the threads less clearly defined, it is more difficult to observe that the substance of the pit-membrane is still free from coloration; and when, owing to the thinness of the closing membrane, all appearances even of striation cease to be recognizable, only an apparent staining of the entire membrane can be observed. Such staining points, however, in the opinion of the author, not to the coloration of the substance of the pit-membrane, but to the staining of protoplasmic threads traversing its structure.

Besides a platinum lifter, the author uses platinum needles, and is careful thoroughly to brush all the sections with a camel's-hair brush, both after the action of the acid or of chlor-zinc-iod and after staining.

To prove that the threads traversing the cell-wall are actually protoplasm, he employed with success a solution of molybdic acid in strong sulphuric acid, which has the advantage of swelling the cell-wall and at the same time colouring the protoplasm. The solution is colourless and gives a beautiful blue colour with alcohol and many other organic substances; and this reaction is extremely delicate. While not affecting the cell-wall for some time this reagent gives at once a fine blue coloration with protoplasm. If a section of some living endosperm, such as that of *Tamus*, is treated with it, the cell-wall will swell up, and it will commence to dissolve the protoplasm; the fine threads perforating the walls will remain for some time unaffected, but will soon be perceptibly coloured, while the main mass of protoplasm will assume an intense blue.

The pit-membrane itself possesses some properties different from those of the cell-wall. After staining with iodine and chlor-zinc-iod, while the cell-wall assumes the usual blue tint, the pit-membrane is but slightly coloured, and, when thin, appears as if not coloured at all, although the examination of a fine transverse section of the pit will prove that a definite staining has taken place. But the depth of the staining is less than might have been expected in proportion to the thickness of the membrane. Methylene blue stains both the wall and the pit-membranes a fine light blue, and, after the action of sulphuric acid, the swollen wall assumes a much lighter tint, owing to the fact that the quantity of the dye taken up by the cell-wall is now distributed over a larger space. If a section is cautiously treated with sulphuric acid, washed, and stained, it will be seen that, whereas the general swollen wall is coloured a light blue, the bottoms and the sides of the pit retain the darker blue colour of the unswollen cell-wall, and

will thus be clearly marked out. If, however, another section is treated for a longer time with acid, or the same section is a second time exposed to its action, no special coloration of the bottoms and sides of the pits takes place on staining, but the whole swollen wall is of a uniform light tint. This shows that the substance of the pit-closing membrane and of the layers immediately surrounding the pit-cavity are more resistent than the rest of the cell-wall; as indeed has already been pointed out by Strasburger.

Exactly the same phenomena are observed when a section, after cautious treatment with sulphuric acid, is stained with methyl-violet. In the case of methylene blue the protoplasm is not coloured, but when methyl-violet is used, a deep staining of that structure occurs, the tint of which is the same as that of the bottoms and sides of the pits; for, while the general cell-wall assumes a violet colour, the protoplasm, the pit-membranes and the sides of the pits appear of a deep purple. Now since protoplasmic processes from the main protoplasmic mass may project for some distance into the swollen pits, when such a stained section of pitted tissue is examined, it appears as if there were, in any two contiguous cells, threads of protoplasm of a purple colour traversing the thickness of the violet cell-wall by means of the pits, and thus establishing a direct continuity of the protoplasm from cell to cell. But after prolonged treatment with dilute glycerin, this purple colour dissolves from the pits, and the protoplasmic processes are left clearly seen, and may or may not be the means of establishing a continuity between the cells. As in the case of methylene blue, so also here, a more lengthy treatment of the tissue with acid will swell up the pit-membranes, and when in that condition the pits will assume the same colour as the rest of the cell-wall.

Method of Preparing Dry Microscopic Plants for the Microscope.*—G. Lagerheim has found the following method convenient for the examination of algæ or other plants which have already been dried.

A fluid is prepared of the following composition:—1 part fused potassium hydrate is dissolved in 5 parts water, and when the solution is complete 5·5 parts are added of glycerin of the consistency of a syrup. The dried desmids, Œdogoniaceæ or other algæ, are treated with water till they are thoroughly moist; a small piece of the material is then taken up with a pincette and placed upon the glass slide. One or two drops of the fluid are added, and the algæ distributed as evenly as possible with dissecting-needles. The glass slide is then warmed for a time over a spirit-lamp, and a cover-glass finally placed on. The potassium hydrate has now caused the previously shrunken algæ to swell and resume their original form. The addition of glycerin gives a consistency to the fluid, so that the algæ can easily be turned over by shifting the cover-glass, and thus observed on different sides, a point of great importance, for example, in the study of desmids.

* Bot. Centralbl., xviii. (1884) pp. 183–4.

The algæ prepared in this way can readily be drawn or measured. The cover-glass is carefully removed, and, if a low power or a dissecting Microscope is used, the object is taken up by a needle or stiff bristle, and again at once placed in potassium acetate or glycerin. If, on the contrary, the whole material thus prepared has to be got ready for drawing or measuring, a drop of acetic acid is added after removing the cover-glass. The algæ are in this way imbedded in potassium acetate and glycerin, fluids perhaps the best adapted of any for the preservation of algæ.

Dry mosses and fungi may also be prepared in the same way.

Chapman's Microtome.*—A. B. Chapman has devised a microtome, which has for its cutting surface two parallel glass-plates cemented to a block of mahogany, through which is inserted a brass cylinder at right-angles to the glass plates; in this cylinder (which forms the "well" of the microtome) an accurately fitted brass plug works, carrying on its top a flat-headed table-like piece which entirely prevents the imbedding agent from rising or turning round while the sections are being cut. The plug is moved up and down by a brass disk, which revolves between the block of mahogany and a similar block underneath. The brass disk is graduated on the edge of its upper surface, each graduation representing a movement of ·0005 in. of the plug. The microtome has a base-board which can be firmly clamped to a table, and the whole is so conveniently arranged that every operation or adjustment can be made at once, the whole being in view on the table.

Use of the Freezing Microtome.†—The tendency at the present time is to make all microscopic sections by the dry method after paraffin infiltration and imbedding; but no doubt there is a place, and an important one, for the freezing microtome in practical histology, and in this note S. H. Gage calls attention to what seem to him improvements in its use.

Disliking greatly the disagreeable mess made by ice and salt, it occurred to him to take advantage of the device of plumbers to thaw out water and gas pipes,—to use strong alcohol with the ice or snow instead of salt. By using snow or finely powdered ice and 95 per cent. alcohol, a temperature of 20 C. below zero is obtained within five minutes, and this temperature may be maintained with far less trouble than with ice and salt. The microtome used is the Rutherford pattern, modified by placing the drain near the top instead of in the bottom. A rubber tube passing from this drain to a jar preserves the overflow. It requires about 250 c.cm. of alcohol to freeze and keep frozen one tissue for cutting, but this is not lost, as little evaporation takes place, and the dilution does no harm for many purposes, hence the method is not wasteful, while it is much more pleasant and expeditious than with salt.

Ordinarily tissues are infiltrated with thick gum before freezing,

* Sci.-Gossip, 1884, p. 137.

† Science Record, ii. (1884) pp. 134–5.

and then the sections are soaked in a relatively large amount of water to remove the gum. Evidently while soaking, staining, and transferring the sections, especially if they be of such an organ as the lungs, there is every liability of their becoming folded or torn. This may be avoided by staining the tissue in the mass as for dry section-cutting, and then soaking in water to remove any alcohol, and finally completely infiltrating the tissue in a thick solution of very clean gum arabic.

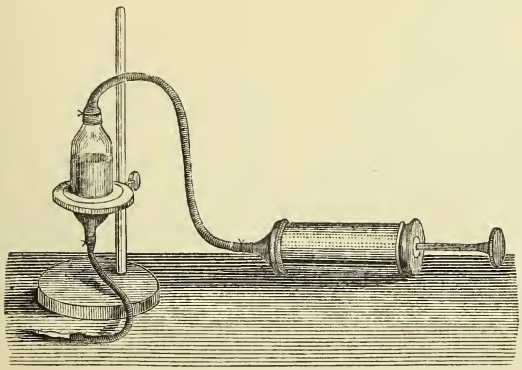
When ready to make the sections the well of the microtome is filled with the thick gum and the tissue introduced at the proper time as usual. Before cutting, the gum is cut away from the tissue as in sharpening very bluntly a lead pencil, then as the sections are cut they are transferred directly to the slide. After several slides are filled, a drop of glycerin is added to each section and the cover-glass applied. This is practically mounting in Farrant's solution.

Apparatus for Injection—Fearnley's Constant-Pressure Apparatus.—Very great variety exists in the forms of this class of apparatus. In the majority of them the leading principle is the compression of the air in an intermediate vessel by the entrance into it of a liquid falling from a greater or less height according to the pressure required, the air then acting on the injecting fluid in another bottle communicating with the first.

In the two following the intermediate vessel is dispensed with.

Ranvier's * (fig. 108) has a syringe connected by an indiarubber tube

Fig. 108.



with the bottle containing the injecting fluid, which is supported on a retort-stand. A second indiarubber tube terminates in the canula.

Ludwig's † (fig. 109) acts by the fall of quicksilver drop by drop into the vessel, A, containing the injecting fluid I.

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, p. 187 (1 fig.).
† Ibid., p. 188 (1 fig.).

Toldt's * (fig. 110) is similar to the preceding, but in addition to the vessel containing the injecting fluid, a second air-vessel is introduced.

Thanhoffer's.† Prof. L. v. Thanhoffer uses the following apparatus (fig. 111). To the wall of the room and near the ceiling a board is fixed. This board carries a pulley, over which a cord is passed, having at one end a large glass vessel A, filled with water; at the other end of the cord is a handle, by which the vessel can be drawn up and down as required. When the tap in A is open, water flows through the india-

Fig. 109.

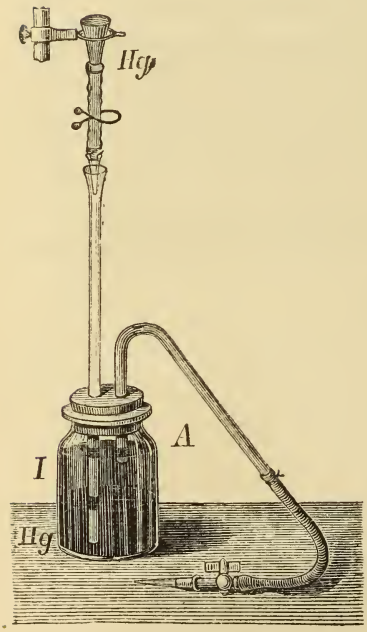
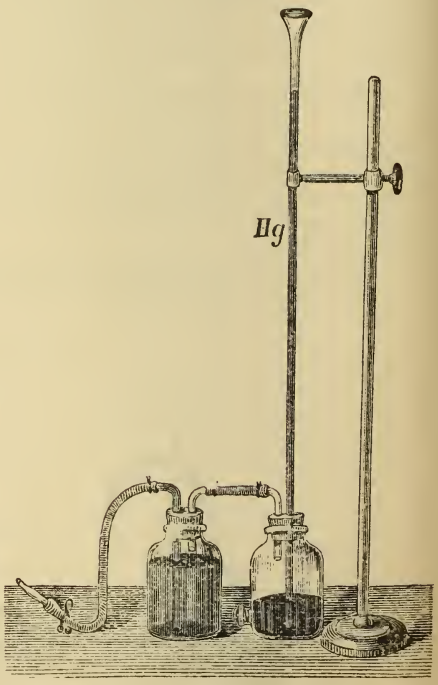


Fig. 110.



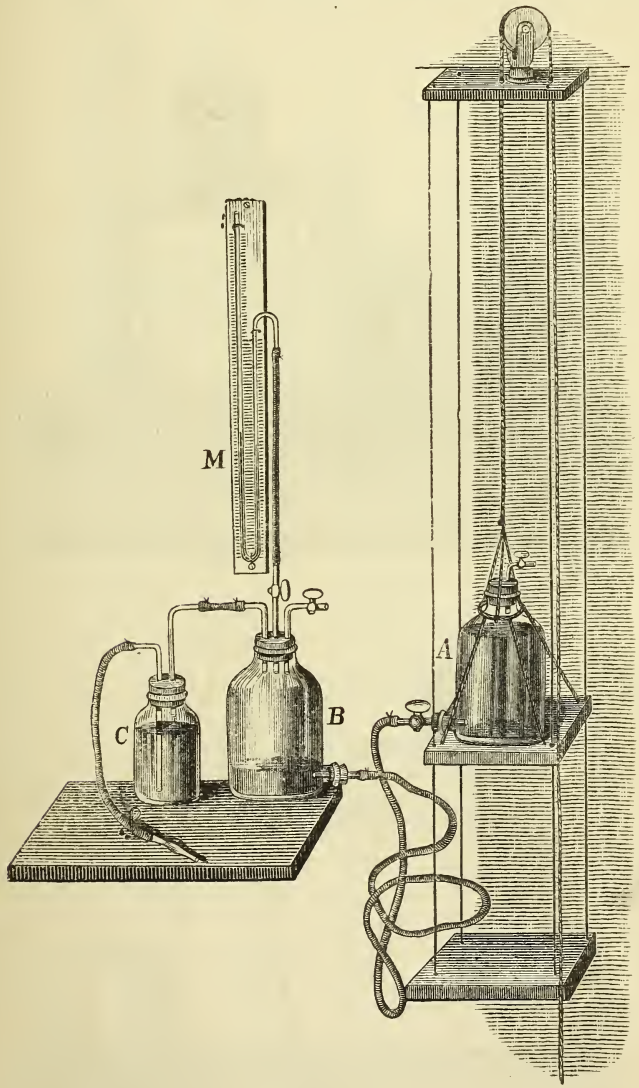
rubber tube into a second vessel B, which acts as an air-reservoir. The air compressed in B passes into C, which contains the injecting fluid, and forces it through the discharge pipes and thence into the vessels. The pressure is of course increased according as A is raised. The amount of pressure is denoted by the manometer M. Quicksilver may be substituted for water, and greater pressure thereby obtained,

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, p. 189 (1 fig.).

† Ibid., pp. 190–2 (1 fig.).

but in injecting fine vessels this is quite unnecessary, for if the room be sufficiently lofty a pressure of from 300 to 400 mm. can be obtained

Fig. 111.



by drawing the vessel A to the ceiling, a pressure which is more than is required.

Ludwig's * (fig. 112) for quicksilver and small pressure, is substantially identical, and requires no explanation beyond the figure.

Fig. 112.

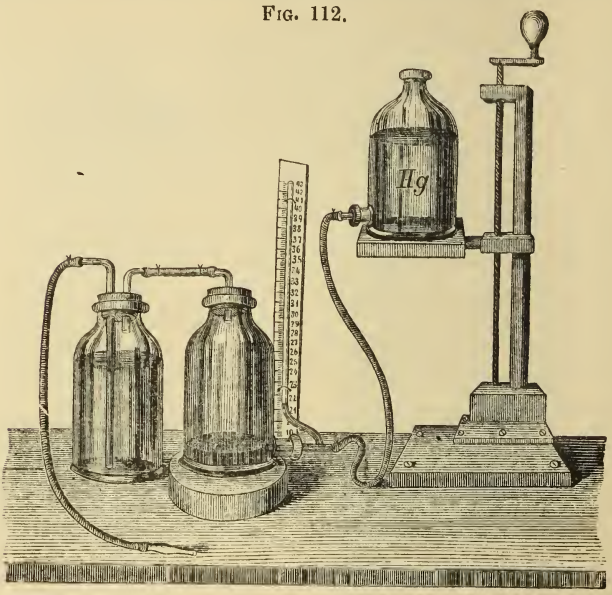
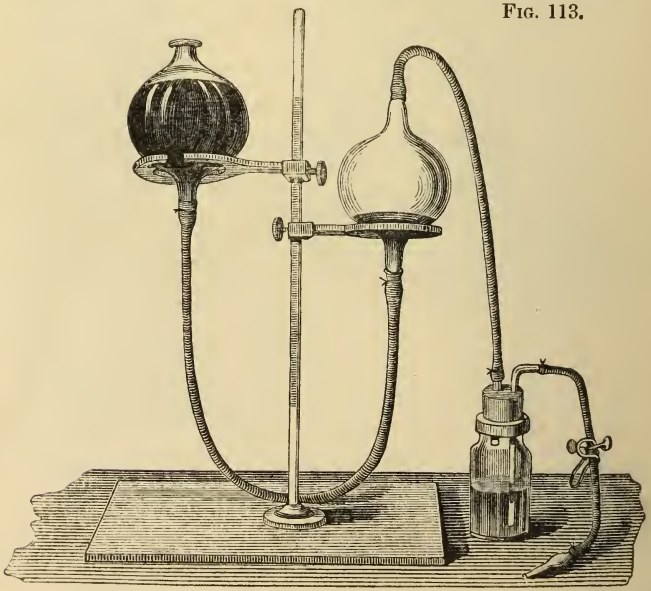


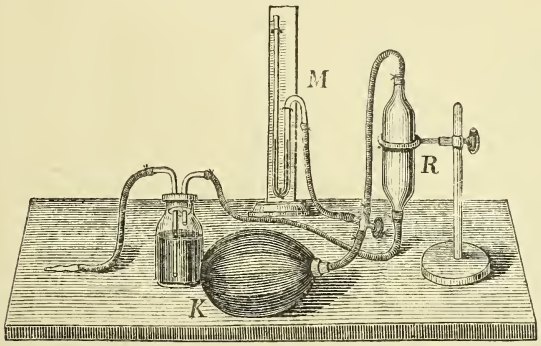
Fig. 113.



* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 192–3 (1 fig.).

Ranvier's * (fig. 113) consists of a glass vessel filled with quicksilver which can be raised and lowered on a retort-stand. The rise of the quicksilver in the intermediate vessel compresses the air which it contains as well as that in the bottle containing the injecting fluid, which is forced out as in the previous case. In another form (fig. 114)

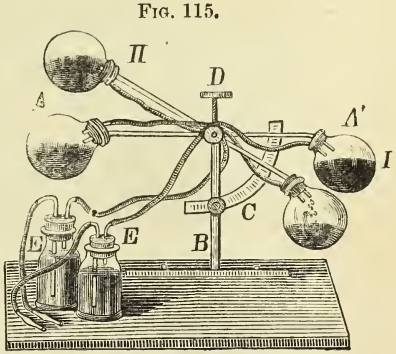
Fig. 114.



the pressure is obtained by compression of an indiarubber ball K communicating with an air-reservoir R (M being a manometer).

Hering's † (fig. 115) consists essentially of two glass bulbs, A A′, having a thin glass tube passing through the stoppers in their necks, and by which the bulbs communicate with each other. A flexible tube from each bulb passes into one or other of the bottles E E, containing the injecting fluid. The ends of the glass tubes are drawn out so fine that the quicksilver passes only a drop at a time from one to the other (even when the air is compressed). When the bulbs are turned on their axis, and instead of the horizontal position I., take the oblique one II., the quicksilver will flow from A to A′, and compress the air in the bulb A′, and act upon the injecting fluid in the vessel E. The nearer a vertical position is approached, the greater the pressure will be by which the injecting fluid is forced into the blood-vessels. The two bottles, E and E, are alternately used according as one or the other of the bulbs is uppermost.‡

Fig. 115.



* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 189–90, 187–8 (2 figs.).

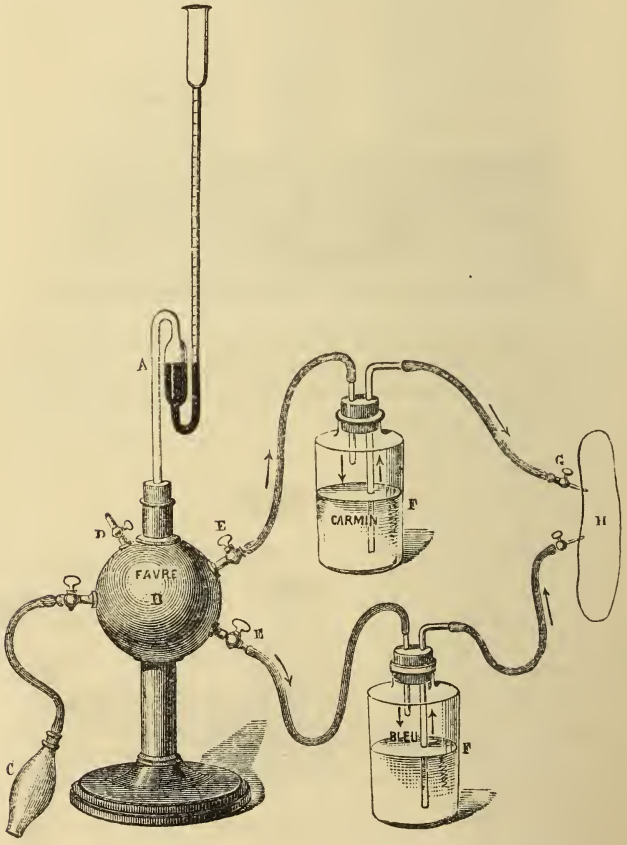
† Ibid., pp. 193–4 (1 fig.).

‡ The figure, which is a cliché of the original, should have indicated one of the two positions of the bulbs by dotted lines. As drawn, there appear to be four bulbs. B, C, and D are not explained but their function is obvious.

Other forms are described by Dr. P. Latteux in his 'Manuel de Technique Microscopique.'

Dr. Latteux's * (fig. 116) consists of a copper globe B, to hold the compressed air, having a tube at A with mercury serving as a manometer. Four taps are inserted in the globe of which one is the air

Fig. 116.



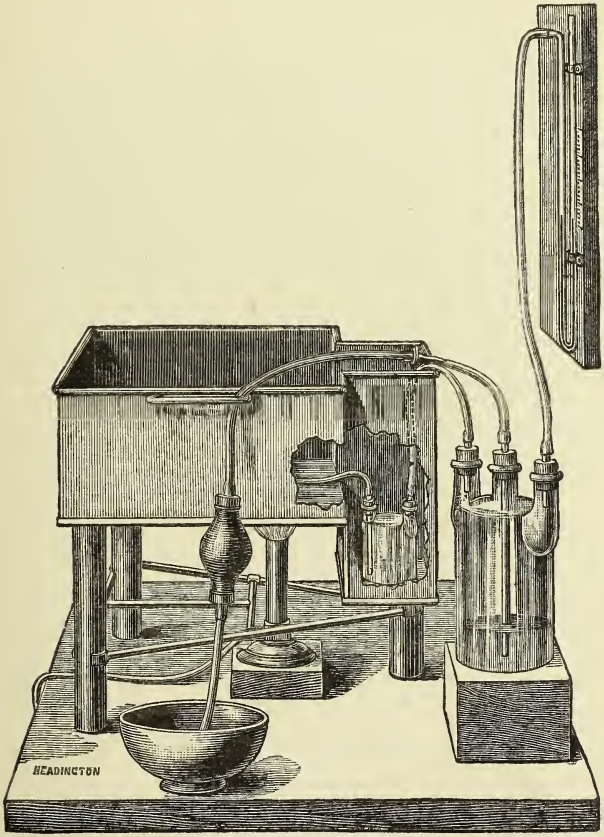
tube from the indiarubber ball C, another regulates the pressure, and the third and fourth E E communicate with two bottles F F containing carmine and blue, the exit tubes G H from these bottles terminating in canulæ for insertion in a vein and artery, or artery and gland duct.

* Latteux, P., 'Manuel de technique microscopique,' 2nd ed., 1883, pp. 110–12 (1 fig.).

The apparatus is sufficient to completely fill the finest vessels of the retina, spinal cord, &c.

*Fearnley's Constant-Pressure Apparatus.**—The method of Ludwig has always been acknowledged as superior to injecting by the syringe except for the one great obstacle—applying the necessary pressure, which had to be effected by elevating and depressing huge water-

Fig. 117.



bottles or by connecting the air-pressure bottle with a water-tap and regulating the pressure as best one could, thus rendering the pressure almost as uncertain and irregular as the thumb-pressure of the syringe. Mr. W. Fearnley's method is to apply the pressure with an ordinary Higginson's enema syringe (figs. 117 and 118).

No practice is required with this simple contrivance beyond introducing and tying in the nozzle in the aorta.

* Brit. Med. Journ., 1883, pp. 859-60 (2 figs.).

There is a bath, having a shallow part for the animal to lie in, and a deeper part for the Woulff's bottle, containing the injection-mass, to stand in. A large (40 ounce) Woulff's bottle, with three necks, is fitted with three perforated indiarubber stoppers. The middle stopper is perforated with a glass tube which goes to the bottom of the bottle. Each of the others is perforated with a glass tube, the depth of the stopper only, and standing above the stopper sufficiently to admit of a piece of indiarubber tubing being fixed upon it. The Woulff's bottle containing the mass has two necks, fitted with indiarubber stoppers. One neck admits a piece of glass tube, which goes quite to the bottom of the bottle; the other admits a short piece of tube the depth of the stopper only. Fig. 117 shows all further detail.

The mercurial manometer allows five inches rise of the mercury in the ascending arm—therefore five inches fall of the descending arm —though four inches will do.

"To inject an animal, a rabbit, for instance, proceed as follows:— Fill the bath with water, and heat the water with a Bunsen's burner to 100° Fahr. or so. The Woulff's bottle containing the mass should be filled and thoroughly stoppered. Then chloroform the rabbit and make an L-shaped incision into the thorax, so as to expose the heart and aorta. This is done by cutting up the middle line of the sternum (breast-bone) as far as the root of the neck nearly, then making a second incision at right angles to this to the rabbit's left. A triangular flap is thus made, and the heart inclosed in the pericardium exposed. Having cut through the pericardium, seize the apex of the heart with a pair of forceps and snip it off, then the heart's apex appears as in A, fig. 118. That is to say, the right and left ventricles are opened, and the animal instantly bleeds to death. Mr. Fearnley uses a nozzle, as in B, Fig. 118, which has an elastic collar *e c*, which is plugged by a nozzle, as here shown.

The opening in the right ventricle leading to the pulmonary artery has a crescent shape or slit-like appearance; whilst the opening in the left ventricle, leading to the aorta, is round. Therefore, if we wish to inject the entire arterial system, we insert our nozzle into the round hole; but if we wish to inject the pulmonary system only, we choose the crescentic slit.

Either glass nozzles,* or those shown in fig. 118, are to be inserted into one or other of the two holes (usually the round one for injecting the entire arterial system with carmine and gelatine mass). We can now either tie the artery only, or we can tie the whole heart substance. In either case a ligature of floss silk is to be passed round (the artery or the entire heart) and tightly tied and secured. Before proceeding further, we wash out the cavity of the thorax of all blood to keep our bath water clean, then we lift the animal into the bath and there let it remain ten minutes or so to get well warmed. It is a good plan to slit open the entire abdomen in the middle line, so as to allow the

* Mr. Fearnley informs us that he now uses glass nozzles with tube connections, which answer quite as well as those figured, and are cheaper.

warm water to freely get round the abdominal contents: the mass thus gets into every organ and into every part of an organ evenly.

We now connect the pressure bottle with the manometer and with the Higginson's syringe, as shown in fig. 117, also with the mass bottle. The tube of the mass bottle, which is to convey the mass away from the bottle, is now clamped, as shown at C, fig. 118, and must never for an instant be allowed to get out of the warm water into the cold air.

Fig. 118.

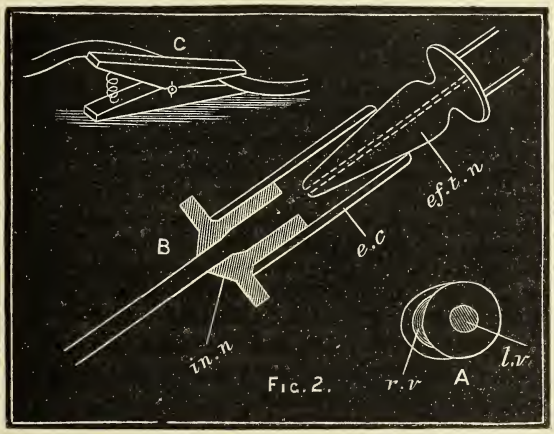


Fig. 2.

Having our small basin full of water, we now squeeze the Higginson's syringe, watching the manometer, to raise the mercury half an inch. This done, we remove the clamp from the efflux tube, and the red fluid after driving out a few air-bubbles begins to flow out; we at once make the connection, and all quicksands are passed if we have tied in our nozzles properly into the artery and the connecting part, and fastened in our stoppers thoroughly into our Woulff's bottles.

Our task is easy now: all we do is to seize the head of the animal, which should be to our left, with our left hand, to watch the pale gums, tongue, and eyelids become suffused with a pale blush which gradually deepens, whilst we gently squeeze and relax the barrel of the syringe and glance at the mercury from time to time. When the mercury has risen four, or at most five inches, the whole animal will be completely injected: the visible mucous membranes and bowels will be dark-red and much swollen.

We now remove the animal, and place it in ice-cold water under a common water-tap for an hour or two, and divide it into parts as required. This method of applying pressure is wonderfully delicate; thus, whilst we can raise the mercury in the manometer almost imperceptibly, one entire compression of the barrel raises the mercury one inch."

Myrtillus for Staining Animal and Vegetable Tissues.*—Dr. M. Lavdowsky (in furtherance of the modern fashion of recommending every conceivable substance which by any chance will furnish a stain) recommends the berries of *Vaccinum myrtillus*, as an excellent staining agent for the nuclei of all cells and the cellulose walls of plant-cells. The karyokinetic figures are shown very plainly.

The fresh berries should be well washed in water, the juice squeezed out and mixed with two volumes of distilled water, to which some alcohol (90 per cent.) has been added. It is then heated for a short time, and filtered warm. For use, a small quantity of the fluid should be diluted with two or three times its bulk of distilled water.

The stain gives a red (carmine) colour with fresh neutral objects, or lilac (hæmatoxylin) when the acid of the fluid is neutralized by an alkali or neutral salt. The latter is the more durable. A double stain is obtained by placing the object in a solution of eosin after treatment with the lilac stain. Directions are given for applying the fluid, but it does not appear to us, from the author's own showing, to be a valuable or even useful addition to the already long list of staining agents.

Hartzell's Method of Staining Bacillus tuberculosis.†—A small quantity of sputum is spread as thinly and evenly as possible upon a slide, and allowed to dry, and is then passed slowly several times through the flame of an alcohol lamp or Bunsen burner. One or two drops of the fuchsin solution recommended by Gradle (prepared as follows: carbolic acid 15 minims, distilled water 1/2 fluid oz., dissolve, and add saturated alcoholic solution of fuchsin 1/2 fluid dr.) are placed upon the sputum, and allowed to remain from three to five minutes. The slide is now washed thoroughly with distilled water, to remove the excess of fuchsin, and the stained sputum completely decolorized by a saturated solution of oxalic acid. It is again thoroughly washed in distilled water, and allowed to dry; it is now ready to be mounted in glycerin or balsam for examination. With a power of 500 or 600 the bacilli will appear as brilliant red rods, no staining of the background being necessary.

One chief advantage claimed over other methods is that in the latter the decolorizing agent employed is dilute nitric acid; but this, besides being disagreeable to handle because of its corrosive and staining properties, is apt to remove the colour from the bacilli too, unless great care is taken. Oxalic acid, however, seems to leave the dye untouched in them.

Safranin Staining for Pathological Specimens.‡—For staining tumours, Dr. V. Babes(in) recommends that fine sections of tissue hardened in alcohol or chromic acid should be steeped either in a solution of safranin which has been dissolved in warm water, or in a mixture of equal parts of concentrated watery and concentrated

* Arch. f. Mikr. Anat., xxiii. (1884) pp. 506–8.
† Amer. Mon. Micr. Journ., v. (1884) pp. 76–7, from 'Medical Times.'
‡ Arch. f. Mikr. Anat., xxii. (1883) pp. 356–65.

alcoholic safranin solution for half an hour; they should be washed slightly in water, and then dehydrated as quickly as possible by absolute alcohol, then transferred to turpentine and mounted in balsam. Some tissues which are not so readily decolorized may be clarified with oil of cloves. Although they appear scarcely red, yet such sections show the following structures: viz. nucleoli of white blood-corpuscles; granules in the same and in most cells of rapidly proliferating granulating tissues; periphery of red blood-corpuscles; filamentous bodies occurring in connection with blood-vessels in process of formation; nuclei of giant-cells and nucleoli of all large-celled sarcomata and carcinomatous tumours.

As the inactive, skeletal part of the nucleus is not stained by the safranin, it is easy to follow by its means the part which the nucleolus plays in cell-division. In large-celled, malignant tumours a great variety of forms are thus brought out in the nucleus, while the spindles and the fibrils connecting them remain uncoloured. In melanosarcoma the fission-stages of the cells, which remain concealed under every other treatment, are well brought out, and in rapidly growing small-celled tumours, e. g. lymphosarcomata, the appearance of universal staining is imparted to the cell by a series of delicate nuclear markings which almost fill the cell.

Secondly, for investigating the structure of the cell and of other histological elements a super-saturated solution should be employed; it is warmed to 60°, and filtered in this state; the sections are placed in a small quantity of the liquid in a watch-glass, which is then warmed * for a few seconds over a spirit-lamp until the precipitating crystals are redissolved; the sections are left for a minute, then washed in water, and treated as in the former case. Tissues which do not stain readily should be warmed again and again. The nuclear network comes out well under this treatment. It is especially adapted for delicate structures and for bacteria; every micrococcus appears brownish-red, while the surrounding tissues assume a fine rose-red; the bacilli of tuberculosis and lepra are not thus stained.

Thirdly, the sections may be left for 12 to 24 hours in the solution (either concentrated watery or alcoholic, or a mixture of the two). Sections thus coloured may be left, if necessary, somewhat longer in alcohol, turpentine, oil of cloves, or, better, origanum; a large number of details are thus brought out, and a similar effect is produced by longer action of a watery solution; the method is especially adapted to tumours of the brain or spinal cord.

The finest representations of the changes undergone by nuclei in fission were produced by rapidly staining with safranin, followed by eosin, and mounting in balsam. Safranin and hæmatoxylin bring out the nuclear skeleton violet and the nucleolus red. Preparations made according to these methods have proved durable. Some points are better seen by mounting in glycerin, but the colour disappears more or less in time, and acetate of potash is preferable both on the grounds of permanency and clearness.

* Cf. this Journal, iii. (1883) p. 918.

Preparations which show only the muscular fibre and the elastic tissue may be made by staining small fragments with a mixture, half and half each, of oil of cloves or origanum and concentrated alcoholic solution of safranin and placing for an hour under the air-pump: sections may then be made at once, or, better, uncoloured sections may be transferred from alcohol to the oily solution; the sections are washed with solutions of caustic potash in alcohol, and mounted in acetate of potash. By putting sections stained with safranin into 30 to 40 per cent. solution of caustic potash the colour is fixed, and the elements come out very distinctly; they should be mounted in acetate of potash.

Collodion as a Fixative for Sections.*—Sections fixed by means of a solution of collodion in clove oil, as suggested by Schällibaum,† may be coloured on the slide. S. H. Gage, who had begun to experiment with collodion before Schällibaum's method was published, recommends that the collodion and clove oil be applied separately.

"A solution of collodion is prepared by adding to 2 gr. of gun-cotton (that used by photographers is good) 54 cc. of sulphuric ether and 18 cc. of 95 per cent. alcohol. After the gun-cotton is entirely dissolved the solution should be filtered through filter-paper or absorbent cotton. The slides are coated by pouring the collodion on one end, allowing it to flow quickly over the slide, and off the other end into the bottle. The prepared slides should be kept free from dust. As the collodion will not deteriorate after drying on the slide, any number of slides may be prepared at the same time. Before using a slide it should be dusted with a camel's-hair brush, and with another brush the collodionized surface of the slide should be thinly painted with clove oil. . . . . The sections are arranged as in the shellac method. The slide is warmed over an alcohol lamp, and then heated in a warm chamber, so as to drive off the clove oil. After cooling, it may be placed in a wide-mouthed vial of turpentine, chloroform, xylol, or refined naphtha, to remove the paraffin. Naphtha is very cheap, and is the best agent we have yet tried for dissolving the imbedding mass. The sections are usually freed from imbedding mass within half an hour, though the slide may remain in any of the solvents mentioned for two or three days, or perhaps indefinitely, without loosening the sections. When the slide is removed from the naphtha, the sections are washed with 95 per cent. alcohol by means of a medicine dropper, or by immersing the slide in alcohol. If the sections are to be stained in Kleinenberg's hæmatoxylin, or in any other stain containing 50 per cent. or more alcohol, the slide is transferred directly from the alcohol used for rinsing to the staining agent, otherwise it should be first transferred to 50 per cent. alcohol, and from that to the staining agent. Whenever the sections are sufficiently stained, they may be mounted in any desired mounting medium. In case Canada balsam is to be used, the slide must be immersed in alcohol to wash away the stain, and finally in

* Medical Student (N. Y.), i. (1883) pp. 14–6.

† See this Journal, iii. (1883) p. 736.

95 per cent. alcohol to completely anhydrate the sections. They are cleared with a mixture of carbolic acid 1 part, turpentine 4 parts. The balsam to be used is prepared by mixing 25 gr. of pure Canada balsam with 2 cc. of chloroform and 2 cc. of olive oil. The latter very soon removes any cloudiness that may have appeared in the collodion film."

Piffard's Slides.—Mr. B. Piffard has patented a slide which is made by forming with a diamond a round recess in an ordinary slide. In this the object is placed, and covered with thin glass. The upper surface of the slide is thus perfectly smooth, the cover-glass being even with the slide. There is no danger of the cover-glass and object being knocked off; and the recess causes a very beautiful diffusion of light.

Mounting in Balsam in Cells.*—R. P. H. Durkee describes the following process:—A curtain-ring, flattened by pressure, is placed upon a clean slide and the slide placed on the hot table. Drop in the centre a small portion of balsam, enough to fill the cell, and heat till the air-bubbles rise and permit of breaking with the needle; at the same time gently moving the ring about, and pressing it down to insure contact with the slide. Place the object in the balsam, taking care to see that it is completely covered; warm the cover and place it in position, in doing so holding it in the forceps parallel with the surface of the slide, so as to expel the air all round. Weight down with a bullet, and apply heat as may be necessary to harden the balsam.

What the author considers a feature is that there would seem to be no possibility of varnish running in, the channel in the top of the ring receiving the excess of balsam when pressed out by the cover, and thus forming a barrier to the influx of the varnish used in ringing. For flattening the rings he used two plates of brass, 2½ in. square by 1/8 in. thick. Place the rings, six or more at a time, between the plates, and press in a lever stamp. This method of mounting seems to him to have the following desirable features, viz. no previous preparation and drying of cells, rapidity and neatness of finish, and no running in of varnish.

Styrax, Liquidambar, Smith's and van Heurck's Media.—Dr. H. van Heurck writes that styrax, when prepared by exposing the raw product to the air and light, dissolving and filtering, is no longer of a dark colour, and that its index is higher than 1·585, as given on p. 475. The purified styrax of commerce is always darker and of lower refractive index. Preparations become completely colourless at the end of a few months, especially if brought into the light occasionally, and the index rises a little.

Liquidambar can be obtained of Lamman and Kemp, William and Cedar Streets, New York. It must be heated to reduce its brittleness, and dissolved by means of the water-bath in a mixture of

* Amer. Mon. Micr. Journ., v. (1884) pp. 84–5.

alcohol and benzine, and filtered. This is also the best solvent for styrax.

Styrax and liquidambar, purified and prepared according to Dr. van Heurck's directions, can be obtained of Messrs. Rousseau, 42–44, Rue des Ecoles, Paris.

Prof. Smith's medium, while most excellent for difficult diatoms of delicate structure, is not better than styrax for ordinary diatoms and preparations of histology or of insects.

Dr. van Heurck also announces that he has discovered a colourless medium analogous to that of Prof. Smith, but with an index higher than liquidambar.

Grouping Diatoms.*—J. Deby calls attention to some slides prepared for him by Möller, each containing many species of the same genus arranged in several lines. Thus there are 72 species or varieties of *Triceratium*, 60 of *Nitzschia*, 45 of *Surirella*, 38 of *Epithemia*, &c. Such slides have, Mr. Deby considers, enormous advantages over the "type-plates" from the point of view of the comparative study of the species of a genus. Equally to be recommended, from a scientific point of view, is, he thinks, the plan by which as many species as possible from the same gathering are united in one slide.

Quantitative Analysis of Minute Aerial Organisms.†—In the reports of the Imperial German Board of Health is a paper on this subject by Dr. Hesse. He employed an apparatus, which in all essentials so corresponds with the portable aëroscope of Dr. Maddox described in this Journal, III. (1883) p. 338, that it is necessary to note the fact, as no reference is made to it by Dr. Hesse. Instead, however, of drawing the air direct into an aëroscope and on to a thin cover-glass smeared with a glutinous substance for examination of the deposited matter by the Microscope, a long tube lined with a layer of gelatine is used. The air is allowed to enter by an aperture at one end, that most suitable being of like diameter with that of the exit tube, and as it traverses the tube slowly it deposits the organisms in its passage.

According to the nature of the deposits, small colonies are developed in the gelatine at different parts of the tube. By employing a long tube and slow traverse of air, the bacteria are deposited before reaching the exit, while the fungi—mildew and spores—appeared more abundant at the exit end than at the entrance. That bacteria are rapidly deposited in tranquil spaces was long since shown by Professor Tyndall.

Microscopical Evidence of the Antiquity of Articles of Stone.‡—An action has recently been pending in New York as to the genuineness of the collection of antiquities brought from Cyprus by Count Di Cesnola and sold to the city.

Mr. B. Braman, President of the New York Microscopical Society,

* Journ. de Microgr., viii. (1884) pp. 230–1.

† MT. aus dem K. Gesundheitsamte, ii. Berlin, 1884.

‡ Amer. Mon. Micr. Journ., v. (1884) pp. 14–5, from New York *Times*, 22nd Dec., 1883.

was examined as a witness and detailed the result of his examination with the Microscope of the surfaces of the statues in the collection.

"The Cypriote stone whereof these statues are sculptured is a cellular calcareous tufa. The cells are minute and crowded. There are about 1500 to the square inch. They are spherical in shape, and about 1/100 in. in diameter. When freshly cut, it will be found that the walls of some cells are harder than the walls of others. The hard walls resist the effects of the atmosphere with more success than the softer ones. During exposure these soft spaces sink first, and leave the hard ones standing, like craters on the face of the moon. The soft spaces sink into dome-like shapes, and small orifices indicate that the atmosphere has begun to affect them. Then the cups thus formed are carried away, the hard projections roll off in small globes, and the process recommences. Each process occupies several centuries. In the case of buried objects in Cyprus, the water filtering through the ground makes a deposit on them, more or less thick, of carbonate of lime. I have given seven or eight hours to the microscopical examination of the statuette of Venus, and it is susceptible of scientific demonstration that the surface of the so-called mirror and the surrounding surface are ancient. On the mirror are eight stipples of carbonate of lime, deposited in the way I have stated, which are an integral part of the ancient surface, and would not appear on a freshly cut surface. These evidences of antiquity could not be taken away without breaking the stone. They fill the cavities whereof I have spoken. They appear on the surface of the drapery within 3/16 in. of the mirror's outline. My Microscope would have disclosed cement 1/1000 in. in thickness."

"B.Sc."—Carbolic Acid and Cement.

[Fresh-water Algæ mounted three years ago in a weak carbolic-acid solution with asphaltum for the cement are still perfectly good.]

Sci.-Gossip, 1884, p. 137.

Briant, T. J.—Notes on putting up Microscopic Objects.

Rep. South Lond. Micr. and Nat. Hist. Club, 1884, p. 13.

Chapman's (A. B.) New Microtome.

[*Supra*, p. 642.] *Sci.-Gossip*, 1884, p. 137.

Cole, A. C.—Methods of Microscopical Research.

Part XI. Mounting (*continued*). pp. lvii.–lxi. (Mounting the Diatomaceæ. Cleaning and Mounting Polycystina. Preparation and Mounting of Insects. Preparation of Vegetable Sections. To Double Stain Vegetable Sections.)

Part XII. pp. lxiii.–lxxii. On Microscopical Drawing and Painting (by E. T. D.).

,, ,, Popular Microscopical Studies. IX. pp. 39–42. The Crane Fly (*Tipula Oleracea*). Plate 9 × 40.

No. X. pp. 43–6. Sponge. Plate 10.

No. XI. pp. 47–52. Starch. Plate 11 (*Sarsaparilla officinalis* × 400).

,, ,, Studies in Microscopical Science.

Vol. II. No. 19. Sec. I. No. 10. pp. 37–40. Nerve of Horse. Plate 10. T. S. × 150.

No. 20. Sec. II. No. 10. pp. 39–42. Vascular Tissue (*continued*). Plate 10. Wood Vessels and Cells.

Vol. II. No. 21. Sec. I. No. 11. pp. 41–4. Human Cerebellum. Plate 11. T. S. × 150.

No. 22. Sec. II. No. 11. pp. 43–6. Fundamental Tissue. Plate 11. T. S. Petiole of *Limnanthemum* × 75.

D., E. T.—See Cole, A. C.

Decker, F.—Ein neuer Schnittstrecker. (A new section-smoother.) [*Post.*]
Arch. f. Mikr. Anat., XXIII. (1884) pp. 537–43 (2 figs.).

Francotte, P.—Description des différentes méthodes employées pour ranger les coupes et les diatomées en sérics sur le porte-objet. (Description of the different methods adopted for mounting sections and diatoms in series on the slide.) *Continued.* *Bull. Soc. Belg. Micr.*, X. (1884) pp. 137–41.

„ „ Petit instrument qui permet de repasser sur le cuir les grands rasoirs du Microtome de Thoma. (Small apparatus for sharpening on the strop the large razors of Thoma's Microtome.) [*Post.*]
Bull. Soc. Belg. Micr., X. (1884) pp. 151–2.

Friedländer, C.—Microscopische Technik zum Gebrauch bei medicinischen und pathologisch - anatomischen Untersuchungen. (Microscopical Technic in medical and pathological-anatomical researches.) viii. and 123 pp. and 1 pl. 2nd ed. 8vo, Berlin, 1884.

Griffin, A. W.—On the Collection and Preparation of the Diatomaceæ. Part I. Collection.
["An attempt to gather together some of the ideas of the best authorities on the question, for the benefit of those whose want of leisure precludes them from searching out these facts for themselves."]
Journ. of Micr., III. (1884) pp. 138–46.

Hillhouse, W.—Preparing Schultze's Solution. [*Post.*]
Proc. Cambridge Phil. Soc., IV. (1883) p. 399.

Hitchcock, R.—Microscopical Technic. V. Mounting in gelatinous and resinous media. *Amer. Mon. Micr. Journ.*, V. (1884) pp. 109–12.

„ „ See Insects, catching small.

„ „ See Mounting, questions about.

Insects, catching small.
[Mounting needle bent into a hook and dipped in alcohol. Dip the needle into alcohol (or concentrated carbolic acid—R. Hitchcock) to free the insects.]
Amer. Mon. Micr. Journ., V. (1884) p. 118.

Jackson, E. E.—Mounting the Skin of a Silkworm.
[Soak in acetic acid for 10 days, then open carefully with scissors from anus to mouth and wash in water. Soak in weak and then strong alcohol, follow with oil of cloves, turpentine, and balsam.]
The Microscope, IV. (1884) p. 133.

Kidder, J. H.—An examination of the external air of Washington.
[Describes and figures an aëroscope in principle "not essentially different from those devised by Pouchet, Maddox, and Cunningham." By bending the tube of the funnel at right angles the glycerine is prevented running off, as is the case when the smeared glass is set vertically.]
Journ. of Micr., III. (1884) pp. 182–5 (1 pl.).

Kingsley, J. S.—Microscopic Methods. I.
[No. II. was given *ante*, p. 484, the Part containing I. having been lost in the post.]
III. Hardening and macerating.
Science Record, II. (1884) pp. 108–10, 155–60.

Lavdowsky, M.—Myrtillus, ein neues Tinctionsmittel für thierische und pflanzliche Gewebe. (Myrtillus, a new staining medium for animal and vegetable tissues.) [*Supra*, p. 652.]
Arch. f. Mikr. Anat., XXIII. (1884) pp. 506–8.

Loew, O.—Ueber den mikrochemischen Nachweis von Eiweissstoffen. (On the microchemical analysis of albuminous substances.) [*Post.*]
Bot. Ztg., XLII. (1884) p. 273.

Mounting, questions about.
[As to the cracking of the covers of Möller's slides; also as to bubbles, and note by R. Hitchcock. "Bubbles are occasionally left in fluid mounts, especially when the cells are deep, under the impression that the air they contain being very elastic prevents injury to the cell from internal pressure when the temperature rises. We confess to grave doubts if such bubbles are of any benefit whatever."]
Amer. Mon. Micr. Journ., V. (1884) p. 119.

Negri, A. F.—Coloration des Spores dans les Bacilles de la Tuberculose. (Staining the spores of the Bacilli of Tuberculosis.) [*Post.*]
Journ. de Microgr., VIII. (1884) pp. 349–51, from 'Lo Sperimentale.'

Piffard's (B.) Improved Microscopic Slides. [*Supra*, p. 655.]
Sci.-Gossip, 1884, p. 136.

Poignand, M.—The Microscope in Palæontology. [*Post.*]
Journ. of Micr., III. (1884) pp. 163–70 (1 pl.).

Prinz, W.—Examen microscopique (1) d'une feuille de papier qui à servi à isoler les plaques du parafoudre de la station de Lebbeke; (2) des lames minces d'un morceau de poterie. (Microscopical examination (1) of a piece of paper used to isolate the lightning conductor of the station of Lebbeke; (2) of thin plates from a piece of pottery.)
Bull. Soc. Belg. Micr., X. (1884) pp. 152–4 (3 figs.).

Ralph, T. S.—Results of a Microscopical Investigation of the action of Ammonium Molybdate and other chemical agents on the vascular and cellular tissues of about 120 different plants. *Journ. of Micr.*, III. (1884) pp. 155–62.

Rataboul, J.—Les Diatomées. Récolte et préparation. (The Diatomaceæ. Collection and preparation.) *Continued.*
Journ. de Microgr., VIII. (1884) pp. 342–5.

Robson, M. H.—Improvements in Microscopic Slides.
[Records his experiments of five years ago to make slides similar to Piffard's, *supra*.]
Sci.-Gossip, 1884, p. 162.

Section-smoother, a simple.
[Practically identical with P. Francotte's, *ante*, p. 315.]
Science Record, II. (1884) p. 112 (1 fig.).

Siddall, J. D.—The Microscopical Examination of Milk and Drinking Water.
Micr. News, IV. (1884) pp. 187–9.

Slack, H. J.—Pleasant Hours with the Microscope.
[Examining flowers of Borage, Comfrey, &c.—Ixodes.]
Knowledge, V. (1884) pp. 430–1 (2 figs.), 472–3 (2 figs.).

Stowell, C. H.—Studies in Histology. III. Section Cutting.
The Microscope, IV. (1884) pp. 123–7.

„ „ New Apparatus.
[Griffith's Turntable, *post*. German Microtome.]
The Microscope, IV. (1884) pp. 131–2.

Taylor, T.—Clearing fluid.
[About equal parts of Squibb's absolute alcohol and Eucalyptus oil forms a very good clearing fluid for animal or vegetable tissues. When the tissues are freshly cut, place them in commercial alcohol for a few minutes. Next transfer them to the clearing fluid, as above described, for a period of about ten minutes. They are next placed in pure Eucalyptus oil, which removes the alcohol; a few minutes' immersion will suffice. It is not well to keep tissues longer than necessary in the fluid. Vegetable tissues become hardened when kept several days in it.]
Amer. Mon. Micr. Journ., V. (1884) p. 119.

Underhill, H. M. J.—Mounting Infusoria.
[Reports his failures with osmic acid, permanganate of potash, and "chromic oxydichloride" acid.]
Sci.-Gossip, 1884, p. 162.

White Zinc Cement.
[Note on the difference of opinion between Mr. R. Hitchcock and Professor C. H. Stowell, *ante*, p. 485. "Perhaps they are not speaking of the same preparation of white zinc."]
Micr. Bull., I. (1884) pp. 28–9.

PROCEEDINGS OF THE SOCIETY.

Meeting of 11th June, 1884, at King's College, Strand, W.C., the President (the Rev. W. H. Dallinger, F.R.S.) in the Chair.

The Minutes of the special and ordinary meetings of 14th May last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Heurck, H. van.—Synopsis des Diatomées de Belgique—Table Alphabétique. 120 pp. 8vo, Anvers, 1884	*The Author.*
James, J. B.—Aids to Practical Physiology. viii. and 24 pp. 8vo, London, 1884	*Mr. Williams.*

Mr. Crisp called attention to the extraordinary character of the latter book, and read extracts from it (*supra*, p. 629).

Mr. Crisp described Prof. Zenger's method of constructing "Endomersion" objectives by using a mixture of ethereal and fatty oils, which he claimed enabled the chromatic aberrations to be much more effectively dealt with (*supra*, p. 616). He exhibited an objective sent by Prof. Zenger.

Mr. J. Mayall, jun., in reply to Mr. Crisp, said that he had examined the objective exhibited, and found that it was not a 1/50 in., as claimed, but in truth not more than 1/8 in. He also found that the spherical aberration was very imperfectly corrected.

Dr. Wallich briefly described his new condenser, which he exhibited in operation at the close of the meeting.

Mr. B. Piffard's new slide was exhibited and described by Mr. Crisp (*supra*, p. 655).

Mr. J. Mayall, jun., exhibited and described a simple mode of applying amplifiers to a Microscope (*supra*, p. 607). Several methods had been devised, and the one by Tolles was no doubt very good, but it was expensive. For the form which he now showed he did not claim any originality, because he remembered to have seen the same plan adopted, though in scarcely so simple a manner. His was simply a slide with three concave lenses, which could be pushed through the tube of the Microscope, so that either could be used as required. By this means the working distance could be increased by 75 per cent. The one to which he had referred had a rotating disk, and he thought

the straight slide was to be preferred, as it could be pushed higher or lower in the body-tube until the best position was found.

The President thought that so far as an amplifier was useful—and in many cases it *was* useful—the form which Mr. Mayall had exhibited was a good one.

Mr. Conrad Beck exhibited and described a new form of Microscope lamp (*supra*, p. 628).

The President thought that the lamp was most ingenious and satisfactory, and that many of the arrangements were such as would be of great utility to working microscopists.

Messrs. Swift's lamp, a cheaper form of the one shown at the March meeting, was also exhibited by Mr. J. Mayall, jun.

Mr. F. F. Hazlewood's note was read as to a human spermatozoon with two tails.

Dr. Anthony confirmed the statement that the occurrence of this variation from the normal type was not unprecedented.

Mr. J. Brennan's further communication on the Potato-blight Insect was read.

Mr. Cheshire described an organism which he exhibited, and which was identified by the President as a *Spirochæte*.

The President said the specimen showed considerable variation in the length and number of the spirals.

Mr. E. H. Griffith's new form of turntable was exhibited and described by Mr. Crisp.

Dr. Anthony read his paper "On Drawing Prisms," and illustrated the subject by numerous specimens of drawings of microscopic and other objects.

The President said the subject of Dr. Anthony's remarks was one of great practical importance to all who desired to make microscopical drawings correctly. He had used various forms himself, such as Wollaston's, Zeiss's, and Nachet's, though he thought he might say that he inclined towards the Wollaston, with which he had made his drawings of the flagellum of *Bacterium termo*. Although at the time he did not know why, he had found it quite necessary to tilt the drawing table in the way Dr. Anthony had described.

Mr. Crisp exhibited, in connection with Dr. Anthony's remarks, an ingeniously contrived drawing rest, which had been sent some time ago by the Geneva Physical Company, and which he thought met the want which Dr. Anthony had felt. It was an adaptation of the principle of the one figured at p. 565 of vol. iii. (1883) of the Journal.

The President said that when working he had a somewhat similar

arrangement made with a tripod on which the instrument was placed. For drawing he had a small table at the level of the stage mounted on a swivel, so that it could be used at any angle. He never worked below the level of the stage.

Mr. Michael said he had used the camera lucida a great deal in making drawings of all kinds, and his reason for rising was that it seemed to be taken for granted that Zeiss's form of camera was not so good as others. So far as his own experience and work were concerned, he had found it to be about the best, and he must confess that he did not see the image of the brasswork as had been described. His plan was very simple, for he used a drawing-board propped up upon books, so that the board was practically a continuation of the stage of the Microscope. If he thought that the image was not true he put in a stage micrometer and drew the image of it, and if this was done in two directions and both drawings were alike he knew that the projection was correct. As to the difficulty of seeing the pencil, he found that this varied very much with different persons, and that when he could not see it, others could do so with perfect distinctness. He liked to work with two lights and to have the light on the drawing-board much brighter than that in the Microscope; but on the other hand he found there were many persons who under these conditions would find that the image of the pencil overpowered the light from the object. He certainly thought the Zeiss form the best for ordinary mounted objects and for all such as were not mounted in fluid, whilst if it was desired to draw an object mounted in fluid there was nothing better for the purpose than the Nachet form. The camera lucida, it should always be remembered, was an instrument for drawing outlines rather than filling up details.

Mr. Beck said that the difficulties arising in connection with the camera lucida had from time to time come pretty prominently before him. There were two central forms which might be taken as types; one of these was the neutral tint reflector, and the other was the Wollaston. The neutral tint glass inverted the image so that a drawing made by it of anything which had the heart on the right side would be drawn as if it was on the left side. The practical difficulty met with in the use of the Wollaston camera was not because the Microscope had to be used in a horizontal position, but because of the difficulty experienced by some persons of seeing the point of the pencil. This might arise from the fact that very frequently persons used a large amount of light so that the pupil of the eye was very much contracted. He thought nothing could be better than the old Wollaston form; he had never himself found any difficulty in using it, and in spite of all the new contrivances which had been brought out, a large number of persons still used it and preferred it.

Mr. James Smith said that with regard to the difficulty which Mr. Beck had stated some people experienced in seeing the point of the pencil, the best plan was to cut a very fine point to the pencil, and then dip it into black ink, which would render it perfectly plain on the white paper. With regard to the adjustment of light, it would

be found that when making drawings by daylight it was a good plan to illuminate the object by the light of a small lamp, and to let the ordinary daylight fall upon the paper.

Mr. Dowdeswell's paper "On some Appearances in the Blood of Vertebrated Animals with reference to the occurrence of Bacteria therein," was read by him (*supra*, p. 525).

Prof. Bell said that Dr. Timothy Lewis who had been making some observations in India opened a dog and removed its two kidneys; one was placed directly into warm paraffin and left to cool, and the other was examined at once; the latter was found to contain no bacteria, but the one which had been put into the paraffin was found to be swarming with them. This fact had not been referred to by those who were at present examining into the nature of cholera germs, but he thought it contained a moral which applied to all forms of disease.

Mr. Beck considered the question to be an extremely interesting one. If what the Secretary had said—that the bacteria were the result and not the cause of the disease—was well founded, the same might apply to other diseases.

The President thought that it was not Mr. Dowdeswell's intention to say that there were disintegrated corpuscles, but that there were pseudo-bacteria. In the case of splenic fever the specific forms had been seen, and it had been not only proved that when introduced into the system they would give rise to the disease, but that when they had been filtered out the disease could not be so communicated, so that it was clear in this case that the bacteria were the absolute cause and not the result of the disease.

Dr. Anthony and the President further discussed the paper.

Mr. Oxley's paper "On *Protospongia pedicellata*, a New Compound Infusorian," was read by Prof. Bell (*supra*, p. 530).

Mr. C. D. Ahrens' paper "On a New Form of Polarizing Prism" (*supra*, p. 533) was, owing to the lateness of the hour, taken as read, Mr. Ahrens explaining briefly the principle of his arrangement by means of a black-board diagram.

The President said that at the last meeting of the Society it was mentioned that the American Society of Microscopists would hold their meeting at Rochester, N.Y., in August next, and he had been appointed, in connection with Mr. Glaisher and Mr. Bennett, to attend as representatives of the Society. Since then the American Association for the Advancement of Science had invited the Society to the meeting to be held at Philadelphia, and it had been proposed that the same gentlemen should attend that meeting also on behalf of the Society.

This proposal was approved unanimously.

Prof. Bell mentioned that the Victoria University of Canada had intimated their intention of conferring an honorary LL.D. degree upon their President during his visit to Canada, and he congratulated him on behalf of the Fellows on the honour thus proposed to be conferred.

The following Instruments, Objects, &c., were exhibited:—

Mr. Ahrens:—New Polarizing Prisms.

Dr. Anthony:—Prisms and drawings illustrating his paper.

Mr. C. Beck:—Microscope Lamp.

Mr. Cheshire:—Spirochæte.

Mr. Crisp:—(1) Zenger's Endomersion Objective; (2) Objective by Nobert, with curious form of correcting adjustment.

Mr. E. H. Griffith:—Turntable.

Mr. J. Mayall, jun.:—Microscope with sliding amplifiers.

Mr. Piffard:—New Slide.

Dr. Wallich:—Condenser.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. T. Breeds, Arthur E. Davis, Ph.D., Robert Harwood, and James West; and Mrs. Catherine Crisp, the Hon. Mrs. Peek, and Mrs. Anne Wilson.

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TRANSACTIONS OF THE SOCIETY.

XVI.—*Researches on the Structure of the Cell-walls of Diatoms.**

(*Continued.*)

By Dr. J. H. L. Flögel.

(*Read 12th December*, 1883.)

Plates IX., X., and XI.

5. *Triceratium.*

The old attempts to explain the sculpture of this group may be passed over, also Prof. A. Weiss's work of 1871 (28), since we have a very good paper by O. Müller on *Triceratium favus* Ehrenb. (15), which elucidates the entire sculpture of the valve in a most satisfactory manner. I might therefore omit my investigation of *T. favus*, the only species I examined, the more so as I have generally only to confirm Müller's results. As, however, *Triceratium* is taken as the type for diatom sculpture generally, and because in minor points I arrived at somewhat different results, I prefer not to suppress my investigations which were made from sections (serial preparations) and casts. The material was presented to me by Herr Möller, of Wedel.

The production of sections perpendicular to the surface of the membrane is a comparatively easy task. The large triangle can be readily seen in the gum, and the knife guided accordingly. Series of 15–20 sections can be made without difficulty.

We have, as Müller correctly describes, a thin basal membrane adjoining the cell-lumen, and apparently quite smooth. On the outer surface is a system of ordinary network mostly representing hexagonal spaces, which are vertical chamber-walls. Above, these lines extend to almost horizontal walls, leaving, however, for each of these chambers a large round central opening. Each of the

* The original paper is written in German, and has been translated by Mr. J. Mayall, jun.

hexagonal cells observed in the surface view is therefore a chamber in the shape of an hexagonal prism; only the base of the same, the outer surface, is not complete, but has the well-known and often-described circular opening. On the vertical walls—namely, the side faces of the prisms—in the corners of every third chamber is a spine. If the thicknesses of these fine membranes are to be measured, very choice sections must be taken. The basal membrane has a very fine sculpture as illustrated by Weiss, but much better and more accurately given by Müller. It consists of a system of fine dots, radiating in lines from the central space of the entire valve, and of which 60–80 are contained in an hexagonal cell. Only on the finest sections with the highest power one catches a glimpse of these points. I cannot say that the line would thus be seen distinctly beaded; and equally invisible are the points adhering at the inner side only of the basal membrane, as Müller represents it in transverse section (his fig. 11). Possibly these are also chamber-like cavities, as with *Pleurosigma*. The definition will be very difficult, but possibly casts will help us hereafter.

We have still to consider the margin of the valve and the three horn-like protuberances. Müller has spoken of these explicitly, but I find some variations. With regard to configuration of the margin, Müller gives correctly (his fig. 9) the view of the surface of the marginal line. The transverse section (his fig. 11 *d*) represents this line too much bent inwards. I have therefore given a diagram, plate IX. fig. 21, of one of my transverse sections. The line is nearly vertical to the membrane surface and is slightly broader at the top, not pointed. The three protuberances at the three corners of the triangle have been correctly rendered by Müller; but everybody who has not seen them in sections will find it difficult to realize them in his figs. 6 and 7, because they exhibit too much of other detail and shadow. For this reason I give the diagram of a true vertical section of such a protuberance, fig. 22. According to Müller, these protuberances might possibly be open at the point, for which I have not found the slightest justification. Nor is his cited example of *Eupodiscus* a proof, in my estimation, because I see the points in this group also closed.

The method of collodion casts confirms in general the results obtained by the section method. The collodion enters through the outer larger opening into the chamber, and leaves on the surface of the dry cast a somewhat round mass which has very little likeness to the beautiful regular prism of the chamber. On closer examination one distinguishes these spines in the cast as distinct depressions in the corners between the masses. The cast of the inner side of a valve is perfectly smooth. I could not succeed in obtaining a cast of the delicate porous structure, either because it does not exist or because the collodion used showed reticulation in hardening.

6. *Coscinodiscus.*

Of this species I have examined four varieties. I collected the material myself on the Norwegian coast, and another portion was from the 'Pomerania' expedition (9).

§ 1. *Coscinodiscus radiatus* Ehrenb.—This species gave the best results, because the chambers are of considerable size, and I had a sufficient quantity of them. Among the specimens obtained with the knife one is especially interesting, because it was obtained during fission. This is represented in fig. 31. I photographed a particularly successful section as a type-image. This section is very good, but for the study of the sculpture a little too thick; for this reason I have delineated in fig. 23 the marginal portion of an adjoining fine section under very high magnification. From both images the sculpture of this species may be deduced as follows:—The general form of *C. radiatus* is a very thin disk like a coin; both faces are circular and display the pretty delicate areolæ. Vertical sections through the disk give everywhere the same image, the central one included. The cell-wall of these disks consists of a very thin basal membrane, having on the outside very delicate but prominent network. This network is enlarged and thickened at the end, and so much enlarged that the lines almost coalesce. In inferior sections one sees a continuous outline, which is divided from the inner membrane by bars, but in very good sections the lines have the shape of a T. In consequence the network forms prismatic chambers, mostly hexagonal, but also five-sided and four-sided, which without doubt must have an opening from the outside, even if it be very small. In the surface view I did not observe this opening until after my attention had been drawn to it by the sections. It is seen with balsamed preparations like a small nodule, having 1/4 to 1/3 of the diameter of an areola, and in superficial examination it may easily be mistaken for the focal image of a chamber. To decide this point search must be made above the acute portion of the chamber-walls. The large number I examined of good sections which all agree when thin enough, and show no continuous outline, prove definitely the existence of a small opening. The opening, in proportion to the size of the chamber, is smaller than the circular opening of the *Triceratium* chamber, as may be seen from the diameter of the chamber-walls, which have a somewhat different shape from *Triceratium*. Otherwise they are both very similar, but *Coscinodiscus* has no spines; the outer surface is therefore smooth. The height of the chamber is equal to its breadth (3–3·2 μ). Towards the edge of the disk both dimensions decrease. The girdle-band is seen in most of the sections; it is without sculpture. Regarding its connection with the two inner newly formed cell-

walls several results were obtained with the sections. These two new disks have the same sculpture as the two of the outer valves, except that all outlines are much finer, and the chambers are also not exactly of the same definite height. One observes that the chamber-walls in the two young disks sometimes touch each other, sometimes not. The manner in which all these parts are connected with one another is very peculiar. I must here refer to what I say further on about *Achnanthes*. With *Coscinodiscus* there is no doubt that at least the one of the two newly formed cells is completely closed outwards. The basal membrane of the one outer valve goes continuously in equidistant curves into the basal membrane of the corresponding inner valve; at the bend a few delicate lines are seen which are the sections of the walls of the considerably reduced marginal chambers. Out of this portion the new girdle-band must be developed, as hitherto it has not been detected. One observes in the other newly formed cell (the lower one in the fig.) existing in all central sections a break, which the membrane of the new valve makes at the bend, and this gives the appearance as if the basal membrane of the old valve was continued here directly in the inclosed girdle-band, which is probably the case; but one also observes here a break. Nevertheless I believe that this second cell is closed at the bend of the membrane, a conviction to be gained only by very careful study of the entire section series. Future investigators who will work with patience have an inexhaustible field before them; they will have to turn their attention specially to the gradual development of the chamber-walls and determine whether, for example, as Müller indicates for *Triceratium*, network arises from a basal membrane at first smooth, or whether it is more probable that at first hollows are developed in the membrane which afterwards become chambers open at the top. It is interesting to see in this fission specimen how, during the process of division, the lumen of both cells was reduced almost to nothing, and very nearly the entire inner space of the former mother-cell was filled up with the substance of the two new walls. A coalescing of the two disks during the imbedding in gum cannot be entertained, inasmuch as they would show cracks at the edge, as old valves are unusually brittle. If we compare with this an ordinary undivided specimen, from one of which I have given a nearly median section out of the marginal portion, fig. 24, the difference is at once apparent. In other respects such a section displays very little variation from the above representation. The first section through the same specimen, which shows the girdle-band of the surface and the minute chambers in the convex edge, is given in fig. 25. I could not obtain collodion casts of any service, nor could I succeed in fixing permanently colouring matters in the spaces of the chambers. If the latter

could be accomplished with not wholly soluble but only suspended colours a further clear proof would be furnished of the existence of the openings of the chambers. Fossil specimens of *Coscinodiscus radiatus* from marl slate from Oran, for which I have to thank Prof. Dippel, appear in their section-images quite in harmony with the above. As a matter of course here is no longer cellulose, and the valves and the girdle-bands are isolated. In the surface-image the opening to the chamber is a little larger than with the other specimens, which may be attributed to the loss of the cellulose. Putting the outer surface (for instance, line 1, fig. 23) under a high power we see these openings as delineated in fig. 26. By slightly raising the slide so that line 2 is seen, the inner ring disappears and distinct chamber-walls are seen, fig. 27. One estimates the thickness of these walls in the surface-image too high, a circumstance connected either with the magnification of the outer marginal thickening of these walls, or which must be explained by the reflection of the light from the walls.*

In a few specimens, not far from the edge, I observe unusually large chamber-walls, fig. 28; the cavity is apparently quite spherical, and only at some distance off does it take the prismatic form. It seems to me quite unimaginable that the membrane should have raised itself as an annular wall until quite above or nearly so, and then have closed itself again over such a cavity (the pointed shaped opening seems really sometimes to be wanting altogether); and for this second reason in support of my former conjecture—according to which the cavities develop and enlarge themselves in the substance of the walls, and in this case open by the resorption of the girdle—I give preference to my explanation rather than to Müller's.

§ 2. *C. Oculus iridis* Ehrenb.—The works of Slack, Stephenson, and Morehouse relating to this species (25, 26, and 13), I know only through Just's 'Jahresbericht.' According to Pfitzer's reference, Stephenson describes an outer layer of deep hexagonal cells which are one and a half times as deep as broad, and which, judging from the positive images which they give of outer objects, are either open on both sides or closed by nearly plane membranes. The latter becomes more probable through the appearance of small depressions in the base of the cells, the edge of which is undulated. The inner layer Stephenson describes as a thin hexagonal areola

* On this subject compare my work on *Pleurosigma*, p. 507, where the reflection appearances within vertical chamber walls are fully discussed. With a stage having an opening covered by a glass plate which is slightly tilted these experiments can be controlled. Since outwards of the edge-line of a wall black always appears first and white within, it becomes evident that with small dimensions an apparent thickening of such vertical membranes must always result, because the eye naturally takes the middle of the black line as the limit.

plate having a spherical opening in the centre of each hexagon. Slack asserts he has seen real depressions and a real projecting network, both composed of small spherules. Morehouse sees duplex valves, the inner of which has spherical openings, the edges representing the thickest parts of the valve; the hexagonal network of the outer valve lies in the depressions between those edges. Across the mesh of the network extends a thin siliceous film with most delicate anastomosing network, having its weakest point in the centre. All sorts of things may be observed on this object if one remains satisfied with a mere examination of the surface. The nearest approach to the real state of affairs was made in 1880 by Prinz (21). His figs. 7 and 8 represent tolerably well the vertical chamber-walls, although by the method applied (the experiments were made with thin rock sections) the real details would be difficult to make out. This species viewed on the surface is to be distinguished by the large areola in the centre of the disk; the section shows that the entire cell has no longer the form of a coin, but, in consequence of the slight curving of the disk, is like a bi-convex lens. The areolæ are slightly smaller than those of *C. radiatus*. My somewhat numerous sections through one specimen are very similar to those of *C. radiatus*, but I find nowhere a definite clue for the existence of an outer opening. In fig. 29 a small portion of a vertical section is given to the right, as observed with most of the sections; on the left are seen small portions in the edge of fine slightly injured sections. Here I am in doubt whether the T-shaped figures may not be produced by the splitting of the very fine outer membranes which are in the girdle; if everything in the gum is uninjured one sees the membrane extending evenly across the supports without indication of holes. It is curious that with this species very often an air-bubble remains behind in the chambers which hardly ever occurs with *C. radiatus* and *Pinnularia*, and this might suggest that the fluid gum does not enter through openings but in the more difficult endosmotic process. It is unnecessary to deal more in detail with the statements of Stephenson and Slack. The former has apparently arrived at his view through examining a specimen in process of fission.

§ 3. *C. centralis* Ehrenb.—This is a very large species, of 1/3 mm. in diameter, strongly convex, having in the centre a few large areolæ. I have before me a number of sections through a valve which had unusually coarse markings, thus differing but slightly from *C. radiatus*. Fig. 30 is a portion of one of the best sections, and shows the chambers with the T-shaped sections of the walls, suggesting arches; the surface view is like *C. radiatus*. Here also no opening can be detected in the finest edge-portions, therefore I believe I am accurate in stating that this species has completely closed chambers. One must not be led away by the

marginal shadows which give the above strongly thickened T lines. A close examination confirms the existence of a very fine line between them. Hence we have here two distinct membranes connected by a system of mesh-like walls. The walls commence at the inner membrane very thin, and gradually become thicker as they approach the outer membrane, so that they appear wedge-like in the section. Similarly the adhesion point at the outer membrane is thickened, and this thickening gradually diminishes over the centre of the chamber. The outer surface of the outer membrane is uncommonly even, so much so, that in a dry condition the valve reflects light as strongly as a mirror. This fact alone cannot be reconciled with the idea of openings (*C. radiatus* does not reflect as a mirror), anyhow the openings could not be estimated at more than 1/8 or 1/10 of the chamber diameter in order not to interfere with the smoothness of the membrane. Collodion casts would be very desirable in the investigation of this species. The dots of the areolæ in the surface view, formerly described and figured by me (9, p. 86, fig. 6), cannot be seen in the sections.

§ 4. *C. concinnus* W. Smith.—This species is much larger and more delicately enveloped than the former, about 0·5 mm. in diameter and equally convex. The section of a valve of a not very large but very finely marked specimen, fig. 31, shows the familiar image of chambers closed on all sides, such as I demonstrated by my *Pleurosigma* investigations, except that with this *Coscinodiscus* they are considerably larger (about 1 μ). The valve reflects light strongly. For the surface view I refer to my former notices and figs. (9, p. 86, fig. 5). After the investigation of these four varieties I believe that in the species of *Coscinodiscus* we have before us the gradual transition from the *Triceratium* type to the *Pleurosigma* type, inasmuch as the small outer opening of the chamber which is still seen in a few varieties, totally disappears in others.

7. *Isthmia.*

It is not at all difficult to cut this giant amongst the diatoms, but it is very difficult to obtain sections of the requisite degree of fineness. The cell-wall is everywhere of unusual delicacy. After examining some forty-five sections I am enabled to give the following description of the cell-wall:—

There is a difference between that portion of the frustule which corresponds to the valves, viz. the sloping ends of the rhomboidal cell, and the middle portion, which is to be regarded as the girdle-band and under which the division takes place. This difference is marked outwards by a strong expression of the areolæ in the end portions in contrast to the delicate markings of small cells in the girdle. With the sections one must always endeavour to determine

to which part the portion belongs which is under examination. In order not to err on this point I have kept to the pointed ends in the investigation of the valves, and which exhibit in the section comparatively very small rings. Photograph 19 illustrates a section through two frustules and through one connecting end being the isthmus proper. The small ring, without doubt the valve, shows on the inner side distinct projections, that is to say, wall-thicknesses apparently vanishing like network produce the cell-figure in the surface view. The membrane at the non-thickened end, that is to say, at the lumen of the pseudo-cells, is of extreme thinness. The immediately preceding much finer section corroborates still more what I say. The thickness of the wall is about $0 \cdot 3\ \mu$, and in the net projections $1 \cdot 2\ \mu$, we thus obtain an image of simple inner cell-envelope thickenings in a manner leaving nothing to be desired, and which has not the slightest similarity to *Triceratium*. The cell-wall of the middle girdle differs inasmuch as the thickening lines producing the markings are undoubtedly on the outer side. The wall-thickness is so extraordinarily small that with a magnification of 1000 it appears only as a mere line. The net-lines are also very flat, about $0 \cdot 7\ \mu$ in height. With reference to the girdle-band one can speak with full conviction of a surface-sculpture, whilst with the valves one must say inner surface-sculpture. Here may be added that *Isthmia* has a large cell-nucleus lying in the inner granular protoplasm, and which was touched by me several times in my sections. It is a spherical transparent vesicle of $16\ \mu$ diameter, having a spherical nucleolus of $4 \cdot 5\ \mu$ in diameter. The result obtained from surface views of dry imbedded *Isthmiæ* does not at all agree with that obtained with the transverse section images; the thickening lines appear like strong refracting masses, and were looked upon as such by the earliest investigators (Ehrenberg, Kützing, and others). It was not at all to be expected from an *à priori* examination that the sculpture of this species would appear so totally different from *Triceratium*. I shall not be expected to enter further into the researches of Slack (25), according to whom the membrane consists of small spheres.

8. *Achnanthes.*

If an obstinate defender of the opinion that diatom sculpture consists of inner cell-wall thickenings, wishes to secure an object substantiating his view, I can very strongly recommend to him the large forms of *Achnanthes*. After having occupied myself inland for years with fresh-water diatoms, on meeting with the marine *Achnanthes* I believed I had found the long-searched-for proof. Each surface view under a good Microscope shows clearly the

projection of lines on the inner side of the membrane, whilst the outer side is perfectly smooth. It can be seen more distinctly in sections, but in proceeding we shall soon have to admit that a part of what we stated has to be reconsidered. The following relates only to *Achnanthes brevipes* Ag.*

§ 1. We have to distinguish three sorts of markings in *Achnanthes*. This diatom has an unsymmetrical shape at the division-plane, so that only the two middle sections vertical to this plane give symmetrical halves. Therefore we get:—(1) A dorsal valve characterized by greater convexity; it has a mid-rib without nodule running evenly from one end to the other; close to it run the smooth transverse lines, the interspaces of which are wider than those of the ventral valve; between every pair of transverse lines are seen in most instances three rows of dots, sometimes only two. (2) A ventral valve, characterized by a thick depression in the middle; it has a mid-rib with even striæ on both sides, in the centre a large nodule which at right angles to the mid-rib extends to the edge, thereby producing, the same as with *Stauroneis*, the image of a cross. The transverse lines are finer than in the dorsal valve; between each pair, as a rule, one row of dots, sometimes two. (3) The girdle-band, always with delicate striæ vertical to the division-plane, which however is subject to variations as we shall presently see. The figs. 33, 37, 38, and 39, plate X., of *A. brevipes* sufficiently illustrate this description.

Two good serial sections are obtained, running vertical to the division-plane and to the two mid-ribs (in fig. 33 this is delineated by lines 1–3); the third series I made approximately parallel to the division-plane. My attempts in the third direction of space (the horizontal) failed. From one of the two former series, numbering twenty-three sections, I have delineated three, viz. 1, 5, and 15, figs. 40–2, plate XI. No. 1 is a marginal cut; 23 has nearly the same appearance. No. 15 cannot be far from the middle, because among the succeeding numbers are a few of too great thickness.

Examining first the general form, we see from the sections in which all three conform, that the ventral valve is depressed, trough-like, along the mid-rib, whilst the dorsal valve appears half-cylindrical, that is to say, rounded off convexly. By this feature

* The difference between *A. brevipes* and *longipes* Ag. is often very great. *A. longipes* commences with a short pedicle; the pointing or rounding of the valves is somewhat variable, and the distance between the striæ is not always definite. From the stria distances and the length of the pedicle, I believe I have determined the specimens investigated to be *A. brevipes*, but they might belong to *A. longipes*. The specimen figured by Pfitzer as *A. brevipes* (19, pl. vi. fig. 15 *s*) I should rather suppose to be *A. ventricosa* Ktz.; anyhow, this variety is not the one investigated by me under the name of *A. brevipes*. I have found *A. ventricosa* on the sea-shore near Sylt, but could not make use of it in the present investigation (*vide* 5, p. 737).

we are able to distinguish either valve even with imperfect sections. The convexity of the dorsal valve fits nearly into the trough of the ventral valve, so that they touch each other when of large size. The section-bundle consisted of three frustules, of which the lowest was probably near the period of its second division, whilst the other two had only recently emerged, therefore the lowest, compared with the others, is probably backward in development. The girdle-band comprises only the limit-line between the lowest and middle frustule. With reference to the fine sculpture, mention must be made of a portion of membrane hitherto unobserved, and which could not have been well detected without transverse sections. This is the projection on the edge of each valve, that is to say, at the limit between valve and girdle-band, a spine turning far inwards as shown in the figs. (*r l*), and is found fourfold in each frustule. All sections of the two series prove clearly these four projections; they can only be the expression of a projecting line running along the edge towards the inner space of the cell, I will call it edge-line, which with the usual division of the frustule plays a prominent part as we shall see. With low powers one sees only the four small spines; applying the highest power one observes that the larger spines, at any rate, are hook-shaped towards the valve-cavity, fig. 43; it may actually become a hook, fig. 46. The end-valves, being the oldest in the row, have the largest hooks and the strongest edge-line. In the youngest valves one sees the partially developed hooks, sometimes hardly nodule-shaped, fig. 44.

The largest hooks penetrate 2 μ into the cavity of the cell. After having discovered the marginal lines in the sections it became easy to trace them again in the surface view; they are particularly well seen in balsam preparations (in consequence of the weaker refraction of the walls). The older investigators, for instance, Kützing (plate 20, IX., 1) and Ehrenberg, figure distinct dark marginal lines ending with a nodule. The transversely cut marginal line is in section far more conspicuous than the mid-ribs; in most instances one sees the mid-ribs as round nodules standing off the membrane; occasionally they may be seen somewhat more distinctly. Altogether the dimensions are very small, and only in the most favourable instances can one determine that they project inwards and not outwards. The valve surfaces are always seen in good sections as distinct rows of dots, pearl-like, and this is the expression of the fine dots of which I spoke above. These pearls I declare to be, according to the best and most reliable sections, chambers closed on all sides situated within the membrane. The direction of the cuts in the series in question being parallel with the actual transverse striæ, one can hardly expect to discover anything about the condition of the latter. But if the section is very thin, one sees on the inner side of the pearl row a fine straight line depressed

at the mid-rib, fig. 45, so that at the side of it are two thin membrane-striæ free from dots, such as we demonstrated in the surface-image. This fine line I consider to be the limit of the inward projecting transverse striæ, and also of the one touched by the section; for if it is thicker and comprises two transverse striæ, it will be looked for in vain in this image, because the interference at the margin then becomes so strong that we can give to the line any interpretation we please. The central nodules and their expansion are not met with with certainty in either series; unfortunately they seem to have broken off at the touch of the knife.

The girdle-band in old valves has always a distinct row of coarse striæ; in the surface-section, fig. 40, this is magnificently brought out. These striæ are about half as fine as the transverse striæ of the ventral valve. In the younger part of an old valve, or in a young valve, the striæ on the girdle-band are very indistinct. In the transverse sections, inasmuch as the sections are in the direction of these striæ, nothing can be seen; one observes no differentiation whatever in this membrane except that sometimes irregularly a dot appears on the inner side, which may indicate the delicate lines running parallel to the marginal lines. The whole matter is to me doubtful. I cannot explain the extremely fine structureless section occurring at the margin of the surface section 1. Since the girdle-band has no such non-striated portions in the surface view, it may possibly be an outer substance hardened by the alcohol.

The serial sections which were made in a direction 90° from the preceding (22 in number) cut through the surface from first to last; but shortly after the first and shortly before the last, as a glance at fig. 33 discloses, the transverse lines of the strongly porous valves must, at the point where the two sides run parallel, have been struck exactly vertical to their direction. This, as a matter of course, occurs likewise with several valves situated between the two ends. Further, the girdle-band is seen in several sections, and is cut vertically to its striæ. The most suitable sections through the part of the dorsal valve under examination, as represented in fig. 48, show that the transverse lines, as we learnt from the surface view owe their origin to the delicate but distinctly raised thickening lines on the inner side of the membrane. These fine lines are about $0 \cdot 9\ \mu$ high, the membrane itself is $0 \cdot 5\ \mu$ thick. In examining the sections near to the last one, one detects the fact not quite so distinctly in those which are unquestionably taken through the ventral valve, but I have obtained with a well-regulated position of one section an unequivocal image, fig. 47. Between the transverse striæ lies the chamber, seen only with very fine sections, fig. 50. As a matter of course, the valve-section is in places entirely surrounded by the adjoining girdle-band section. The girdle-band can always be easily distinguished in these sections

by its peculiar regular fine pearl-like sculpture, figs. 45 and 52. Now, what are these pearl rows? I believe they must be interpreted similarly to the sections of the Flensburg *Pleurosigma* described by me (6, pp. 475–8), hence, in this case, probably a long, extended, cylindrical chamber within the membrane. The apparent projection on both sides of the surface must be an optical effect. Clearness in these details with the extreme delicacy of the object is hardly to be expected. The central nodule of the ventral valve is a strong inward-projecting thickening, without any other distinction except that from every side it sends off a thinner line in the transverse direction to the edge of the valve.

§ 2. With this we conclude our examination of sections in general. I believe I have thrown some new light on the complicated structural details of the species *Achnanthes*, although I admit that much remains to be done. With the ample material at hand it became interesting, apart from the above results, to make the attempt to discover the development-processes which take place in the gradual formation of these sculptures during ordinary fission. Now that we know more exactly the connection of the girdle-band with the valves, the former, not being structureless like most of the fresh-water diatoms, will probably furnish data for further elucidation of these hitherto obscure problems. In aid of further research we should also avail ourselves of simple surface-views as well as the examination of numerous freshly imbedded and well-preserved specimens in balsam, because with the help of transverse images the appearances can be correctly explained. I do not hesitate to add here the observations which I have made with a larger number of balsam specimens of *Achnanthes brevipes* even at the risk of engaging in controversy.

Taking a recently divided specimen, such as is shown in fig. 33, and examining it with reference to the formation of the girdle-band, one finds that between the two valves, viz. between the one older and the one younger, there is no space. We observe the marginal line, and close to this extends the young valve. If we keep well in mind the image of the marginal line of another fuller grown specimen, we shall be easily convinced that the younger specimen has only one single line. Fig. 33 shows the frustule at the edge where the young valves have only recently obtained the necessary solidity to enable them to withstand the influence of contracting fluids (I might have started from earlier stages, but my objects not hardened with osmium show all sorts of bendings of the young valves which I attribute to the modus operandi). Adjusting the left cell as the optical middle section one sees the edge-line of the old dorsal valve like projecting nodules: close adjacent is a smaller nodule which can be nothing else than the commencement of formation of the marginal line of the younger ventral valve. On

the surface of the frustule such a second line cannot yet be traced at all; on the contrary the transverse striæ of both valves run to the apparently common marginal line. This companion cell on the right is in this respect slightly more developed, especially at the one end (the lower in the figure). Not only is the small nodule more distinct in the middle section, but it is also more distant from the larger, and on the surface one can clearly see two marginal lines not quite parallel. Fig. 34 gives the line of the optical middle section again, but more highly magnified. Turning now to another still younger specimen, fig. 35, we observe the two marginal lines slightly further apart. The divergence of the lines continues until the cell obtains the requisite breadth to divide anew, fig. 37. The question arises with this divergence, what becomes of the girdle-band and how is a new one formed? With regard to the old, one sees clearly the edges are extending over the other, of course mostly only with an immersion objective, and it would easily be overlooked if we did not know where to search for it from Pfitzer's pioneer work. With regard to the processes accompanying the formation and development of a new girdle-band we find but little information in Pfitzer (19, p. 56). He states that the girdle-band in *Pinnularia* is formed unusually late, only after the new valves are complete, and then where it adheres to the valve; that it is seen almost at first in its definite thickness reaching slowly to its normal breadth. According to Pfitzer (19, p. 9) the girdle-band has an outer edge in organic connection with the valve, and an inner free edge touching the other ring but not grown together.

With *Achnanthes*—and here the non-existing marginal line of *Pinnularia* renders capital service—we can establish with all desirable certainty that the girdle originates in these lines. One has only to go backwards in the various stages of development in order to establish the fact. At the point where the distance between the old and the young line can be well observed, one sees distinctly with an oblique position, fig. 36, that the cell-wall between the two lines is of double thickness, hence at that point there must be already a younger girdle-band. Of course, with the extreme thinness of the two bands the duplicature cannot be observed directly; the line expressing one cleft extends, as far as I see, up to the young marginal line, fig. 36, *r l*. But since this was attached originally to the older line, the girdle-band without doubt is so far a double membrane, as it has already been rendered probable by its thickness. Following up backwards this very thin narrow girdle-band, fig. 33, on the left, we find here its origin in the depression of the marginal line. We further deduce from these *Achnanthes* images that, according to my examination, it is clearly evident the girdle-band from its commencement is attached to the cell, since it fills up entirely the inner space

between the two marginal lines. From this I deduce further: there is no free edge of the girdle-band, such as Pfitzer has described with *Pinnularia*, anyhow not so long as the cell is only of moderate breadth; both edges are grown to it.*

When this connection ceases must be discovered by future researches. But there can be no doubt that at some time or other a process of forcible separation must take place. This separation always occurs in a segment of the old marginal line. We are therefore justified in stating that at that spot the new formation of cellulose takes place, whilst further on towards the new line, the membrane is already solidified and capable of resistance. Some proof of the correctness of this view is found in the development of a strong margin near this spot; the lines become weaker the further one goes from this margin. In the cell, shortly before division, fig. 37, the tearing-off of the young girdle-band has taken place. This looks like the signal for a new division; at the moment of tearing off, the compressed contents in the rigid cell-envelope become suddenly free, at least in one direction, and can hence extend, inasmuch as the girdle-bands are drawn out like telescope-tubes. If these views are correct they lead us to the conviction that the older outer girdle-band is a safety-sheath for the inner younger girdle-band; it prevents injuries to the latter whilst partially in a non-silicified condition; it protects with its older strong portion the younger recently formed annular portion of the inner band. From this may be deduced that *Achnanthes* is in many respects similar to the growth of the cell-envelope of *Œdogonium* (may we say to the large marine *Confervæ?*).†

We must now cast a glance again at the sections. None of the uninjured (fig. 43) confirm these assertions; one observes from marginal line to marginal line a fine simple membrane, consequently without doubt twofold. But only when a section is injured and its substance has been slightly removed by the knife during the operation of cutting is the real state of affairs brought to view. In fig. 44, otherwise very similar to fig. 43, we see a portion of such a section in which the young girdle-band can be traced; a depression being nowhere observable in the space up to the old marginal line, the girdle-band must have grown there. We also find in such slightly injured sections clear proof that it easily tears off at the old marginal line. If I wanted to convince the reader of

* I might mention *en passant* the physiological objection against the non-connection of the two valves, that the water must find access to the inner space, however narrow, and would thus come into direct contact with the protoplasm, through which the latter, according to all established experience, would swell and possibly effect a separation of the halves.

† Whether the enlargement of the cell-envelope of *Rhabdonema adriaticum* (*vide* Nägeli and Schwendener, 17, p. 544) has its cause in a similar law seems to me to require fresh investigation.

the accuracy of these views which I acquired in the examination of the sections, I should have been obliged to photograph an entire series.

The question whether the diatoms become smaller through repeated division can be well elucidated with *Achnanthes*, especially if one is possessed of richer material than I have, and by examining and comparing the measurements. In doing this we should start with the marginal lines of very young specimens. What I have seen in my examination of *Achnanthes* preparations confirms the results obtained by Braun and others, especially Pfitzer (19, pp. 20–3, 100–102) with *Himantidium*. I confess I see several specimens in which the younger valve is shorter than the older; but I have also found some where the length is greater than in the older, which may possibly be caused by the girdle-band having enlarged itself at the edge. The normal condition appears to me to be an exact equality of both valve-lengths. On the one hand this follows from the manner above described in which the first traces of the young marginal line are developed, fig. 34, and where with the best methods of measurement no difference will be found. On the other hand one sees, by careful examination of such young cells, that the older girdle-band is always slightly raised, that is to say, about as much as its thickness $0 \cdot 4$–$0 \cdot 5\ \mu$; to this extent it grows over the old valve. Next, one can often see with *Achnanthes* longer cell-rows in connection, all of equal size. This has been minutely discussed by Pfitzer. We have lastly in *Achnanthes* in so far a very favourable object, that the valves are not similar as with *Pinnularia* and *Himantidium*, but on the contrary are very different, and no definite judgment can be arrived at with regard to age and number of generation. Now, if I examine a few good rows composed of eight frustules, where for example the lowest and oldest ventral valve is together with the youngest dorsal valve coming out of the third division, then I find no difference in size between the grandfather and the great-granddaughter, although the threefold thickness of the girdle-band, always a good measurable size, would have to be deducted with the latter if Pfitzer's theory were in this instance correct. However, who will guarantee that we have here to do with the grandfather and the great-granddaughter? The hundredth division may already have taken place, since it is known that in time only individuals connected by mucus are thrown off. All considered, I am of opinion that *Achnanthes* contradicts rather than confirms Pfitzer's theory, and that the supposed corrective of the cell diminution, namely, the formation of auxospores, may have other purposes. The decision of this question must be left to future investigators. Whether the corner of the ventral valve developing the longer or shorter spine by which this diatom is fastened on other algæ, is of different

structure from the one at the other corner seems probable at the first glance, but nothing definite on that point could be made out. It seems to me that the spine is the outdrawn end of a general gelatinous cover secreted by the entire valve-surface. The cell-nucleus of *Achnanthes*, fig. 46, is a small spherical vesicle of 4 μ in diameter with nucleolus of 1 μ.

9. *Synedra.*

With *Achnanthes* I have given numerous transverse sections of *Synedra Gallionii* Ehrenb., often and everywhere found in Kiel harbour, fig. 53. Beyond its general form very little can be deduced, especially as we are left in the dark as to how the insignificant transverse striæ are caused on the edges of the square.

III. Results and General Remarks.

The detailed researches given in the preceding chapters shall only be mentioned here in so far as they relate to the sculpture of the cell-envelope, whilst I must refer to the above for the facts in connection with the girdle-bands, fission, &c. These researches comprise in all, seventeen varieties of diatoms (*Pinnularia major, viridis*, and *Crabro; Navicula Lyra; Pleurosigma balticum, angulatum, Scalprum; Surirella biseriata; Triceratium Favus; Coscinodiscus radiatus, oculus iridis, centralis*, and *concinnus; Isthmia enervis; Eupodiscus Argus; Achnanthes brevipes*, and *Synedra Gallionii*), which have all been examined by the section-method, also to some extent by other methods. The result is that the marking of the diatom coatings has its origin in various forms of the wall-thickness and in the cavity formation within the membrane. The results can be grouped as follows:—

The marking is caused:—

(1) by the sharply projecting wall-thicknesses.

a, on the inner surface of the membrane:

Achnanthes = transverse striæ, *Isthmia* = valves, probably also *Grammatophora, Epithemia*, and others.†

b, on the outer surface of the membrane:

Isthmia = girdle-band.

(2) by developed chambers within the membrane, and

a, with distinctly observable openings.

* Which are on the outer surface of the cell, whilst they are closed inwards (in a certain degree transition from type 1 *b*):

Triceratium, Coscinodiscus radiatus, and possibly a few other varieties.

† Weiss, 28, p. 9; Müller, 16.

** Which are situated on the inner surface of the membrane where the chambers at the same time have the enormous extent of almost half the breadth of a valve.
Pinnularia, and probably all single striated forms.

b, without distinct openings, but of considerable size.
* With quite smooth chamber-walls:
Coscinodiscus centralis, and others.
** With nodular thickened chamber-walls:
Eupodiscus.

c, closed on all sides, and extremely small, approaching the limit of discrimination:
Pleurosigma, Navicula Lyra, Surirella, Achnanthes (the finer marked variety), and probably most of the finely dotted striated forms.

Having thus given proof of the existence of various types as the cause of the surface-image, the necessity arises of refuting those investigators who constantly talk of a diatom sculpture in general, of surface-sculptures, of furrows, cup-like depressions, hemispherical-shaped prominences, &c. In so far as this has not already been done in my paper I now undertake the task.

Prof. Weiss propounded in 1871 (28) an entirely new view of the sculpture of diatoms, which is formulated by him (pp. 15–6) as follows: "The markings of the various diatom species, however different they may appear under low magnification, differ only apparently; under high magnification, and with a correct interpretation of the sculpture, all diatoms are constructed on the same principle, namely, they consist of more or less polygonal cellules, the walls of which, with low magnification, produce and condition the configuration of the so-called markings." The inner cavity he compares (p. 9, footnote) with the embryo-sac of the higher plants. The notion that the envelope consists of numerous minute cells is so thoroughly erroneous that we need not quarrel about it. The attributes of a cell do not consist, according to our present knowledge, in the wall alone which surrounds a cavity, and it is impossible to look upon each cavity as a cell-lumen even if it should have regular form. The discovery of nuclei within the so-called cells (p. 30) must be traced back to an error in the examination; they would never have escaped me in my manifold staining processes. Nuclei which take up no colour I may say do not exist. The idea that all diatoms have a common sculpture, I contradict most emphatically. I cannot at all comprehend how Prof. Weiss, with his great knowledge of details, and with the enormous quantity of material at his disposal, can have arrived at such an opinion. We must, however, give Weiss the credit that he was the first to demonstrate that the presence of cavities closed

on all sides was the cause of the marking during the development of the valve. Considering the criticisms Weiss's work has experienced through the erroneous theory of furrows, sculptures, &c., the credit due to him must be kept prominently in view.

Of similar tendency are the works of Count Castracane, for which I refer to Just's Botan. Jahresb., 1873. It will be equally unnecessary to enter upon their contents.

I have at various times in the course of this paper referred to Prof. Pfitzer's epoch-making work (19). I am obliged to speak of it once more, because at the conclusion, speaking generally of the cell-envelope of diatoms (p. 174), he reproaches me with having in my *Pleurosigma* researches insufficiently estimated the possibility that the connections between the two surfaces of the cell-wall are distinguished from the interspaces by the stronger refractive power due to the molecular constitution. Then he refers to the bast-cells which have similar sculpture, and as worthy of notice he mentions that with diatoms differences could not usually be due to water, but to silica-contents. I do not know Pfitzer's reason for this statement; I have fully explained (6, p. 474) that I have examined fresh specimens which had been boiled in nitric acid and in chlorate of potash, and further (p. 485) that through continued boiling the sculpture does not alter. In the latter case, surely nothing else but silicic acid remains; then what does he mean by making a difference by saying silica-contents? The transverse section of a boiled valve shows exactly the same walls as previously. It appears to me that my demonstration of closed cavities came to Pfitzer's notice at an inopportune moment, because in the same journal he brought forward his furrow theory which, as we have seen above, is wrong in every respect. Since *Pinnularia* seems to be the only diatom examined by Pfitzer by the section method, in order to discover its sculpture, he adopted it as the type of diatom sculpture, and when, soon afterwards, Müller proved real outer openings in *Triceratium* and tried to make useless corrections of my work, Pfitzer evidently believed that I had fallen into error, and that his so-called surface-sculpture was a property common to all diatom frustules, *Pleurosigma* included. In proof of this, one need only glance at Pfitzer's subsequent writings. Let me only draw attention to his latest (20), from which we might infer that it expounded to some extent the latest views on the subject. But about the structure of the cell-wall it contains nothing other than Pfitzer's furrow theory, and O. Müller's sculpture of *Triceratium*.

Another paper which we have to discuss is by Prof. Abbe: 'Beiträge zur Theorie des Mikroskops.' In this work (1, p. 450) it is demonstrated "that all the finer sculpture of an object, of which the elements are small and close enough to produce by their

proximity an observable diffraction phenomenon, are not imaged geometrically in the Microscope, that is to say, not as if the homofocal emergent pencils of rays from the object represented it point for point on one image-surface." From this he draws the conclusion (p. 453)—"all attempts to determine the sculpture of the finer diatom-valves by morphological interpretation of their microscopical images seem founded on inadmissible premises. Whether *Pleurosigma angulatum* has two or three systems of striæ or whether real striæ are there at all, or whether the observed markings are caused by isolated elevations or isolated depressions no Microscope can determine however perfect it may be or however strong its magnifying power." Further (p. 454)—"that the same condition of things exists very nearly for a great number of purely organic images in histological work, can be learnt by the example of striped muscular fibre. In good preparations the diffraction phenomena can be easily observed, and their effects in the microscopical image can be studied experimentally in the former-described manner. The manifold differences in the character of the image explain to some extent the disputes which have arisen between different investigators on this point; but at the same time they also establish the impossibility of stating anything definite about their real organic composition in the sense of the attempts made hitherto."

I am not aware whether Professor Abbe still clings to these views expressed in 1873, or whether he has since convinced himself of their error. From his publications which I have since occasionally seen, I believe he still holds to the former opinion. These theses figure as principal results in a journal of eminence, which must be read by everybody who wishes to keep an account of what he sees in his Microscope. Therefore I consider a refutation of these theses in this place a necessity.

Since the structure of muscular fibre and the differences amongst histologists of that date are put forward as examples of the correctness of the assertions, it may be well to bear in mind that the greater number of histologists have not adopted in their researches Prof. Abbe's views; and that now-a-days the complicated structure of the transversely striated muscle-fibre is nearly established. This is not only valid as regards the single layers composing the fibre, but also for the double-refraction of certain parts, of which Abbe also states (p. 453), it was futile to entertain the idea. I will not here enter into the full details how, at the commencement of the last decade, the confusion chiefly brought about by Heppner's wrong views about the muscle structure was dispelled by my work (8), based on the examination of an unusually favourable object, and I likewise demonstrated at the same time that with the application of good hardening methods one can

obtain similar results on other objects, but less distinctly. Shortly afterwards, the classical works of Engelmann, and more recently of Merkel, whilst confirming the complicated muscle structure and further by investigating the relations of the elementary particles before and after the contraction, have closed the question for some time to come.

If after this Prof. Abbe's objection against muscle sculpture in general is tacitly accepted as set aside, then, in view of the fact that among the numerous diatom investigators hardly one has seriously occupied himself with the structure of diatoms, it becomes all the more difficult to controvert Abbe's views since I am the only one to whom falls the task of doing so. I must not forget, however, that Dr. Altmann has every now and then vindicated my views against Abbe.*

It would lead too far away from our subject if I were here to enter on the merits of their differences; he who takes an interest therein should read Archiv für Anat., 1880, pp. 111 *et seq.* In our present discussion it is enough that all my results obtained hitherto are in direct contradiction to Abbe. Any one desirous of arriving at a definite opinion can inform himself by my diagrams and photographs, or by repeating my experiments. Suppose the student in microscopy investigates the sculpture of an object which is unknown to him, limiting himself to the surface-view only, say, for instance, the *Pleurosigma* valve, it is certain that he will be unable to solve various doubts, and in this I quite agree with Prof. Abbe; he will not be able to decide whether certain lines are raised or depressed, whether they are situated inside or outside; on this subject microscopical literature records the most unfruitful squabbles. But if the investigator examines the object by sections and makes casts of the surface, and makes use of the staining processes, &c., and finds, for example, exactly at the place of a previously doubtful line a projection, then it becomes immaterial to him whether the Microscope deceives us in the surface-view and gives images which do not correspond to reality. If the Microscope deceives us in one case, then it also does so in others. The change in the methods of investigation puts us in the position to find out the truth. As soon as the investigator takes the result obtained by all his methods and compares it with the surface-image, he will in most cases have answers to all his questions without being obliged to enter into the depths of the diffraction theory. I observed these maxims in my work on *Pleurosigma* sculpture, and I hold to them at the present day.

To this cannot be opposed the fact that one can obtain by artificial means images like diatom markings, and such diffraction-

* Personally I do not know Dr. Altmann, therefore I take this opportunity to tender him my best thanks.

spectra as diatoms produce, and that therefore the microscopical image is unreliable, and that for this reason no Microscope could clear up the true facts. The first portion of the sentence I admit, but the second I deny. That the half wave-length of light *in praxis* indicates the limit beyond which in 1869 no Microscope showed details, I had clearly demonstrated in my paper on the optical appearances in diatoms (5); the great honour of having proved theoretically the existence of this limit is due to Prof. Abbe. I had surmised conclusions on the results of my diffraction studies on the finer sculpture details, which I considered unreliable after having successfully used the section method. Several other objects furnish diffraction-spectra, although they are of totally different sculpture which we cannot bring into parallel with the diatoms: for instance, butterfly-scales,* and the skin of the Ascarides whose diffraction phenomena have been studied by Leuckart (12, vol. ii. p. 164). From the latter nobody can arrive at definite conclusions on the sculpture; but it would be wrong to assert that no Microscope in the world could elucidate it. Summing up we may say: the diffraction phenomena suggest only the existence of small particles of approximately equal size in layers, but they convey nothing as to their form or arrangement. The diffraction theory does not put a stop to the closer investigation of the sculpture of muscles, diatoms, &c., and Abbe's assertion that we could never arrive at anything reliable about this sculpture is unfounded and was practically refuted at the time he published it. With this I believe to have given sufficient courage to all timid students to continue their researches which otherwise would be without prospect as long as Abbe's opinion predominated.

The latest work by Prof. Strasburger (27, p. 143) treating of the sculpture of the cell-wall of diatoms, mentions me with the very unflattering sentence—"Flögel believed he had found out that the cell-wall contained chambers opening above as well as below." Then comes O. Müller who proves the opening with *Triceratium*. I may expect that Prof. Strasburger after reading my present work will alter his views considerably. Should I be disappointed therein the way would be open to him to investigate the matter himself personally, and I own that among all living botanists, I consider him to be the most able to assist in solving the question. Should he in such case also "believe" he has arrived at results slightly different from mine, I would request him before presenting the world with his results to try again a second and a third time with different weather, with other sections, and with other physical disposition personally, and then he will soon convince himself that his former "belief" was unbelief.

* About their finer sculpture I shall publish my investigations shortly in a zoological journal.

If in the preceding pages one or other essay on this subject, which has appeared during the last decade, has not been mentioned, I would ask indulgence on account of the seclusion of my place of residence; but I believe that no essential questions regarding the subject have been overlooked.

With this I conclude my work, and for the present, on account of other studies, I take leave of a subject to which I owe many pleasant hours of my lifetime. Whether the text-books of botany will take notice of the fruits of my investigation, or whether they will adhere to the old mistakes, may be left to the future. Up to the present I have only seen one work, the excellent synopsis of botany by Leunis, newly edited by Professor Frank, which gives a true account of the newest standpoint in these questions.

Only by constant and persevering work can we expect further progress; it cannot be done by the mere purchase of expensive immersion objectives. He who will only judge from a usurped high position; he who believes he can do something by setting up diffraction theories; he who looks upon diatoms as aggregations of crystals; he who believes he can decide upon all sculpture questions by observation of the surface; he may keep to his own errors, but he must not expect that I should answer his attacks which he has based upon such means in order to find fault with my work, however learned may be his phraseology. Considering my positive results, I must be excused in saying that I will not enter into discussion with such opponents. The literature of the last decade furnishes so many cases where persons who, after their own more or less special occupation with diatoms, look upon themselves as important microscopists, bring to light the greatest imaginable nonsense relating to sculpture questions. If I cannot indulge in the hope of putting a stop to this by my present work, it will no doubt contribute much for the intimate knowledge of these interesting organisms, and when in future the structure of these cell-walls is in question, the works of Pfitzer and Müller will not be exclusively referred to, but precedence will be given to an investigator who ten years ago put the leading facts into clear light.

Lastly, I have to thank those scientists who sent me their papers, also Herr Möller, of Wedel, for sending various material for investigation.

EXPLANATION OF PLATES.

All the figures have been drawn by the excellent 1/18-in. objective of Dr. Hugo Schröder. All are magnified 1550, unless otherwise stated. The variety in the amplification is due to the change of the eye-pieces and the alteration of the correction-adjustment. They are, with the exception of fig. 7, no flighty sketches, drawn after mere eye measurements, but all dimensions are based on micrometrical measurements.

Plate VIII.

Figs. 1–7.—*Pinnularia major.*

k a, chamber.
m e, median, *l e*, lateral } ends of the same.
k ö, entrance to the chamber.
m r, median, *l r*, lateral } edge of the opening.
m i, mid-rib.

Fig. 1.—Transverse section through a valve touching the chamber-openings somewhere in the line at 4 in photograph 1 (or perhaps nearer the central nodule).

Fig. 2.—Transverse section about the same place, line 5, in which is contained the vertical partition-wall between two chambers, the openings indistinct.

Fig. 3.—Middle portion of a similar transverse section to illustrate a very common appearance of the sloping away of the middle furrow. *s*, the closing envelope which in many cases is torn during cutting, whereby balsam enters into the cleft and produces the appearance of a continuous cleft through the entire membrane.

Fig. 4.—Transverse section touching the centre of the central nodule (line 3 in photograph 1).

Fig. 5.—Part of a longitudinal section touching the chamber openings, i. e. in the direction of the dotted line 1 in figs. 1 and 2, or photograph 1. *a f* outer surface, and *i f* inner surface of the cell-wall; *k w*, a vertical partition-wall between two chambers.

Fig. 6.—Portion of a longitudinal section along the side of the chamber openings, i. e. in the direction of the dotted line 2 in figs. 1 and 2, or photograph 1. The membrane on the inner surface is much stronger than that on the outer surface.

Fig. 7.—Diagrammatical figure of a collodion cast. *a*, a single T-shaped continuation in side view (as it becomes elucidated by the different focal positions). *b*, a group of the same, in perspective as seen from above. *z*, the smooth collodion surface. *c*, a piece of the serrated stripe which is formed along the chamber openings, and on which the T continuations stand like a row of trees. *x*, the collodion thread which was in the chamber. *y*, the spine of the same, which in consequence of the collodion contained in the opening contracts.

Fig. 8.—*Pinnularia* (*Navicula*) *Crabro.*

Transverse section from the middle of the valve. *k a*, chamber; *k ö*, opening of the same. *g b*, girdle-bands; the outer has in all sections the position figured; the second valve is wanting.

Figs. 9–12.—*Navicula Lyra.*

Three sections out of a series of 27 transverse sections through one valve.

Fig. 9.—Middle section (No. 13) touching the central nodule *m k*, which forms at that point a very flat thickening. *k a*, chambers.

Fig. 10.—Four sections further on (No. 17). *m r*, mid-rib. *l p*, lyra plates. *k a*, chambers.

Fig. 11.—Section near the end of a valve (No. 1).

Fig. 12.—Small portion of the surface-view of a valve of somewhat considerable size, corresponding to fig. 10.

Plate IX.

Figs. 13–20.—*Surirella biseriata.*

q l, transverse ribs.
m r, mid-rib.
f l, wing.
r r, marginal tube in the wing.

Figs. 13–19 × 830.

Fig. 13.—Transverse section No. 2
„ 14. „ „ „ 9
„ 15. „ „ „ 39
„ 16. „ „ „ 40
„ 17. „ „ „ 66
} through one and the same valve.

„ 18.—Portion of the longitudinal section No. 1
„ 19.—Longitudinal section „ 8
} through one and the same valve.

„ 20.—Portion of the section No. 8.

The longitudinal section, fig. 19, corresponds to the dotted line in the transverse sections figs. 15 and 16. In figs. 13, 15, and 16 the more faint contours indicate the outlines of the membrane with slight change of focus, corresponding to the undulations in fig. 19. The small continuation *f* at the edge of several transverse sections is probably due to the adhesion of the girdle-band.

The thick longitudinal section fig. 18 comprises nearly the entire wing; the fig. in consequence shows a portion of the wing in surface view. *a*, the places where both membranes of the fold cling together, corresponding to fig. 14 in transverse section. *b*, the folds, but not clinging together, i. e. the tubes which connect the cell-lumen with the continuous marginal tube, corresponding to fig. 15 transverse section.

Figs. 21–22.—*Triceratium Favus.*

Fig. 21.—One end of a section going nearly through the middle of a valve. *a f*, outer surface. *i f*, inner surface. *r l*, marginal ridge. *n*, portion where the section goes through the hexagonal prismatic chambers, consequently touching the chamber-openings *k ö*. *w*, portion of a section near the edge of a chamber, consequently the vertex shows a connection of the heads of the net-lines. *d*, spines in the angles between the hexagons. *g r*, basal membrane.

Fig. 22.—Similar section, touching the middle of one of the three protuberances.

Figs. 23–8.—*Coscinodiscus radiatus.*

Fig. 23.—Marginal portion of the middle section of a specimen at the moment of division (from the Norwegian coast). *g r'*, basal membrane of the original cell. *g r''*, basal membrane of the valve in process of formation. *g b*, the girdle-bands. *a b s*, the nodule of which mention is made in the text. *p r*, protoplasm.

Fig. 24.—Marginal portion of a middle section through an undivided specimen. The letters have the same signification as in fig. 23.

Fig. 25.—The first section from the series from which the preceding was taken; the girdle-band *g b* in surface view with the very small chambers of the margin *r k*.

Fig. 26.—Small portion of the surface view of a specimen (from the marl slate of Oran) focused to the plane indicated by line 1, fig. 23. *k ö*, chamber openings.

Fig. 27.—Similar portion with slightly lower focal adjustment, line 2, fig. 23.

Fig. 28.—Portion of a specimen from the edge with abnormally thick chamber-walls.

Fig. 29.—*Coscinodiscus oculus iridis.*

Small portion of a vertical section. *a f*, outer surface, *i f*, inner surface of the membrane.

Fig. 30.—*Coscinodiscus centralis.*

Portion of a section through a valve with unusually coarse marking. *a f*, outer surface; *i f*, inner surface.

Fig. 31.—*Coscinodiscus concinnus.*

Portion of a thin section; outer as well as inner surface can only be distinguished at the common curve (not figured).

Fig. 32.—*Eupodiscus argus.* (Omitted.)

Plates X. and XI.

Figs. 33–52.—*Achnanthes brevipes.*

m k, central node.
d s, dorsal valve.
v s, ventral valve.
r l, marginal ridge (*r l'* old, *r l''* young).
g b, girdle-band.
s z, marginal view of the same.

Fig. 33 × 670.—A chain consisting of two young frustules. The cell on the left is figured in full detail in the manner usually adopted in representing diatoms; i. e. by focusing as a whole. The cell on the right is naturally similarly conditioned. The transverse lines are only indicated, but for the central part the highest focus has been chosen for the representation; it brings to view the marginal striæ *s z'* of the old girdle-band. Further on towards the edge it is focused a little lower; then only are seen the very short dotted striæ *s z''* of the young girdle-band between the two marginal ridges. In the cell on the right, near one end, the young ridge has separated considerably more from the old one than at the other end. The numbers refer to the direction of the sections, figs. 40–2.

Fig. 34.—The upper edge of the preceding fig. under exact medium focus. The marginal ridge shows a saddle-shaped depression, the small elevation is the young ridge in process of splitting away from the old one. The depression between the two must be looked upon as the first visible indication of the young girdle-band. The old girdle-bands extend one over the other only in the direction *s*. The cells are without doubt completely closed. The girdle-band is raised at the marginal ridge slightly. Marking of the surface view given with the valves below.

Fig. 35 × 670.—A chain similar to the preceding, but a little older; the young marginal ridges *r l''* are further apart from the older *r l'*. Only the striæ of the young girdle-band *s z''* are represented.

Fig. 36.—The upper edge of the left cell in fig. 35, in order to bring to view the relation between the two marginal ridges and the doubly thick membrane between them.

Fig. 37 × 670.—An older cell, probably shortly before division. The peculiarly interrupted striated marking of the girdle bands is given. This is about the most complicated striation of all; between this and fig. 35 one finds all transitions. It seems as though the boxed-up girdle-band had already separated from its marginal ridge.

Fig. 38 × 670.—A dorsal valve and

Fig. 39 × 670.—A ventral valve viewed from the surface with full marking.

Fig. 40 × 660.—Transverse section No. 1,
„ 41 „ „ 5, and
„ 42 „ „ 15
out of a series of 23. They correspond to the dotted lines 1, 2, 3 in fig. 33 (naturally with the modification that we have here to do with a chain of three frustules). Fig. 40, extreme marginal section which has touched only one portion of the lowest cell. Fig. 41, the middle cell partially injured in cutting. Fig. 42, the uppermost cell crumbled out.

Fig. 43.—Transverse section No. 12 of the same series. The uppermost cell quite uninjured. Quite distinctly is here observable the difference in size between the old (*r l'*) and the young (*r l''*) marginal ridge; the hook shape of the former also visible. The valve membrane is distinctly dotted (as expression of the dots between the transverse lines in the surface image). *m r*, mid-ribs.

Fig. 44.—Portion of the same uppermost cell from the transverse section No. 9 of this series. The adjoining cell is split off whereby the duplex of the girdle-band becomes distinct, because in consequence of the fracture both membranes have separated; *g b'* the old, *g b''* the younger girdle-band.

Fig. 45.—Portion of the ventral valve of this uppermost cell to show the mid-rib *m r* and the surrounding fine spaces as in the sections Nos. 8 and 16 of the above series. The fine line *q* is the inner limit of one of the transverse striæ.

Fig. 46.—The dorsal valve of a cell with the cell-nucleus from the second transverse section series.

Fig. 47 × 660.—Longitudinal section through a ventral valve in the direction of line 4, fig. 33.

Fig. 48 × 660.—Longitudinal section through a dorsal valve in the direction of line 5, fig. 33.

Fig. 49 × 660.—Section quite through the girdle-band in the direction of line 6, fig. 33.

Fig. 50.—A portion of fig. 47,
„ 51.— „ „ 48,
„ 52.— „ „ 49,
highly magnified. *q*, the ridge-shaped transverse lines projecting inwards. *p*, the fine dots between them (? chambers).

Fig. 53.—*Synedra Gallionii.*

Any middle transverse section through a frustule.

EXPLANATION OF THE PHOTOGRAPHS DEPOSITED IN THE LIBRARY.

All photographs except No. 12 have been made by me personally without eye-piece according to the old method with wet plates. No touching up has been done to any of them. No faults in the negatives are specially mentioned, but they can easily be distinguished from the objects used in demonstration.

1. *Pinnularia major;* large specimen in balsam; a little more than half a valve. Produced by Schröder's immersion 1/18 in.; × 631.

The lines on the tracing paper covering the photographs which can be connected by a ruler, indicate the direction of the sections in the space between *a* and *b*:—

1	is the direction of the	longitudinal section	fig 5, photograph 3.
2	„	„	6, and portion of photograph 2.
3	„	transverse section	4.
4	„	„	1.
5	„	„	2.
6	„	oblique section, photograph 7.	
7	„	transverse section of the valve *m* in photograph 6.	

On the right-hand side the chamber openings are distinctly seen; in making line *m r* the median edges of these edges are touched; in the same manner *l r* will touch the lateral edges. On the left and in other places on the valve the focus is not so good, although both edges glimmer everywhere.

From *c* to *d* is the region where presumably the mid-rib shows the depression almost at right angles on the transverse section (fig. 3). From *c* to the end-nodule *e*, and from *d* to the line 7, the mid-rib is simply a vertical incision (fig. 1). *f*, irregularly formed chambers on the right; the walls are here black and vanish at the lateral end.

2. *Pinnularia major.* A coarser longitudinal section through two valves lying one in the other. Like all other following sections, so here the section is imbedded in gum, the entire gum-chip surrounded by balsam. Position and magnification as in 1. The focus from *a* to *b* is the best; one sees in the valve on the right the transverse sections of the chambers with the inner membrane which closes the chambers; the section direction is approximately the same as with line 2, photograph 1. In the valve on the left the openings are seen, but in consequence of the great thickness of the section the oblique ridge-shaped vertical chamber-walls glimmer and disturb the image, and which only becomes quite intelligible by photographs 3 and 7. In the lower part is a zigzag-shaped cleft *r* through the gum-chip; there the section is very thick and the focus unsuitable. This will convince us what errors can arise with a coarse object through mistakes in focus and cutting, and which in a less degree occur with finer objects like *Pleurosigma.* The valve on the right has lost the outer membrane, which has apparently stuck on the gum on the right; the vertical chamber-walls are therefore torn off at the point of connection with this outer wall, and the

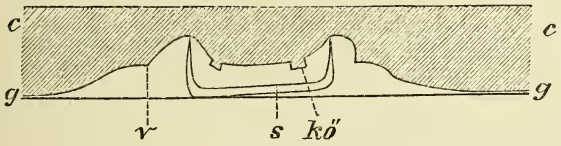
chambers erroneously suggest an outer opening. In the left valve these vertical chamber-walls appear on the inner side serrated (naturally, with both, the inner surface is on the left); this also is an optical delusion. In both valves the very dark walls are much thicker and more clearly expressed than in a reliable image; but the lumen of the chambers is reduced and strongly rounded off (also wrong!). The connection between the vertical walls with outer and inner membrane appears therefore like a thick nodule; whilst with good sections little can be traced of such end thickenings.

3. *Pinnularia major.* Extremely thin longitudinal section exactly through the chamber-openings, focus and magnification as in 1. This is probably the best section in my collection, and can be recommended for all finer measurements. The best focus is from *a* to *b*; less good from *b* to *c*. The section direction runs in the line 1, photograph 1. One sees (best with the help of a lens) the club-like thickening of the chamber-walls; one can measure the thickness of the outer membrane, &c. The inner surface is on the right, proved by the bend in the section. On the left is a surface section of another valve.

4. *Pinnularia major.* Collodion impression of the outer surface of a valve, in air. Produced by Schröder's dry 1/6, × 298. The strongly black marginal line is the expression of an elevation in the collodion originating in the same manner as we shall see when we come to photograph 5. The mid-rib is distinctly seen; it is a delicate ridge, corresponding to the cleft in the valve, and ends at the central nodule with a stronger point. The smooth space on both sides of the mid-rib slopes, beginning at that portion of the surface where the chambers are situated in the valve, and is there slightly different; this difference probably originates by a change in the evaporation processes. Starting from the upper corner on the right we observe on the cast a chain of numerous small crystals of unknown origin (on the preparation itself). The lines on the left are Newton's rings in the thin collodion film. All other dotting is the granulation of the collodion surface.

5. *Pinnularia major.* Collodion impression of the inner surface of a valve. Produced as No. 4, same magnification. With regard to the general sketch of the valve the following is to be observed:—If in making a collodion cast of a valve (shown in fig. 119 as *s*) lying with its surface towards the slide (*g*), the fluid

Fig. 119.



naturally fills up at first all the inner spaces. In hardening the mass contracts, and occupies afterwards as a solid film the shaded space *c* in the image. The quantity that originally entered into the angle between valve and glass thins away and appears as projection *v*; this accounts for the remarkable enlargement of the outline in the cast in comparison with that of the valve. Next to the so-formed dark surrounding edge follows an inner portion partly lighter, partly darker, and often interrupted. This is the depressed furrow in which lay the extreme edge of the valve (*vide* photograph 6), and had been so squeezed into the collodion that during the separation from the valve many small fragments of this sculptureless edge remained behind in the furrow. On the surface one observes the impression of the central nodule, and further two longitudinal lines. These represent the collodion which ran into the chambers (*vide* text), and are raised ribs (*k ö* in the fig). In several places are seen the threads described in the text. A part of this longitudinal line is drawn in fig. 7; *conf.* their description. (These raised ribs I have sometimes seen on casts of extremely small undefined *Pinnularia*; one would otherwise only look for them in *Navicula*. The real details can only be learnt from large varieties.) On the left of the cast a large air-bubble had been enclosed in the collodion; near its centre we observe the granulation, elsewhere so distinct, decrease, which circumstance I have made use of for the explanation of the faint granulation

above the chambers on photograph 4. In the centre of the bubble Newton's rings. The *Stauroneis* valve lying at the side is not free from the collodion.

6. *Pinnularia major.* A number of exact transverse sections. Produced like No. 1, × 647. The section made after method I. is of exquisite thinness and flatness. It was photographed a few days after being made, therefore the little air-bubbles which ought to be formed in the chambers during the hardening of the gum are visible, whilst with other sections kept for some time they have been mostly absorbed by the balsam. Altogether transverse sections of twenty valves can be seen, and they are lettered A to U. Of A and B only portions are seen, but the others are entire.

The focus on the left not very good; on the right chamber opening very fine; at the lateral edge of the same an oval air-bubble in the chamber.

D, focus in the left not suitable; on the right median end of the chamber, and median edge of its opening fairly good; in the extreme lateral end of the chamber an air-bubble.

E, similar section to M, but broken in the middle line; on the left median end of the chamber pretty good.

F, broken up and useless.

G, a tolerably good transverse section, a little broken up; chambers indistinct; mid-rib good; has the angle-depression of fig. 3.

H, only good above; shows the fine pointing of the valve margin very sharp; in it several air-bubbles; lower down, broken up.

I, quite similar.

K, very beautiful section; chamber opening on the left is good, but not so distinct on the right; mid-rib is observable as a delicate cleft not quite through.

L, similar section, mid-rib burst; on the left, chamber and its opening very fine; a few air-bubbles in the lateral end do not interfere much.

M, one of the most magnificent sections, quite close to the central nodule (corresponding to the line 7 in photograph 1). The mid-rib is here an unusually deep vertical narrow cleft; one sees the closing envelope very distinctly (with a lens); chamber of the upper half good, that of the lower indistinct, because only the partition-walls remain (like fig. 2).

N, only the lower good, crushed at the top.

O, central nodule section, hardly of use.

P, useless.

Q, apparently central nodule section, but injured; focus unsuitable.

R, focus unsuitable; the chambers can be recognized in outline.

S, particularly beautiful, showing the mid-rib as a right-angled bent cleft, like fig. 2; the chambers are tolerably good in the upper half.

T, chamber of the upper half very good, also its narrowed lateral end; the mid-rib is broken, and the lower half useless.

U, good section, but the focus not sharp; both chambers visible.

The section encloses a girdle-band section.

7. *Pinnularia major.* Slightly oblique longitudinal section, produced like No. 1, × 650. This is another most elegant section in the direction of line 6 in photograph 1, and represents the end portion from line 4 to *f*. This, like photograph 3, is very suitable for all finer measurements under the lens. The following are chiefly remarkable:—In the region *a* the vertical division-walls thickened below between the chambers; the openings of the chambers; the very thin outer membrane. At the point *b* the lateral edge of a chamber opening is touched, and there appears in great strength the inner membrane (closing the chamber below). At *c*, is a favourable image of a chamber lumen: the thin outer membrane, the more than twice as thick inner membrane, rounding off of the square transverse section of the lumen at the inner membrane.

8. *Eupodiscus argus.* Middle section through a valve. Produced with Schröder's 1/6 dry objective, × 298. On the left is observed the inner cavity in which is an air-bubble at the end. In the middle region is a faint indication of vertical chamber-walls. Spine-like points are observable on the lower outer surface of the valve, similar to *Triceratium* spines.

9 and 10. *Pleurosigma balticum.* Transverse sections, produced like 1, × 669. The section is made after method I. (in pure gum in collodion), and was photo-

graphed a few weeks after. It is No. 76 out of 150 transverse sections. Through a number of 14–16 frustules, partly parallel, partly one on the other. Image 9 was taken with somewhat higher focus, and image 10 with lower focus; the difference is naturally very insignificant. For the examination of these two images and of photograph 11 a lens should be used. For the representation of the sculpture my former description of the transverse sections of *P. balticum* should be referred to (6, pp. 481–5, figs. 13, 14 and 15). The separate frustules are marked A–L. For the comprehension of the arrangement of the frustules in comparison with photograph 11, we must observe that only the *Pleurosigma* A to D are in the original position, that the gum section on the right of D on account of extreme thinness is broken off, and that this broken-off and still further broken-up portion has fallen obliquely across the other portion which remained intact. The thinness of the gum-chip in this instance can be best estimated by noting that hardly any trace of the collodion limit lines can be seen (*vide* photograph 11), which must have existed below B and D. About the separate sections the following is to be observed:—

A, very thick section, kidney-shaped within. The left valve is broken in the middle, only the one half is seen. The right valve is broken up, but both the chief and secondary ribs, with a portion of thin membrane attached to the former distinctly visible; the chambers slightly indicated.

B, a slightly thinner section, strongly notched within. The left valve twice fractured; the right valve quite uninjured; only well focused in image 10; the thin membrane-stria next to the mid-rib very beautiful; slight indication of chambers; the girdle-band at the top is in normal position, below out of place, in photograph 10 clearly duplex.

C, section thinner than B. Content wanting. The upper valve uninjured. Best focus in photograph 9; indication of chambers very good, particularly in the left half; a depressed furrow beside the mid-rib good, also the secondary rib. The lower valve is broken in the thin portion, although both halves are not much displaced. Focus in both images not exact. The left girdle-band is injured; on the right clearly duplex; both still adhere to their original valve, although slightly displaced one towards the other.

D, this magnificent central nodule section, which forms the chief object of representation, and is rendered on a larger scale in photograph 12, I shall describe further on.

E, injured section, only the lower valve good. The content adheres to the girdle-band. On the left a few fragments of valve transverse sections.

F, a much injured section. The upper valve broken in two pieces, but the fracture is not in the thin membrane stria; the half lying a little higher shows in photograph 10 very good indications of chambers; the lower half to which is attached the content is not so good; tolerable in photograph 9. The lower valve broken up; the girdle-band has got out of place.

G, imperfect section, which very clearly proves what kinds of deception can take place in researches not conducted critically. In the half-valve on the right at the top one sees in photograph 9, without much trouble, the outlines of a base membrane, with ridge elevations noded at the ends. A little more imagination will add outer openings of the chambers. Photograph 10 destroys all these illusions, and proves at the same time that this section is much too thick for such studies; it is almost exactly the reduced copy of *Pinnularia*, photograph 2 at *r* (*vide supra*).

11. *Pleurosigma balticum.* Everything like 9 and 10, except the transverse section No. 80 out of the same series (Nos. 77–8–9 were useless fragments cut through totally different portions of the bundle). This image chiefly serves to show that by using my section method the separate frustules can be identified from section to section, whereby real series of sections can be obtained. A to D can be easily recognized by comparing with images 9 and 10. Below B D E run two slightly bent parallel lines through the field of view; these form the limit of the transversely cut delicate collodion film on which the arrangement of the *Pleurosigma* took place. On the right of E the section is broken off and another gum-chip has fallen obliquely on it; the frustule sections H and I therefore lie one upon the other. For the separate sections the following remarks may be serviceable:—

A, very thick and useless, in some places indications of chambers.

B, scarcely better; the right valve has possibly a useful thinness, but is not distinct.

C, has in the upper valve the deceptive image described above with G.

D, the focus is tolerably good only for the lower valve, where at the same time is visible how the image of the central nodule transverse section passes over into the ordinary transverse section image.

E, F, G, focus entirely wrong.

H, shows specially the asymmetry of the secondary rib, exactly as I have described above (fig. 13). Indication of chambers in some places good.

I, indistinct.

K and L, two fragments of valve sections, the former showing the chambers very well.

12. *Pleurosigma balticum.* The frustule D from the photograph 10. Enlarged from the negative by means of the ordinary portrait objective. Total magnification, 2340. The image has been made, fearing that the delicacies of the negative during the printing would suffer considerably, and further to facilitate measurements. The valve *a'* is uninjured throughout, and gives an unblemished picture of the central nodule. The chambers disappear to the eye at some distance from the centre. Instead of the usual membrane-thinning commencing with mid-rib and secondary rib, the wall remains solid throughout (*b'*), but has two very small projections inwards (*c'*), between which is a slight depression. The chamber-walls are here distinct, the cavities dark; the focus of photograph 9 is for this valve more advantageous. The valve *a''* is uninjured in the lower half, but the two projections *c''* of the central nodule are still visible; evidently here has been the extreme fine edge of the section. By comparing photograph 9 with it one detects faint traces of this lower half-valve, which we find again indicated in photograph 12. From the preceding we deduce that this section of the upper half-valve is sufficiently thin for the minutest investigations. The chambers are seen in full clearness and in such accordance with my former diagrams as if this preparation had served for them as model. The girdle-band *g b'* is not quite distinct, in consequence of being crumbled; the other *g b''* partly covered by the section of the frustule E.

I have formerly given the greatest thickness of the cell-wall as $1{\cdot}8\,\mu$. Considering what is clear in the valve *a'* and what is dark in *a''*, and that one must not reckon in *a'* the dark seam beyond the clear space, we get in this photograph the greatest thickness of the wall near the central nodule as 4·2 mm., consequently the true thickness is $\frac{4{\cdot}2}{2340} = 1{\cdot}8\,\mu$. The height of a chamber lumen may be estimated at 1/3 of this size; therefore these are all valves not beyond the power of microscopical observation.

Valve E *a* belongs to frustule E, also the girdle-band E *g b* and the contained portion E *i*. In the former is seen the indication of chambers tolerably well; the same may be seen in the valve fragment lying on the left.

13 and 14. *Triceratium Favus.* Section No. 11 from a series of 19 vertical sections through a valve. Fig. 13 with high focusing; fig. 14 with low focusing. Produced with Seibert and Krafft's immersion VII. *b*; × 652. The inner surface of the valve is turned downwards.

15 and 16. *Coscinodiscus radiatus.* Middle section from a series of 31 vertical sections through a specimen in process of division. Produced like No. 1; × 660. Fig. 15, for the greater part of the section correct focus, especially reliable in the centre and a little lower. Here are the T-figures of the chamber-walls distinct, also the four base-membranes. Of less use is the lower end, although pretty distinct. For the upper end the focus is unsuitable. Image 16, gives the correct focus for the upper end, but not so well for the lower end; the middle is quite unreliable. At both ends is seen the overlapping of the thick girdle-bands.

17. *Triceratium Favus.* Thin but not quite plane section. Produced like 1; × 680. The section direction is not exactly through the middle of the hexagons, therefore every pair of chamber-walls are brought closer and connected on the outer surface (on the left), and thus between each pair there is a slightly larger

space (*a*); here the outer entrance-opening is touched (*b*). The section is only thin enough and focused correctly at *a*. Below, near the marginal portion, another piece of diatom lying by accident on the valve has been touched.

18. *Surirella biseriata.* Collodion cast in air. Production and magnification like photograph 4; it is the cast of the inner surface of a valve. The deep black edge is a raised collodion ridge, which is formed on the outer side of the wing as described above with *Pinnularia.* The distinct border next to it is a deep brown of the collodion; in it must have been the valve edge (figs. 13–17). The dark ribs on the surface are raised places, i. e. wave-elevations, the clearer inner spaces are depressions. At the lateral end of each wave-elevation, not far from the distinct marginal line, is a dark dot. In the cast is a vertical projection; these thorn-like spines naturally are the contracted outlets of the channels. In the mid-rib a stria of the valve has remained behind. Collodion surface remarkably smooth.

19 and 20. *Isthmia enervis.* Two successive sections. Production as in 1; × 633. The one section must be adjusted to the other like a mirror image. The separate sections are A, B, C. The situation of the cells in the gum has unfortunately not been figured before cutting, and it is now almost impossible to define them; but so much is certain, a few sections further on A and B coalesce, consequently both belong to one cell, whilst C is a second cell, apparently touched nearly transversely. B is therefore, as its small extent teaches, doubtless a section through the extended end of the rhomboidal cell, either through a free corner or more probably through the isthmus proper. This is here important. 19 is a very thick, 20 is a very thin, section in which the isthmus section is a little injured; the section of the cell C is flapped over at the top or pushed together. In both sections one sees in the ring B on the inner side ridge-projections, which are the cause of the well-defined cell-marking. Had I given this with only one section, some severe critic might have retorted that the ridges might be on the outer side, and that the apparent inner projections were obliquely struck in projecting marginal portions. Such like opposition is refuted by the image of the second section. Designating here the projections, for example, 1, 2, 3, &c., one will find that all fit exactly one to another except that, instead of No. 3, photograph 20, we see two projections standing close together in photograph 19, evidently because here in the first instance an areola corner was touched. This comparison proves further, that the membrane was touched exactly vertically by the section on the right side in photograph 19 (or on the left in photograph 20), but on the opposite side obliquely. The more reliable thinner section 20 proves undoubtedly the turning-in of the ridges and the outer smoothness of the membrane.

The section through the cell C is by far too thick for the study of the sculpture. In section A are found a few places in photograph 19 (just below the middle), where it has the required thinness for the observation of the very thin ridges on the outer side of the membrane. Judging from the numerous examples of these images in other sections I can only declare it to be the girdle-band.

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XVII.—*On Drawing Prisms.*

By J. Anthony, M.D. Cantab., F.R.C.P., F.R.M.S.

(*Read* 11*th June*, 1884.)

When the scientist is investigating matters of special interest by means of the Microscope, he naturally wishes to record pictorially what he sees, and particularly if the objects under examination should chance to be of a perishable nature. If he has not undergone some sort of artistic training, his efforts with the pencil will generally fail lamentably to convey an idea of what he sees in the Microscope; his drawing will probably be utterly wanting in "character," and his outlines poor and uncertain—shortcomings which he will probably try to make up for by a painful elaboration of detail. This is not altogether a fancy picture. A man may have a most intense and learned appreciation of what the Microscope reveals to him, and yet be utterly unable to make a reliable sketch, much less a picture. It is under such circumstances that inventive brains have been stimulated to devise appliances which, placed upon the eye-piece of a Microscope, should, by well-known laws, project the Microscopic image on to a blank sheet of paper in front of the observer, who would be enabled to trace with the point of a pencil the outlines and salient points of the shadowy microscopic image.

This is, of course, a very rude description of the general action of all the mechanical aids to drawing from the Microscope, but further on we shall see that special means have been devised to attain special ends.

Three questions have repeatedly been put to me.

1. What is the special advantage of using a drawing prism?
2. Does it require a knowledge of drawing to use it?
3. What form of prism will be the best to employ?

The answer to the first question is easy. The employment of a prism means an enormous saving of time, and not only that, but used with simple precautions, it means the power of delineating with almost rigid accuracy the outline of all objects seen in the Microscope. And this is not all the advantage, for an absolutely identical magnification can be insured in every successive drawing by simply marking on the Microscope a fixed observing or sketching angle, and by using for successive sketches the same objective and same ocular duly armed with the prism. As each drawing is completed, a simple substitution of a micrometer on the stage of the Microscope allows a "scale" to be projected on to the drawing, or on the side of it, which may be thus said to have received its official stamp.

To reply to the second question:—Most assuredly no special knowledge of drawing is needed for making accurate outlines with the aid of a prism; little more than the first lesson in free-hand drawing is required, viz. the power of tracing lines with firmness and certainty of touch.

The third question, as to the best form of prism, will be met by a short review of the various forms of drawing appliances from the days of Wollaston, who devised a prism which in many of its qualities has never been surpassed. In making such a review this evening, as I shall have to "name names," it need hardly be said I shall strive to keep within the bounds of fair criticism, and especially to eschew invidious comparisons. Time would not allow me to go into the optical construction of the various appliances which I shall have to bring before your notice; all these particulars can be learned from the back numbers of our Journal. I prefer to take these little adjuncts to the Microscope just as they were supplied to me by their more or less sanguine inventors, and to narrate what they have respectively done in my hands, premising a hope that as I have had one or the other in pretty constant use for some forty years, a description of their performances will neither be unwelcome nor unprofitable to the practical microscopist.

In illustration of the remarks I have to make, and as showing the various applications and "all round" character of the drawing prism—and particularly in its more recent forms, I venture to exhibit selections from among the thousands of drawings I have made, choosing those which may be said to be typical of the uses of the prism.

The subjects are, as you will see, of all sorts, but having this in common, that they were all drawn under the Microscope; all outlined by the prism. When you see copies from photographs, from book-illustrations, magnifications of the exquisite engravings in Yarrell's 'British Birds,' and Bell's 'Reptiles'—such as the venomous and non-venomous snake—and proceed from these low-power magnifications through the whole range up to the delineations of living diatoms as seen with my grand Tolles 1/25 objective, I think you will feel an incipient respect for the use of the little instrument, the use of which I advocate. Just let me call attention to the important fact, that in each rapidly executed copy of an engraving, every mark of the graver's tool has been indicated at one operation by pen and ink while still under the Microscope; and in mere outlines of microscopic objects—whether executed with pen or pencil, all have been purposely left as they were traced under the instrument; or to use other words familiar to drawing academies, they have not been "touched up."

As an example of the satisfactory character of this untouched outline, I hand round copies of the well-known *Pleurosigma*

angulatum, as executed with various prisms, the sketch of each having occupied as nearly as possible half a minute! Those who have sketched *P. angulatum* will be conscious that several minutes are generally needed to get the peculiar curves of this diatom satisfactorily. Here are many outlines made in succession of this same lorica, to show how identical they all are in character. The large drawing or diagram of some well-known forms of diatoms is a *tour de force*, and here the effect would be better, or easier got, by copying some moderate-sized prism outlines, by means of the pantograph; but the drawing as it stands really was executed under the Microscope; the paper was laid on the ground with a bright light thrown upon it, the Microscope was well raised over the edge of the table. The image—enormously amplified—got from a 1/6 objective, was projected by the prism, and was traced upon the paper by the aid of a pencil; which pencil might be said to be some 5 feet long, inasmuch as it was formed by a crayon tied firmly on a joint of a fishing-rod. That the outline so traced was a bit "shaky," and needed "mending" may well be imagined, but the reparation has, I think, not been made at the expense of the characteristic curves of the various diatoms. I am sure the relative size of each may be depended on, though I must own to depicting the largest and boldest specimen of *P. angulatum* I could lay my hands on.

After this much of preamble, permit me to name the various forms of drawing appliances or prisms from which to make a selection; all of them have some merit, and some of them, as I trust I shall be able to show, are pre-eminently useful. First come "steel disk" or "neutral-tint" glass reflectors; then prisms proper, by Wollaston, Gundlach, Beck, Oberhauser, Zeiss, Nobert, Abbe, Nachet, and Schröder. They may be classed thus, Wollaston, steel disk, and glass reflector can only be used when the Microscope is placed horizontally—a position which is always a more or less cramped one for the observer, and which is all but impossible to adopt in connection with dissections, and indeed with most objects mounted in fluid and more or less free to move in the cells. The prisms of Beck, Gundlach, Zeiss, and Schröder are available when the Microscope is set at the usual observing angle. The prisms of Oberhauser, Nobert, Abbe, and Nachet can only be employed when the Microscope is placed in a vertical position; the image is projected a few inches to the right-hand side of the Microscope, and falls on a sheet of paper fixed to a 2 ft. drawing board, so that the point of a pencil, which is held in the right hand, is in a convenient position to trace the outline of the projected image.

I will now proceed to describe the special qualities which some of these prisms have as adapting them for particular purposes.

The "reflectors" and the "Gundlach" will be found in use to "invert the image"; this inversion is very troublesome, and if not well understood, and met with certain devices, is apt to lead the draughtsman into endless confusion. In practice when you use one of these inverters you are compelled to sketch from the one side of a slide of objects, and to fill in detail from the other, and as a clever writer has pointed out with respect to this arrangement, "the back and the front of an object are not always alike."

The image got by a Wollaston prism is so excellent that this instrument would always be used, were it not that the setting of the Microscope in a horizontal position, the re-arrangement of the light, &c., the dependent position of the eye while drawing, the more or less cramped position, and other difficulties with respect to the slipping of fluid preparations oblige one to employ more convenient though perhaps in other respects less satisfactory appliances. Of the prisms used at the ordinary observing angle of the Microscope, Gundlach's, as I said, inverts the image, and I am sorry to say that the Zeiss prism, though it is quite satisfactory in my hands, in most respects, projects the image so far forward as almost to come upon the stand of the Microscope, and so practically cramps the position of the drawing paper or board; I therefore seldom use it. I like the Beck prism, and I make perhaps more use of it than of any other, as the light transmitted, the field, and the sight of the pencil are all satisfactory.

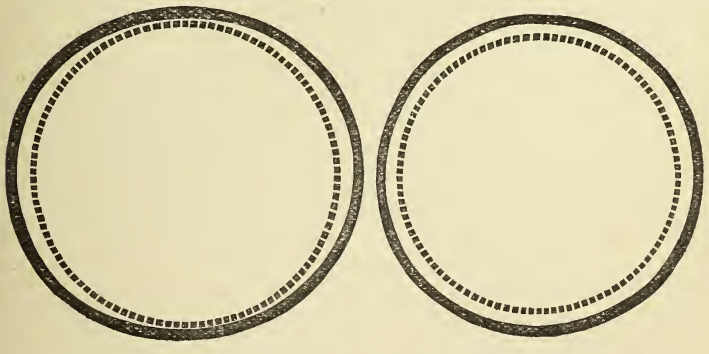
The Schröder prism just invented has several points of excellence, which will win appreciation. It shares with the Wollaston the rare quality that the pencil is seen with equal distinctness in all parts of the field, and that there is no apparent change in the position of the point of the pencil from involuntary oscillation of the head of the draughtsman. I am only sorry to be obliged to say, that I find the usefulness of this neat little instrument is much limited by the very small amount of light it transmits from the object under the Microscope; entailing the condensation of such a body of light by "racking up," when anything like a high power objective is used, as rather to strain the vision and make anything like detail too much a matter of guess. I am encouraged to hope that this condition may be susceptible of modification, and in such case the Schröder prism would not leave much to be desired.

I may just say, that while not appreciating the Abbe prism used for the purpose for which it was constructed, I recognize a most valuable quality which it possesses, for copying drawings and engravings of small area, either of the size of the original or with a slight magnification at will. I think I can see a considerable future for this prism in certain branches of the fine arts.

For the Microscope placed vertically, I will only call attention to one drawing appliance, viz. the "Nachet hooded prism," which you will see I have placed on the ocular of a Microscope in the usual position for sketching. Looking through this prism the image in the Microscope will be seen projected some 5 in. on to the drawing-board placed on the right-hand side. As a prism this has all the advantages and the faults of the class to which it belongs; a very prominent fault being the all but total loss of sight of the image of the pencil when an attempt is made to follow the outline of an object seen between the centre and the outside edge of the field of view—calling the outside that which is apparently farthest away from the microscope-body.

If the drawing-board is placed flat upon the table, you will find that your drawing so made by the Nachet will be much distorted. A good article in our Journal* set me off to experiment on this distortion, and how to get rid of it. I show the satisfactory results arrived at. The boy's head—a cutting from 'Punch'—has been copied twice, in the left-hand picture the drawing-board was flat upon the table. The eye will detect the distortion in a moment, in the head being far too deep from front to back. The right-hand image—taken with the board raised 2 in. at its right-hand end—shows not a trace of distortion. Here is a still more severe test: these (fig. 120) are copies of the circles in Möller's smaller

Fig. 120.

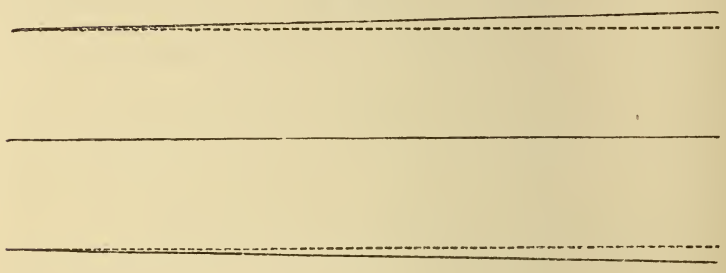


"typenplatte" under the same conditions as to position of drawing-board. The right-hand picture is shown by the dotted circle struck by the compasses to have lost the distortion, which is painfully evident in the one on the left-hand side.

* Vol. III. (1883) p. 560.

In this drawing (fig. 121) of the lines of a fine stage-micrometer, with drawing-board horizontal and inclined, all appreciable

Fig. 121.



distortion has been got rid of by the simple device of raising the right-hand extremity of the drawing-board. Well, this distortion being eliminated, and the loss of sight of the pencil under certain conditions condoned, we must recognize this prism of Nachet as being exceedingly useful and convenient in practice, it being so hinged upon the collar which clasps the ocular, that the optical part can be thrown back like a hood, so as to give a clear view of detail through the ocular only, and the prism can be tilted forward again at will to resume the sketching of outlines with no fear of loss of coincidence with its former position. A tinted glass which can be interposed between the object and pencil respectively, helps to make the Nachet hooded prism a great favourite of mine.

Speaking of this "light-moderator" brings me to the point that one of the great secrets of success in prism drawing from the Microscope is the equalization or balancing of light from object and pencil. The best effect by far is got by two lamps. Where light from the paper is too glaring, as will often happen with the Schröder prism used in daylight, the half-shadow of a curtain allowed to fall upon the paper conduces wonderfully to ease in sketching. I have intimated that with the Schröder prism you may move your head as much as you like, but not so with the other little optical appliances, and this keeping the head steady is as difficult as it is wearisome. Failing an appliance something like a photographer's "head-rest," let me suggest a substitute in a microscope-box, in the position that the left elbow can rest upon it, when the outspread thumb and fingers placed against the forehead will be found to keep the head of the draughtsman fairly steady. A small black velvet curtain, so hung as to touch the microscope-tube just below the ocular, will be found to aid materially in distinctness by cutting off diffused light. You want to see all you can of your object, but make up your mind you will never see

anything like the amount of detail through a prism which you do through the unarmed ocular.

My conviction then is, that the prism has done very much—and indeed all it can do—in enabling you to get rapidly and correctly as a sketch the outlines and salient points of your object under examination, to which your more or less artistic eye will have to supply the detail.

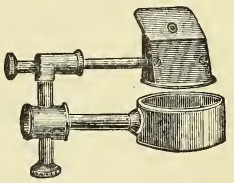
Now to sum up the evidence for the most useful forms of prism:—

At the usual observing angle of the Microscope, and when the object is fairly transparent, Beck or Schröder will do good work, but where there is opacity, then Gundlach is to be preferred, in spite of its inverting the image.

When the Microscope can be placed horizontally, and the objects are suitable, Wollaston's prism gives results of pre-eminent beauty.

With the Microscope vertical, Nachet's hooded prism, I think, stands alone for making copies of almost all objects susceptible of magnification, and it is especially good when dissections are made under the Microscope by aid of an "erector," as the convenient tilting backwards and forwards of the prism allows outlines to be traced, and then dissection to be resumed with the most charming facility.

Fig. 122.



This review of prisms has been a mere outline, but it has taken up all the time I could venture to occupy. While striving to criticize fairly, and placing most stress upon practical points, I have ventured to show what a long and assiduous use of the prism has effected in my hands: permit me to end with the hope that it may do still more in yours.

N.B.—Fig. 122 is a woodcut of the Beck prism, which I believe has not previously been figured.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Embryology of the Sheep.† —Dr. R. Bonnet has investigated the earlier stages of development in the sheep embryo.

His positive results commence from the twelfth day after impregnation. Embryos of this age showed round, uniformly bilamellar, germinal vesicles, with a round, bilamellar, embryonic disk of about ·25 mm. in diameter. The epiblast of the disk consisted of two or three layers of cylindrical cells continuous with the flattened ectoblast of the vesicle. The entoblast formed a single distinct layer of cells, distinguishable into two classes, according to position, viz.:—

1. Ovoid cells, beneath the disk.
2. Flat cells, forming a retiform membrane, lining the vesicle generally.

The ovoid cells form "the entoblast of the (future) digestive tract," the flat peripheral cells "the entoblast of the yolk-sac."

On the thirteenth day there appears in the vesicle, peripherally to the disk, a formation of mesoblast in the vesicle. No trace of such a mesoblastic growth is found at this stage in the disk.

Within the disk, mesoblast is formed a little later in a twofold manner. Beneath what eventually is the primitive groove there is formed an ectoblastic "thickening" (*Knoten*). From this is developed the "central" or "ectoblastogenous" mesoblast, which remains in direct and intimate connection with the ectoblast axially. The "peripheral" or "entoblastogenous" mesoblast arises as a peripheral,

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Arch. f. Anat. u. Physiol. (Anat. Abtheil.) 1884, pp. 170–230 (3 pls.).

lenticular thickening of the entoblast of the digestive tract, and its cells wander or are thrust in, centripetally, to meet the centrifugal growth of the ectoblastogenous mesoblast. Very soon, however, the production of entoblastogenous mesoblast is observed to take place, not merely at the periphery, but over the whole surface of the entoblast of the digestive tract. Dr. Bonnet concludes that the cells of the mesoblast are to be regarded as mesenchyma in the sense of the Hertwigs.

The primitive thickening of the ectoblast grows caudally to form the primitive streak, whilst the primitive concavity which is hollowed out in it elongates caudally in a similar manner to form the primitive groove.

By the fourteenth day there is a cranial process of the primitive streak, the first "rudiment of the ectoblastogenous chorda."

The formation of the cœlom in the sheep commences peripherally from the disk in the outlying tract of mesoblast, and progresses centrifugally, its proximal limit being formed by the very distinct mesoblast-forming border of the entoblast of the digestive tract, now underlying the growing disk.

The author has found a canal piercing the cranial process of the primitive streak, and placing in (temporary) communication (1) the surface of the epiblastic thickening from which the neural canal is later formed, and (2) the digestive cavity. This canal he identifies with Balfour's neurenteric canal.

The first beginning of the blood-vessels was discovered in the proximal region of the cœlom, external to the embryo, and was seen to arise contemporaneously in both layers of the mesoblast at this point, developing centrifugally at a later period. As both layers of mesoblast are, according to Dr. Bonnet, entoblastic, arising in the first instance at the border of the entoblast of the digestive tract, there is proof of the "indirectly entoblastic origin of the rudiments of the blood-vessels."

Dr. Bonnet promises a further paper on the further development of the sheep's embryo.

Development of the Generative Organs.*—O. Cadiat has an important memoir on the development of the generative organs in the embryos of the sheep and of man. The results are as follows:—

The internal always appear before the external generative structures. The cloacal cavity, which is formed early, commences to divide in embryos of 8 mm. long into an intestinal and genito-urinary portion; but at the lower end of embryos of this age the two are still in communication. When the embryo has attained to 1 cm. in length the separation has advanced somewhat further back, but at the level of the caudal extremity there is always a small common cloacal cavity. In embryos a little older (12 mm.) the genital become partly separated from the urinary passages; it is not until much later (embryos of 6–7 cm.) that the separation between the intestinal, genital, and urinary tubes is complete.

* Journ. Anat. et Physiol., xx. (1884) pp. 242-59 (4 pls.).

The prostate glands are stated by Kölliker to make their appearance at about the third month in the human embryo; in reality, they appear somewhat earlier, about the second month; in a previous investigation carried out in conjunction with M. Robin, it was found that the prostate glands form a system entirely independent of their ducts and of the ejaculatory canals; and the present research confirms this idea; the prostate also is not connected with the urinary apparatus, as it was said to be by Virchow, but with the genital system; it is comparable to the glands of the urethra in the female; the entire urethra in the female is consequently homologous with the prostatic portion only of the male urethra, while the penial portion, including Cowper's glands, corresponds to the vulva in the female.

The external genital organs are fully formed at a somewhat earlier date in the male than in the female; at three and a half months they are very nearly complete in the male, while in the female at this period there is still a slit uniting the urethra with the vagina; a complete separation is accomplished after four months.

Spermatogenesis.*—MM. Swaen and Masquelin have published their very interesting observations on the developmental history of spermatozoa, in continuation of the work of Lavalette St. George. To understand the work of the later observers, it is necessary to recapitulate St. George's conclusions. They are as follows:—Spermatozoa originate in special cells, very similar to young ovules, which may be called *spermatogonia*. These elements multiply and form groups of small cells, *spermatocytes*, which remain grouped together so as to constitute *spermatogems*. At the periphery of the spermatogems a certain number of spermatocytes are modified so as to form a membranous envelope, a cyst (amphibians and insects). In other cases (Selachians), a single spermatocyte is modified at the base of the spermatogem and forms the *basilar cell*. In mammals, on the other hand, the spermatogem developes neither a cystic membrane nor a cystic basilar cell. It is the spermatocytes which are transformed into spermatozoids.

In addition to these elements there occurs a second kind of cell, forming a more or less complete envelope for the spermatogonia. These *follicular cells* play only a very secondary part in spermatogenesis, eventually disappearing.

MM. Swaen and Masquelin conducted their researches on the testicles of *Scyllium catulus*, the salamander, and the bull.

In *Scyllium*, the seminiferous ampullæ of the testicle (cf. Graafian follicles) contain groups of two kinds of cells, (1) the central spermatogonium or *male ovum*, a large nucleolo-nucleate cell partly in contact with the adjacent connective tissue, partly bounded by (2) the smaller, oval or irregularly shaped, follicular cells. As the "male ovule" multiplies (by *indirect* cell-division), the follicular cells also multiply and force their way inwards between the resulting daughter-cells of the spermatogonium to finally form a bilamellar body

* Arch. de Biol., iv. (1883) pp. 749–802 (5 pls.).

composed peripherally of the latter cells and internally of the follicular cells.

The two classes of cells remain throughout perfectly distinct, and Semper is mistaken in thinking that male ovules can be formed from follicular cells.

Cell-division of the male ovules eventually forms bicellular columns of radiating cells. These columns are the *spermatogems*, of which the component cells are the *spermatocytes*. Each spermatogem is proximally capped with a follicular cell, generally crescent-shaped. When each spermatogem consists of six cells this follicular cell makes its way centrifugally between the columns, and attaches itself to the distal end of the spermatogem as the so-called "basilar nucleus" (really a complete and distinct cell).

When this stage has been reached, the remaining follicular cells atrophy and further multiplication takes place in the spermatocytes, the resulting rows of cells (*nematoblasts*) arranging themselves with reference to the axis of the spermatogem (or *nematogem*, as it may now be called) much as the plumules of a feather with reference to the rachis.

A *caudal cavity* is now formed internally in each nematogem, and into this space protrude the "tails" of the resulting spermatozoids. The nematoblasts in their development become rectilinear, and their distal ends eventually form a parallel series, capped by the basilar nucleus. The head of the nematoblast is composed both of nucleus and of cell-protoplasm. The appearance of the nematogem is that of a cone of tapering filaments.

As regards the "problematic body," nothing new was observed.

Eventually the basilar nucleus forms a simple tube surrounding the "sheaf" of spermatozoids, and it is probably by its contractions that these latter are finally expelled.

In the salamander the ampullæ show a cavity, and the follicular cells form an investment for the male ovules. Multiplication and other phenomena occur much as in *Scyllium*.

In mammals the true male ovules are the small parietal cells considered as follicular by Lavalette. These male ovules behave in mammals much as their counterparts in Selachians, &c., except that of the two first products of their division, the one remains inactive for a certain time (*inert male ovule*), whilst the other (*active male ovule*) multiplies by division to form a spermatogem. This peculiarity of mammalian spermatogenesis is due to the continuous production of spermatozoids in the same seminiferous tube.

In conclusion, MM. Swaen and Masquelin institute the following conclusion between cell-development in testicle and ovary:—

1. In the *ovary*, the ovule little by little assumes considerable proportions, the follicular cells multiplying actively to form a continuous envelope, and in some cases to effect the expulsion of the ovule.

2. In the *testicle*, the ovule forms a number of little cells which eventually become spermatozoids. The follicular cells multiply to only a slight extent; more commonly they increase in size (Selachians and salamander).

Factors of Sexuality.*—K. Düsing commences by discussing the correlation of the organs, and reminds us of the familiar fact that agriculturists are in the habit of removing the genital organ from those individual cattle that they wish to fatten. It is next pointed out that in nearly all cases where organs disappear, as for example in parasites, the reproductive apparatus is always retained, while, on the other hand, in sterile hybrids there is a marked development of the organs which preserve the life of the individuals.

With regard to the proportional relations of the sexes, we have some statistical observations; to these the author now adds some considerations from the point of view of the doctrine of natural selection, and he points out that the numerical supremacy of one sex may be of considerable advantage in the development of a large progeny. He thinks, further, that it is possible to demonstrate mathematically that, where there is an abnormal relation of the sexes, an animal which produces a large number of the kind of individuals that are wanting will leave more descendants than one that does not do so. This peculiarity will, in time, be confirmed by natural selection. In illustration of this reference may be made to what seems to be a statistical truth; late fertilization of women tends to the production of males, and, in all circumstances, the first-born are, in the majority of cases, boys. Further, the author believes that statistics show that after a war there is a large preponderance of male babes.

Where, among cattle, demands are largely made on an individual bull, the majority of his progeny are males, and this is because young spermatozoa tend to produce males; this view of the different value of spermatozoa of different ages has the support of so high an authority as Prof. Preyer. Reduced to a general law, the results may be thus enunciated: the larger the want of individuals of one sex, the more frequently are their genital products required, and, therefore, the more frequently do the minority produce young of their own sex. The investigations of Thury have shown that young ova tend to form progeny of the female sex, while delayed fertilization leads to the production of males; the calves of the earlier stages of the rut are more frequently females than those of the later.

The indirect causes which are equivalent to an absence of individuals are (α) insufficient nutrition; the effect of this is seen in the the fact that a well-fed cow served by a starved bull always produces males, and inversely. In other words, there is a close connection between nutrition and reproductive capacity. (β) Difference in age. Every individual at the time of its highest reproductive capacity tends to produce its own sex; and the preponderance of males is greatest when the male is considerably older than the female. This law was discovered by Hofacker and Sadler, and is supported by the 58,000 cases reported on by Goehlert and Legoyt.

We come, then, to this conclusion: Animals have by adaptation acquired the power, in the presence of abnormal sexual relations, of producing more individuals of the sex of which there is a want; and the same balance is maintained by the same methods when there are

* Jenaisch. Zeitschr. f. Naturwiss., xvi. (1883) pp. 428-64.

at work indirect causes which are equivalent to a want of the individuals of one sex.

In another sense the influence of nutriment is of the greatest importance; notwithstanding the fact that a starving animal may reproduce itself numerously, the progeny are feebler than those of one which only produces as many as, under these conditions, can live and thrive. Surplus nutriment leads to the production of a stronger, and insufficient food to that of a weaker progeny. Domesticated animals breed earlier, and are more fruitful than the wild; townsmen and sedentary people more than countrymen who take much hard exercise. More children are conceived in summer than in winter; and in Scotland, according to Haycraft, the maximum of conceptive capacity is simultaneous with that of the thermometer. Birds, bats, and insects breed less numerously than fishes, and especially than parasites who use up little or no force in movement.

The differences we observe between males and females are easily explained when we consider the very different parts that they play in the physiology of reproduction; it must always be remembered that it is the office of the female to produce the material out of which the embryo is built up.

The author concludes by reasserting his conviction that it is in the principle of natural selection that we must look for the explanation of the differences between the sexes.

Rudimentary Placenta in Birds.*—One of the principal distinctions between the Mammalia and the lower Vertebrata has been hitherto supposed to be the possession by the former of a placenta. M. Duval has, however, come to the conclusion that this structure is not exclusively confined to the Mammalia, but that it also exists, though in a rudimentary form, in birds.

The allantois in passing inwards into the pleuro-peritoneal cavity does not become attached to the amnion or to the umbilical vesicle, but joins the chorion, becoming fused with it; it ends by forming a sac which incloses a mass of albumen; into this sac the villi of the chorion project, and an organ is thus formed which is completely analogous to the placenta of the Mammalia; the different form of the organ in birds and in mammals is evidently owing to the difference between the oviparous and viviparous method of reproduction; the villi of the chorion in Mammalia are attached to the body of the mother, while in birds the necessities of the case demand that they should be developed upon the opposite side of the chorion and attach themselves to the nutritive albumen. It is, however, quite intelligible that in an ovoviviparous vertebrate, where the egg has a thin membranous shell, the placentoid organ should become attached to the internal surface of the oviduct. This placenta of birds is therefore a rudimentary organ which enables us to understand how the placenta of the Mammalia may have originated. A physiological difference between the placenta of birds and of Mammalia is that in

* Journ. Anat. et Physiol., xx. (1884) pp. 193-201 (4 pls.). See also this Journal, *ante*, p. 360.

the former the exchange of gases takes place, of course, by the outer surface, so that the two functions of respiration and nutrition are relegated to two different portions of the placenta, while in mammals they both take place on the outer surface of the organ.

Permanence of larval conditions in Amphibia.*—As a general rule the Amphibia when mature cease to breathe by means of gills; the latter disappear and respiration is carried on solely by means of the lungs. There are, however, a number of cases known, and they are increasing daily, where branchial respiration is carried on for a longer or shorter period of the life of the adult. L. Camerano has lately paid some attention to this subject, and has investigated a certain number of these Amphibians, paying special attention to the dimensions of the adult animal, its organs of reproduction, colour, alimentary system, lungs, and nervous system. The period during which branchial respiration continues varies in different Amphibia; the shortest known to him is in *Salamandra atra*, the longest in *Proteus anguineus*, the axolotl, and *Triton*. In almost all the Amphibia of Europe cases are known of an abnormally short or abnormally long "branchiate-period." These may be divided into two classes: (1) those instances of simple hibernation, where the animal has not had time in a single summer to attain maturity; and (2) other cases where the branchiæ remain functional for several years. In this respect, however, the Urodela differ from the Anura; the former are influenced by local conditions, such as food, presence of floods, &c., which render it necessary for them to continue an aquatic life though the development of the other organs of the body goes on quite as rapidly as in individuals that have adopted a terrestrial life. In the Anura, on the other hand, the permanence of the branchiæ for several years is accompanied by an incomplete development of other structures. Such cases are, however, rare, and are not, as in the Urodela, a modification owing to local causes, but are a reversion to an ancestral condition.

The Amphibia as a class are clearly most nearly related to the fish, and the occasional permanence of a branchiate condition is the best proof of this relationship; it is, however, none the less possible that branchiæ were acquired later, and that the Amphibia were primitively land-dwellers, assuming the branchiate condition as a "retrograde metamorphosis" by the adoption of an aquatic life. Keeping in view this possibility it is easy to understand how by artificial interference with the biological conditions, the Amphibia may pass from a branchiate to a pulmonate respiration and back again.

The old division of Perennibranchiata and Caducibranchiata is therefore unphilosophical: the real proof of the adult condition of an Amphibian is the maturity of the reproductive organs, and its branchiate or pulmonate condition must be neglected since it is merely an instance of dimorphism dependent upon the influence of the environment.

* Mem. R. Accad. Sci. Torino, xxxv. (1883) 64 pp. (2 pls.). Naturforscher, xvii. (1884) pp. 273–4.

Embryo Fishes.*—The Bulletin of the United States Fish Commission contains a series of articles upon various matters connected with the development of fishes, embodying the results of the investigations of Mr. J. A. Ryder during the year 1882.

The mode of absorption of the yolk of the embryo shad differs in the absence of a vitelline circulation from that which obtains in *Tylosurus* (*Belone*), *Fundulus*, *Esox*, and *Salmo*. The great mass of the yolk in the shad embryo consists of coarse irregular masses of very clear protoplasmic matter, separated by a protoplasm which is optically different. The covering of the yolk is a palish amber-coloured layer, quite different from the clear body of the yolk, and usually thicker at the end next the heart. The intestine lies in a longitudinal furrow on the dorsal aspect of the yolk-sac, and is never connected with it in this species. The yolk-sac is surrounded by a space filled with serous fluid. This space is capacious anteriorly, between the heart and the yolk, and this part is identified by the author with the segmentation-cavity. The delicate pericardial membrane that separates this cavity from the pericardial space may, possibly, be perforated. In *Tylosurus* the two cavities are certainly connected. The heart opens freely into the segmentation-cavity, and the appearance presented is that its persistent pulsation breaks up the yolk-substance into small spherules, sucks them out of the segmentation-cavity, and carries them into the body of the embryo. The corpuscles develope on the surface of the outer yolk-layer, and after a while drop into the serous fluid, appearing like the white blood-cells of human blood. As development proceeds, the yolk-sac becomes pointed in front, and the external layer becomes thicker, while the pericardial membrane becomes funnel-shaped to fit the anterior part of the yolk-mass. Before the final disappearance of the yolk, the liver of the young fish becomes more developed, and the portal vein makes its way over the dorsal aspect of the yolk towards the venous end of the heart. As the peculiar amber-layer around the yolk persists to the last, it is probable that the central clear portion is transformed gradually into it.

This is the history of the yolk-mass after the embryo is hatched, but as it grew in size before hatching, yolk-absorption must have taken place before the heart was sufficiently developed to be an active agent in the process. This must be by intussusception, and in the amber yolk-covering it is undoubted that a process of cell and blood-cell differentiation takes place. Mr. Ryder concludes that the hypoblast of Gensch, said by that investigator to be the source from which the blood is derived, is the equivalent of the amber yolk-covering of the shad, and not the true hypoblast. This amber layer is a temporary structure, which disappears entirely, and does not enter into the formation of any organ or membrane. The serous cavity around the yolk in the shad represents the body-cavity, and the outer covering of this, though only 1/2000 of an inch in thickness, contains epiblast, mesoblast, and hypoblast.

* Bull. U.S. Fish Commission—Observations on the Absorption of the Yolk, the Food, Feeding and Development of Embryo Fishes, &c., pp. 179-205. Amer. Natural., xviii. (1884) pp. 395-8.

There is practically little difference between the modes of yolk-absorption in the chick and in the fish.

The author brings forward facts to prove that there is between ova, even of allied genera, considerable differences, and that at no stage is there a positive identity.

The mechanical construction, as it may be termed, of ova affects the course of their development. The Teleost ovum has a relatively enormous yolk, which must be included by the blastoderm in order to be absorbed, and this relatively large yolk has much to do with the difference observed between its development and that of a Marsipobranch or Amphibian. The eggs of the Salmonidæ have an abundance of oil-drops in the vitellus, especially just under the germinal disk. These by their buoyancy keep the disk constantly directed upward. The cusk, the crab-eater, Spanish mackerel, and moon-fish have eggs which are buoyant from the possession of a single large oil-sphere situated almost exactly opposite to the germinal disk, and thus keeping it face downwards—just the reverse of what occurs in the Salmonoids. Even after hatching, the young are at first unable to right themselves on account of the presence of the oil-drop. The cod ovum has no oil-drop, yet floats with the germinal disk downwards. That of *Morone Americana* (white perch) is adhesive and fixed with a very large oil-sphere, which keeps the disk on the lower side of the vitelline globe. The shad egg is non-adhesive, and heavier than water, and the germinal disk has a constant tendency to arrange itself at the side of the vitellus as viewed from above, though there is no oil to influence it. In *Fundulus* and *Syngnathus* the oil-drops appear uniformly distributed. The number of proto-vertebræ or primary somites differs so much that while *Tylosurus* has so many as seventy-five pairs, *Alosa* has only eighteen to twenty. The author ventures this bold remark: "When our knowledge is more complete, we shall perhaps be able to distinguish the species apart by the eggs alone, just as botanists have used the characters presented by seeds to distinguish plants."

Development of Viviparous Minnows.*—J. A. Ryder describes the development of viviparous minnows, and particularly *Gambrusia patruelis* B. and G. The young fish develope within the body of the female parent, and within the follicles in which the eggs themselves are developed. The follicles, which are covered with a rich network of fine capillary vessels, assume the office of a respiratory apparatus, by which the gases are interchanged between the embryo and the parent fish. This follicle also acts as an egg-membrane, being actually perforated by a round opening ("follicular pore") which is analogous to the micropyle of the ordinary fish-egg. The arrangement of the follicles of the ovary within the body of the female is described, and the peculiar differences between the two sexes in the arrangement of the viscera pointed out. The fibrous bands, which act as supports or stays to the basal portion of the anal fin of the male, which is modified as an intromittent organ, are also described.

* Science, iii. (1884) p. 769.

The great difference in the sizes of the sexes is also referred to, the female weighing over six times as much as the male.

Formation of and Reactions of Nuclei.*—C. Frommann finds that the application of acids to nuclei of non-amœboid cells does not result at first in a great change in the yellowish granules of the protoplasm, but that, after the acids have acted for some time, they become pale and can no longer be accurately distinguished from one another, and the nucleus appears to be surrounded by a distinct membrane. With amœboid cells the action of acids results in the appearance of a firm stroma and a firm more complete investing membrane; from the material of the protoplasmic granules new nuclei as well as separate longer filamentar structures are formed, or granules only are formed, and the protoplasm becomes clearer and more homogeneous. It must be borne in mind that we have here to do with artificial products. The author criticizes the views of Robin, and points out that structures, which we are bound to compare with nuclei, are to be found in the living colourless blood-corpuscles; this has been proved by Stricker for non-defibrinated, and by Frommann for defibrinated blood, and Flemming speaks very positively as to the presence of nuclei in living leucocytes, whether in or out of the vessels of the larvæ of the salamander.

If a homogeneous body, either spontaneously or after the action of chemical or physical reagents, differentiates into a formed and a homogeneous substance, the phenomenon may be explained by the supposition that both bodies were present, but had the same refractive index, or by supposing that the apparently homogeneous body was really so, and that the appearance of formed elements is due to a differentiation of its substance into elements which are more highly refractive, and a clear substance which fills up the interspaces. The author is inclined to accept the latter view as applying to what obtains with nuclei, and supports it by various considerations. Experiments with salt solutions show that, after the fusion of the whole mass of the grains and granules with the nucleus, the whole structure thus formed becomes converted into a nucleus with sharply defined stroma and firm investment, so soon as spring or distilled water is added to the preparation. Various other experiments are detailed, the study of which is a matter of great importance for those who are making observations or experiments in connection with the phenomena exhibited by nuclei.

Indirect Nuclear Division.†—E. Strasburger commences an essay on the subject of the controversy with regard to indirect nuclear division by an account of some specimens of the embryonic sac of *Fritillaria imperialis*, which had been prepared by Herr Heuser. He concludes from his numerous observations that it is very probable that in all typical processes of the indirect division of the cell-nuclei of plants there is a stage in which the segments of the nuclear filament divide longitudinally. This process is not, however, always

* SB. Jenaisch. Gesell. f. Med. u. Naturwiss., 1883 (1884) pp. 4–16.
† Arch. f. Mikr. Anat., xxiii. (1884) pp. 246-304 (2 pls.).

found to be associated with the same definite arrangement of the segments in the nucleus, and it may either precede or succeed the arrangement of the segments into the nuclear plate.

If we compare what is now known as regards plants with the results of studies on the division of the nuclei of animals we find that, with one exception, there is really no important difference between them. The investigation of plants shows that the spindle-shaped fibres almost certainly arise from compressed cytoplasm. The whole framework of the nucleus is to be found in the filamentar coils, while the nuclear cavity is only filled by homogeneous nuclear fluid. The whole mass of spindle-shaped fibres have their origin in the cytoplasm.

The difference in the way in which cell-division is completed is a point of distinction between animals and plants, but it does not obtain in the lowest forms of either kingdom. The formation of the connective filaments in the separation of the cell-body is a distinctive characteristic of plants; but, notwithstanding this, the result of cell-division is the same in both plants and animals.

In both we find that in the "prophases" of nuclear division cytoplasm is collected at the future poles of the cell-nucleus; this phenomenon is often very striking in animal-cells, and is especially well marked in ova. The nucleus becomes provided with two radiating systems, even before any dicentric arrangement can be detected in the cell-nucleus. The observations which the author has made lead him to think that the spindle-shaped fibres derived from the cytoplasm have a directive influence on nuclear division; the frequently simultaneous division of nuclei in multinucleated cells may be easily supposed to be due to this influence and the surrounding cell-plasma.

Strasburger thinks that some of the aberrant forms of division noted by Flemming may be explained by what he has seen in plants. The tub-shaped figures which become apparent during the arrangement of the segments in the testicular epithelium of the salamander call to mind what was seen in the embryo-sac of *Fritillaria*, and suggests that an explanation is to be found in the divarication of the daughter-segments on one side, and their approximation to one another on the other. In the red blood-cells of *Salamandra* the cell-nucleus becomes considerably enlarged during the development of the filamentar coil, and a large amount of cell-substance is taken up into the nuclear figure. If the spindle-shaped fibres form only a small figure in the cell, it would be clear that all the cytoplasm was not used up in forming this figure, and we should have a case similar to that seen in the pollen-mother-cells of *Fritillaria persica*, where in the first act of division granular cytoplasm is found between the spindle-shaped fibres.

The ideas now derived from a study of animals and plants cannot be directly applied to the Protista, where the separate parts of the cell-body often undergo great changes and become adapted to new functions; we must greatly increase the number of our observations before we can hope to arrive at generalizations of universal value.

The function of the complicated nuclear division appears to be that of dividing the nucleus into two completely equal halves; in the first segmentation the parts are often very unequal in size, and if, as Heuser supposes, there are several different substances in the disks of the microsomes longitudinal division would be the safest means for distributing the substances equally to the two daughter-nuclei. It is quite clear that the nucleus has a nutrient function for the cell, though we do not yet know what its character is. In the internodes of the Characeæ we see the nucleus increasing in proportion to the mass of the increasing cytoplasm, although here cell-division does not accompany nuclear division; here indeed direct division of the nucleus (by constriction) takes the place of indirect division.

Nucleus of the Auditory Epithelium of Batrachians.*—The results of J. Chatin have a double interest, as affording us more complete information as to several points in the comparative histology of the auditory epithelium, and as bearing on the structure of the nucleus.

The study of the epithelial layer which invests the labyrinths of Batrachians demonstrates a close relationship between the sustaining and sensitive elements; they are intimately connected, and they undergo the same kind of modifications. What is true of Batrachians is true also of other vertebrates; in the Mammalia, for example, there are auditory rods and ciliated cells, but between the two all intermediate stages are to be made out, and this even at some single point.

As to the intranuclear corpuscles the author finds that, so soon as they have acquired their definite characters and become grouped in a plexus they are all perfectly identical; there is no trace of any nucleolus. In insects, Chatin has noted the inconstant character of the nucleoli, and Klein, working at certain glandular elements of the Batrachia, likewise bears witness to their absence.

Epidermis of the Chick.†—C. Frommann has examined the epidermis of the chick during the last week of its stay in the shell, and finds in it granular cells and net-cells; the former are rounded or oval and contain granules which are fused into cords of various forms; these are connected with one another by filaments of various degrees of fineness, which traverse the delicate spaces left between them; here and there, however, there are larger spaces. In neither case have the spaces any special wall. The body of the net-cell is traversed in all directions by a wide-meshed network; part contains neither nuclei nor any aggregations of cell-substance, while in other parts the nodal points have nuclei. On the whole, the characters of the cells of the epidermis are the same as after the period when the chick leaves the egg. Certain differences are presented in the parts of the skin which are feathered, for there is there ordinarily a layer of small granules imbedded in a pale, finely granular substance, in which nuclei are either completely absent or are irregularly scattered

* Ann. Sci. Nat. (Zool.), xvi. (1884) 5 pp.

† Jenaisch. Zeitschr. f. Naturwiss., xvii. (1884) pp. 941–50.

about; such nuclei are always small and vary in character. Schenk has already noted the presence of non-nucleated cells in the ectoderm when describing the process of fusion of the folds of the amnion.

Scales, Feathers, and Hairs.*—The idea largely taught to students that scales, feathers, and hairs are identical in nature is combatted by J. E. Jeffries. He considers the epiderm to be the primitive skin, if not the true one, as it is formed long before the corium, which is a late and very variable product of the mesoblast; and because all the organs of sense are formed from it. The epiderm may be regarded as primitively consisting of a smooth mucous layer, an epitrichial layer, and perhaps an intermediate layer of parenchymatous cells. In birds and mammals the outer layer is lost, and never renewed, while the middle layer becomes thickened and subject to various modifications, as drying, conversion into horn, &c., and enters into the structure of all the appendages. Scales are moulted and renewed, scuta are not. The toe-pads of birds may be seen to pass over into scuta on the sides of the toes of many birds. Scuta bear feathers as epidermal appendages—scales never do, thus pointing to scuta, which have a mucous layer and outer horn coat with a mesodermal core, as simple folds of the skin, not as appendages.

The early stages of a feather and of a hair differ. The latter is formed in a *solid* ingrowth of the epiderm, the latter from the epiderm of a large papilla. A hair does not contain any of the mucous cells, while a considerable portion of a feather consists of them. The supposed homology between feathers and scales seems to fail before the facts that the mucous layer is absent in the latter, and that Studer has shown that the imagined scale-like nature of the remiges of penguins is a fallacy. Mr. Jeffries avows his belief in the distinct origin of the dermal appendages of the higher vertebrates, and asserts that the nakedness of the Amphibia is a strong argument against the identity of any of the avian appendages with those of reptiles and mammals.

Locomotion of Animals over smooth Vertical Surfaces.†—Dr. H. Dewitz has extended his observations on this subject, at first confined to insects,‡ to a variety of other forms, including some Vertebrata. He finds that the same means, the exudation of a secretion, are adopted in many cases, even where sucking-disks are used. Thus the leech can walk on a wire network, on which the disks could not act by exhaustion of the air, and the secretion of the disks of *Piscicola* has been examined by Leydig. A long series of animals is enumerated from Worms and Echinoderms to Apes among the Mammalia, which are known with more or less certainty to use similar means for climbing.

The tree-frog (*Hyla*) maintains its hold as firmly within the exhausted receiver of an air-pump as in the open air, and in fact a piece of glass passed over the balls of the tips of the toes shows clear

* Proc. Bost. Soc. Nat. Hist. Cf. Amer. Natural., xviii. (1884) p. 640.

† Pflüger's Arch. gesammt. Physiol., xxxiii. (1884) pp. 440–81 (3 pls.). See also *infra*, Insecta.

‡ See this Journal, iii. (1883) p. 363.

traces of the secretion. If studied by sections, the ball of the foot exhibits on the upper surface some globular mucous glands imbedded in the cutis, and some elongated glands, imbedded in the connective tissue, on the lower side; this is the case on the balls of all the phalanges. In *Rana temporaria*, too, these dermal glands have a similar form, only being less numerous and long; they probably serve a similar function.

The glands in *Hyla* are tubular, there is a *tunica propria*, and the cells are longish and somewhat cubical in longitudinal, but mostly hexagonal in transverse section; the nucleus, which is the only part which is stained readily by picrocarmine, lies at the lower end; the cells end distally in two pointed processes. The glands do not open in the annular furrow, but over the whole of the sole, especially at the hinder part; the ducts are lined by a cuticle which is shed with the skin. The spongy connective tissue of the ball of the toe is filled with lymph, and is thus rendered elastic, so that it adapts itself to inequalities of surface; balls of similar structure are found on the tarsal joints of Orthoptera. By fastening insects feet uppermost on the under side of a covering-glass which projects from a glass slide, the hairs which clothe the grasping lobes of the foot may be seen (e. g. in *Musca erythrocephala*) to be tipped with drops of transparent liquid. On the leg being drawn back from the glass, a transparent thread is drawn out, and drops are found to be left on the glass.

The grasping apparatus is constructed as follows: The short grasping foot-hairs in *Telephorus* and other Coleoptera are each traversed by a canal which opens at its extremity. Sundry long hairs on the lower side of the tarsal joints in *Telephorus* are connected with nervous filaments which lead from small ganglia, and thus constitute tactile organs. The observation of what appear to be nerve-fibres in the glands which supply the hairs with the sticky secretions is not sufficiently certain.

In the Orthoptera the arrangement is different: thus the tarsus of a Locustid has the chitinous covering of the lower side rendered very flexible by being composed of small parallel tubes, the underlying matrix is deeply plicate, and constitutes a large gland, whose secretion is transmitted through the chitinous tubes and through another intermediate chitinous layer to the surface. In the house-fly, the grasping foot-lobes appear to be only called into play when the insect has to walk on vertical smooth surfaces, for in other cases they hang loosely down. So also the Echinoidea use the tube-feet only on vertical surfaces.

The use of a glutinous secretion for walking has been shown by Burmeister for Dipterous larvæ; Dr. Dewitz finds the larva of a *Musca* to use for the purpose a liquid ejected from the mouth. Thus, too, the larvæ of *Leucopis puncticornis* accomplish their loop-like walk—the liquid in this case comes from both mouth and anus. A *Cecidomyia*-larva is able to leap by fixing its anterior end by means of a liquid of this kind. The larva of the alder-leaf beetle (*Galeruca*) moves by drawing up its hinder end, fixing it thus, and carrying the

anterior part of the body forward with its feet until fully extended, when it breaks the glutinous adhesion; under even the lower powers of the Microscope the drops of secretion may be seen on the feet. A *Chrysopa*-larva (probably *Hemerobius*) was able to crawl well on vertical glass, but on sand the feet became clogged; some larvæ of this group, on the other hand, had the grasping lobes but slightly developed, and these adopted the loop mode of walking; the adhesion of the posterior end of the body was so strong that many larvæ long resisted all attempts to shake them off by twisting the glass suddenly round.

Among the Hymenoptera the ventral feet of some sawflies have this power. Most spiders are devoid of it, but leaping spiders leap and crawl on vertical surfaces, and have grasping disks for adhesion. Among Cœlenterata, *Hydra* may be seen to excrete mucous adhesive matter from its foot.

Zoology of the Voyage of the 'Alert.'*—The Zoological collections made by Dr. R. W. Coppinger, Staff-Surgeon H.M.S. 'Alert' in the Melanesian Seas and in the Western Indian Ocean were so large that the Trustees of the British Museum ordered the account of them to be published as a separate volume. The magnitude of the collection may be inferred from the statement that "irrespective of a number of specimens set aside as duplicates not less than 3700 referable to 1300 species were incorporated in the National Collection;" of these the most important were marine invertebrates, and 490 of the species are either new or are additions to the Museum. The specimens were admirably preserved, and collected, Dr. Günther says, with singular judgment.

In place of the one species of lancelet which Dr. Günther thought to be cosmopolitan, six distinct species are, he now thinks, to be recognized.

The Mollusca are treated of by Mr. Edgar A. Smith, who finds that of the Melanesian specimens the general character is Malayan.

The Echinodermata are dealt with by Prof. F. Jeffrey Bell, who found that 30 of the 124 Melanesian species were new; fifteen of these were Comatulids. He adduces evidence to show that pattern of coloration is not as important a characteristic of the species of *Ophiothrix* as has been generally supposed. He proposes some alterations in the mode of formulating the characters of Crinoids. Having had the opportunity of examining a large collection from the Sydney Museum he finds that no view can be more erroneous than one which speaks of an Australian (marine) fauna without some sort of qualification; Cape York and Port Molle are as much part of Australia as Port Jackson, but between the two faunæ the resemblance is as slight as is in the nature of things possible. He concludes, in fact, that "to-day, as in those Tertiary times when a wider sea separated the Australian from the Asiatic continent, there are forms whose breadth of range is coincident rather with isothermal lines than with topographical boundaries." The marked manner in which the species

* 'Report on the Zoological Collections made in the Indo-Pacific Ocean during the voyage of H.M.S. Alert, 1881–2.' 8vo, London, 1884, 684 pp. (54 pls.).

of Crinoids vary among themselves leads to the hope that the details of the tropical fauna may be elucidated by their aid.

Similarly, according to Mr. Miers, the Crustacea collected have one-third of their species widely distributed through the Indo-Pacific region; the affinity of the Australian with the European Amphipoda is very remarkable, some of the species being identical. Mr. Miers gives a very elaborate table of the distribution of the higher Crustacea on the East Coast of Africa and the adjacent islands.

Mr. S. O. Ridley deals with the Alcyonaria and Spongiidæ; of the former there are 38 Melanesian species, and the author thinks that few novelties are in the future to be expected from the shallow water; one-third of the Alcyonaria are new to science; *Psilacabaria* is a new genus of Melithæids, and its species is remarkable for the large size of its spicules. Thirty-eight per cent. of the Melanesian sponges are certainly new to science; the greater number of novelties belong to the Ceratosa; as to individual variation, it is noted that this often affects the size of the spicules; variation in form of the spicules is less common, that of external form is sometimes very striking. Only a quarter of the species of sponges are known to occur outside the Australian seas; the most widely ranging are the most generalized, but in some cases it is possible that the same specific characters have been independently acquired. Twenty-eight per cent. of the sponges obtained in the Western Indian Ocean were found to be identical with those of the Australian Seas. The most striking point with regard to the sponges appears to be "the comparative scarcity of forms showing marked distinctive characters of generic importance which are not also found in the more familiar Atlantic fauna."

B. INVERTEBRATA.

Origin of Fresh-water Faunæ.*—Prof. W. J. Sollas points out that the poverty of fresh-water faunæ, as compared with marine, is commonly attributed to a supposed inadaptability on the part of marine organisms to existence in fresh water. That this is erroneous is shown by the existence of fresh-water jelly-fish such as *Limnocodium*, and still more directly by the experiments of Beudant, who succeeded in accustoming several kinds of marine mollusca to a fresh-water habitat. The view of Von Martens that the severity of a fresh-water climate is prohibitive of the existence of most marine forms in rivers is insufficient, and a more thorough-going explanation is necessary. This is to be found in a study of the means by which the distribution of marine animals is secured.

In the case of stationary forms, free-swimming embryos are distributed over wide areas by currents, and they can never pass from the sea into rivers, in which the current is always directed seawards. Nor, probably, could an attached form once introduced into a river permanently establish itself so long as its propagation took place exclusively through free-swimming larvæ, for these would be gradually borne

* Nature, xxx. (1884) p. 163.

out to sea. Hence, fresh-water animals should not, as a rule, pass through a free larval stage of existence, nor, as a matter of fact, do they. In *Hydra*, fresh-water sponges, and Polyzoa, the young usually emerge from a horny cyst in the complete state. In the Unionidæ, the glochidium-stage provides for distribution without involving a seaward journey. The young of fresh-water molluscs do not enter upon a free existence till they are similar to their parents, and *Paludina* is viviparous. The suppression of a free-swimming larval stage not only occurs in fresh-water, but in many marine invertebrates.

This is connected with the fact that the larval stage is in a position of disadvantage as compared with the adult. Hence there is an advantage to the organism if the larval stage can be passed over in a state of seclusion. From this various other modifications follow; development in seclusion involves a supply of accessible food, hence the appearance of yolk and other kinds of nourishment furnished by the parent to the imprisoned embryo. Again, the secluded larva being spared the drudgery of working for its own existence, and supplied with nutriment in a form that puts the least tax on its digestive powers, a larger balance of energy remains available for metamorphic changes. Thus arise the phenomena of accelerated and abbreviated development. Further, the shortening of the larval life probably leads to the lengthening of the adult life, and shifts the chances of variation and selection forward into the adult stage. Thus, animals which hatch out in a complete state will most probably suffer modifications of that, and not of previous ones, except very indirectly. Here we discover a direct tendency towards a mode of development which explains the "arborescent" character of our zoological classifications, i. e. the tendency of the tree of life is now to produce leaves rather than new branches. In the case of fresh-water faunæ very direct reasons have existed for the suppression of the free larval stage. In this connection may be noticed the richness in species and the poverty in genera of the fresh-water mollusca.

In discussing the origin of fresh-water faunæ there are three hypotheses from which we have to select: (1) that marine forms have migrated into rivers; (2) that they have migrated into marshes, and thence into rivers; and (3) that marine areas have been converted into fresh-water ones. The last course has been the most usual, especially in the case of non-locomotive forms. Hence the origin of fresh-water invertebrates is connected with the great movements which have affected the earth's crust.

Pelagic Fauna of Fresh-water Lakes.*—O. E. Imhoff first deals with the "Langensee," and refers to the remarks of Crisp as to the synonymy of some of his species with those previously described by Gosse, pointing out certain errors or lacunæ in Gosse's descriptions. Dealing with the pelagic fauna of four of the lakes of northern Italy he adds to them one Flagellate, *Dinobryon divergens* Imhoff, a species of *Ceratium*, *Conochilus volvox*, *Anurœa cochlearis* and *longispina*, *Asplanchna helvetica*, and a species of *Polyarthra*. Among the

* Zool. Anzeig., vii. (1884) pp. 321–7.

Cladocera we have *Bythotrephes longimanus* of Leydig and a species of *Daphnia*.

The pelagic fauna of fresh-water lakes consists of genera which, like *Piscicola* or *Argulus*, are occasionally found there, and others which do not voluntarily leave it; the latter are divisible into such as live on true pelagic animals or plants, like *Acineta*, *Vorticella*, and *Epistylis*, and others which are truly pelagic (*Eupelagici* Pavesi), such as the genera referred to above and *Bosmina* and *Leptodora*.

Lowest and Smallest Forms of Life as revealed by the modern Microscope.*—The following are some of the principal passages of the lecture delivered by the Rev. Dr. W. H. Dallinger, at the Montreal meeting of the British Association. The 'Times' says † of it, "But, perhaps, the most popular and most generally instructive feature in connection with biology at Montreal was the address of Dr. Dallinger, in which he exhibited by word and picture the wonderful revelations of the lowest forms of life made by the modern Microscope; and in which he showed that however easy it may seem to be to generate life in the proper conditions, no one has ever yet succeeded in producing 'spontaneous generation.' And here Dr. Dallinger is in accord with the most competent scientific opinion."

Dr. Dallinger said:—"The labour, enthusiasm, and perseverance of thirty years, stimulated by the insight of a rare and master mind, and aided by lenses of steadily advancing perfection, has enabled the student of life-forms not simply to become possessed of an inconceivably broader, deeper, and truer knowledge of the great world of visible life, of which he himself is a factor, but also to open up and penetrate into a world of minute living things so ultimately little that we cannot adequately conceive them, which are, nevertheless perfect in their adaptations and wonderful in their histories. These organisms, while they are the least, are also the lowliest in nature, and are totally devoid of what is known as organic structure, even when scrutinized with our most powerful and perfect lenses. Now, these organisms lie on the very verge and margin of the vast area of what we know as living. They possess the essential properties of life, but in their most initial state. And their numberless billions, springing every moment into existence wherever putrescence appeared, led to the question, How do they originate?—do they spring up *de novo* from the highest point on the area of not-life which they touch? Are they, in short, the direct product of some yet uncorrelated force in nature, changing the dead, the unorganized, the not-living into definite forms of life?

Now this is a profound question, and that it is a difficult one there can be no doubt. But that it is a question for our laboratories is certain. And after careful and prolonged experiment and research, the legitimate question to be asked is: Do we find that in our laboratories and in the obscured processes of nature now that the not-living can be, without the intervention of living things, changed into that which lives? To that question the vast majority of practical

* 'Times,' 2nd September, 1884. † Ibid., 4th September, 1884.

biologists answer without hesitancy, 'No, we have no facts to justify such a conclusion.' Professor Huxley shall represent them. He says: 'The properties of living matter distinguish it absolutely from all other kinds of things;' and, he continues, 'the present state of our knowledge furnishes us with no link between the living and the not-living.' Now let us carefully remember that the great doctrine of Charles Darwin has furnished biology with a magnificent generalization—one, indeed, which stands upon so broad a basis that great masses of detail and many needful interlocking facts are of necessity relegated to the quiet workers of the present and the earnest labourers of the years to come. But it is a doctrine which cannot be shaken. The constant and universal action of variation, the struggle for existence, and the 'survival of the fittest,' few who are competent to grasp will have the temerity to doubt. And to many, that which lies within it as a doctrine and forms the fibre of its fabric, is the existence of a continuity, an unbroken stream of unity running from the base to the apex of the entire organic series. The plant and the animal, the lowliest organized and the most complex, the minutest and the largest, are related to each other so as to constitute one majestic organic whole. Now, to this splendid continuity practical biology presents no adverse fact. All our most recent and most accurate knowledge confirms it.

But the question is—Does this continuity terminate now in the living series, and is there then a break—a sharp, clear discontinuity, and beyond, another realm immeasurably less endowed, known as the realm of Not-life? Or, does what has been taken for the clear-cut boundary of the vital area, when more deeply searched, reveal the presence of a force at present unknown, which changes not-living into the living, and thus makes all nature an unbroken sequence and a continuous whole? That this is a great question, a question involving large issues, will be seen by all who have familiarized themselves with the thought and fact of our times. But we must treat it purely as a question of science; it is not a question of how life first appeared upon the earth, it is only a question of whether there is any natural force now at work building not-living matter into living forms. Nor have we to determine whether or not, in the indefinite past, the not-vital elements on the earth, at some point of their highest activity, were endowed with or became possessed of the properties of life. On that subject there is no doubt. The elements that compose protoplasm—the physical basis of all living things—are the familiar elements of the world without life. The mystery of life is not in the elements that compose the vital stuff. We know them all; we know their properties. The mystery consists solely in how these elements can be so combined as to acquire the transcendent properties of life. Moreover, to the investigator it is not a question of by what means matter dead—without the shimmer of a vital quality—became either slowly or suddenly possessed of the properties of life. Enough for us to know that whatever the power that wrought the change, that power was competent, as the issue proves. But that which calm and patient research has to determine is, whether matter

demonstrably not living can be, without the aid of organisms already living, endowed with the properties of life.

Judged of hastily and apart from the facts, it may appear to some minds that an origin of life from not-life, by sheer physical law, would be a great philosophical gain, an indefinitely strong support of the doctrine of evolution. If this were so, and indeed so far as it is believed to be so, it would speak and does speak volumes in favour of the spirit of science pervading our age. For although the vast majority of biologists in Europe and America accept the doctrine of evolution, they are almost unanimous in their refusal to accept, as in any sense competent, the reputed evidence of 'spontaneous generation': which demonstrates at least, that what is sought by our leaders in science is not the mere support of hypotheses, cherished though they may be, but the truth, the uncoloured truth, from nature. But it must be remembered that the present existence of what has been called 'spontaneous generation,' the origin of life *de novo* to-day by physical law, is by no means required by the doctrine of evolution. Prof. Huxley, for example, says, 'If all living beings have been evolved from pre-existing forms of life, it is enough that a single particle of protoplasm should once have appeared upon the globe, as the result of no matter what agency; any further independent formation of protoplasm would be sheer waste.' And why? we may ask. Because one of the most marvellous and unique properties of protoplasm, and the living forms built out of it, is the power to multiply indefinitely and for ever!

What need, then, of spontaneous generation? A locomotive on a great journey, that is specifically endowed with the power to generate its own steam, surely does not need stationary engines placed all along the line to generate steam for it. It is certainly true that evidence has been adduced purporting to support, if not establish, the origin in dead matter of the least and lowest forms of life. But it evinces no prejudice to say that it is inefficient. For a moment study the facts. The organisms which were used to test the point at issue were those known as septic. The vast majority of these are inexpressibly minute. The smallest of them, indeed, is so small that 50 millions of them, if laid in order, would only fill the one-hundredth part of a cubic inch. Many are relatively larger, but all are supremely minute. Now, these organisms are universally present in enormous numbers, and ever rapidly increasing—in all moist putrefaction over the surface of the globe." Referring to an experiment made with a few shreds of fish muscle and brain in pure water, and which in a brief space gave rise to a multitude of many living and moving organisms, Dr. Dallinger asked, "How did these organisms arise? The water was pure; they were not discoverable in the fresh muscle of fish. Yet in a dozen hours the vessel of water is peopled with hosts of individual forms which no mathematics could number! How did they arise—from universally diffused eggs, or from the direct physical change of dead matter into living forms?

Twelve years ago the life-histories of these forms were unknown. We did not know biologically how they developed. And yet with

this great deficiency it was considered by some that their mode of origin could be determined by heat experiments on the adult forms. Roughly the method was this. It was assumed that nothing vital could resist the boiling point of water. Fluids containing full-grown organisms in enormous multitudes, chiefly bacteria, were placed in flasks, and boiled for from 5 to 10 minutes. While they were boiling the necks of the flasks were hermetically closed, and the flask was allowed to remain unopened for various periods. The reasoning was: Boiling has killed all forms of vitality in the flask. By the hermetical sealing nothing living can gain subsequent access to the fluid; therefore, if living organisms do appear when the flask is opened, they must have arisen in the dead matter *de novo* by spontaneous generation. But if they do never so arise the probability is that they originate in spores or eggs. Now it must be observed concerning this method of inquiry that it could never be final; it is incompetent by deficiency. Its results could never be exhaustive until the life-histories of the organisms involved were known. And further, although it is a legitimate method of research for partial results, and was of necessity employed, yet it requires precise and accurate manipulation. A thousand possible errors surround it. It can only yield scientific results in the hands of a master in physical experiment. And we find that when it has secured the requisite skill, as in the hands of Prof. Tyndall for example, the result has been the irresistible deduction that living things have never been seen to originate in not-living matter. Then the ground is cleared for the strictly biological inquiry, How do they originate?

To answer that question we must study the life-histories of the minutest forms with the same continuity and thoroughness with which we study the development of a crayfish or a butterfly. The difficulty in the way of this is the extreme minuteness of the organisms. We require powerful and perfect lenses for the work. Happily during the last fifteen years the improvement in the construction of the most powerful lenses has been great indeed. Prior to this time there were English lenses that amplified enormously. But an enlargement of the image of an object avails nothing if there be no concurrent disclosure of detail. Little is gained by expanding the image of an object from the ten-thousandth of an inch to an inch, if there be not an equivalent revelation of hidden details. It is in this revealing quality, which I shall call magnification as distinct from amplification, that our recent lenses so brilliantly excel. It is not easy to convey to those unfamiliar with objects of extreme minuteness a correct idea of what this power is. But at the risk of extreme simplicity, and to make the higher reaches of my subject intelligible to all, I would fain make this plain." Dr. Dallinger then went on to give a series of greatly magnified illustrations, beginning with the sting of the bee, and going on through a long series of interesting specimens of the lowest forms of life. He described and illustrated with great minuteness experiments in the generation of these forms of life, from all of which he maintained it to be clearly proved that dead matter cannot be developed into living.

"We conclude," he said, "with a definite issue—viz. by experiment it is established that living forms do not now arise in dead matter. And by study of the forms themselves it is proved that, like all the more complex forms above them, they arise in parental products. The law is as ever, only the living can give rise to the living."

Intelligence in the Lowest Animals.*—"No one," writes Dr. G. J. Romanes, "can have watched the movements of certain Infusoria without feeling it difficult to believe that these little animals are not actuated by some amount of intelligence. Even if the manner in which they avoid collisions be attributed entirely to repulsions set up in the currents which by their movements they create, any such mechanical explanation certainly cannot apply to the small creatures seeking one another for the purposes of prey, reproduction, or as it sometimes seems, of mere sport. There is a common and well-known rotifer whose body is of a cup shape provided with a very active tail, which is armed at its extremity with strong forceps. I have seen a small specimen of this rotifer seize a much larger one with its forceps and attach itself by this means to the side of the cup. The large rotifer at once became very active, and swinging about with its burden until it came to a piece of weed, it took firm hold of the weed with its own forceps, and began the most extraordinary series of movements, which were obviously directed towards ridding itself of its encumbrance. It dashed from side to side in all directions with a vigour and suddenness which were highly astonishing, so that it seemed as if the animalcule would either break its forceps or wrench its tail from its body. No movements could possibly be better suited to jerk off the offending object, for the energy with which the jerks were given, now in one direction and now in another, were, as I have said, most surprising. But not less surprising was the tenacity with which the smaller rotifer retained its hold. . . . This trial of strength, which must have involved an immense expenditure of energy in proportion to the size of the animals, lasted for several minutes, till eventually the small rotifer was thrown violently away. It then returned to the conflict, but did not succeed a second time in establishing its hold. The entire scene was as like intelligent action on the part of both animals as could well be imagined, so that if we were to depend upon appearances alone, this one observation would be sufficient to induce me to attribute conscious determination to these microscopical organisms.

But without denying that conscious determination may have been present, or involving ourselves in the impossible task of proving such a negative, we may properly affirm that until an animalcule shows itself to be teachable by individual experience we have no sufficient evidence derived or derivable from any number of such apparently intelligent movements that conscious determination is present. Therefore I need not wait to quote the observations of the sundry microscopists who detail facts more or less similar to the above, with expressions of their belief that microscopical organisms display a

* 'Animal Intelligence,' 8vo, London, 1882.

certain degree of instinct or intelligence as distinguished from mechanical or wholly non-mental adjustment. But there are some observations relating to the lowest of all animals, and made by a competent person which . . . in my opinion prove that the beginnings of instinct are to be found so low down in the scale as the Rhizopoda."

The observations of Mr. H. J. Carter are then quoted.* One relates to *Æthalium*, which will make its way over the side of a watch-glass to get to the sawdust in which it has been living. In another case he saw an *Amœba* climb up the stalk of an *Acineta* which contained a young one ("tender and without poisonous tentacles"), place itself round the ovarian aperture, receive the young one, incept it, descend from the parent, and creep off with it. This Dr. Romanes considers, although certainly very suggestive of something more than mechanical response to stimulation, is not sufficiently so to justify us in ascribing to these lowest members of the zoological scale any rudiment of truly mental action. The subject, however, is here full of difficulty, and not the least so on account of the *Amœbæ* not only having no nervous system, but no observable organs of any kind, so that, although we may suppose that the adaptive movements described by Mr. Carter were non-mental, it still remains wonderful that these movements should be exhibited by such apparently unorganized creatures, seeing that as to the remoteness of the end attained, no less than the complex refinement of the stimulus to which their adaptive response was due, the movements in question rival the most elaborate of non-mental adjustments elsewhere performed by the most highly organized of nervous systems.

In Cœlenterates Dr. Romanes notices M'Crady's account of a medusa which carries its larvæ on the inner side of its bell, moving the manubrium from side to side to give suck to the larvæ on the sides, but he does not consider this is due to intelligence. The mode in which *Sarsia* seeks the light is in the nature of a reflex action, and he does not concur in Dr. Eimer's distinction between the "involuntary" and "voluntary" movements of medusæ.

Some of the natural movements of the Echinodermata, as also some under stimulation, are very suggestive of purpose, but Dr. Romanes has satisfied himself that there is no adequate evidence of the animals being able to profit by individual experience, so that there is no adequate evidence of their exhibiting truly natural phenomena.

Of Vermes, the only instances cited are Mr. Darwin's observations on earth-worms, and Sir E. Tennent's on Ceylon land-leeches.

In Mollusca, the more important observations relate to snails, limpets, and oysters. There is no doubt, he considers, that if a larger sphere of opportunity permitted, adequate observation of the Cephalopoda would prove them to be much the most intelligent members of the Sub-kingdom.

The foregoing occupies pp. 18–30 of Dr. Romanes's book; the remainder (pp. 31–498) deals with Ants, Bees and Wasps, Spiders and Scorpions, remaining Articulata and the Vertebrates.

* Ann. and Mag. Nat. Hist., xii. (1863) pp. 45–6.

Mollusca.

New Type of Mollusc.*—W. H. Dall describes a remarkable new form of mollusc, being a pelecypod or lamellibranch with an internal shell.

The animal is about 1 in. in length, somewhat of the shape of a small globose *Cypræa*, of inflated ovoid form, translucent, jelly-like, dotted above with small, rounded papillæ, which appear of an opaque white on the general translucent ground. The mantle which covers the dome of the body is tough and thick: the sides are smooth, and nearly free from papillæ. The superior median line is a little depressed. The basal part of the anterior end in life is prolonged beyond the general mass in a wide trough, with the convexity upward, and somewhat expanded at its anterior extremity. About one-third of the way from the anterior end, the mantle is perforated by an orifice, which pierces it in the vicinity of the mouth. The edges of this orifice project from the general surface, and it is lined with close-set, small papillæ. At about the same distance from the posterior end is another tubular perforation, holding a similar relation to the anus; which has, however, plain edges, and is not internally papillose.

Turning the animal over, we find the anterior trough of the mantle prolonged backward, like a slit with plain edges, to about the posterior third; from this projects a narrow, hatchet-shaped foot, with a strongly marked byssus-gland at its posterior angle; from this a bunch of white byssus extends to the stone or other object to which the mollusc attaches itself. The cavity of the mantle extends some distance behind the commissure of the pedal opening. The anterior point of the foot is roofed by the trough-like expansion above mentioned. The mouth is provided with two pairs of small palpi. Two gills, very finely microscopically laminate, extend backward from near the mouth, on each side, to the posterior end of the body, the wider one being the inner: between their posterior ends a thin reticularly perforate veil connects the two pairs, and shuts off the anal area from the rest of the mantle cavity. The intestine contains a hyaline stylet, and is considerably convoluted; but the viscera offer no marked peculiarities when compared with ordinary pelecypods. The shells are enclosed in two little sacs in the substance of the mantle. The umbones are near together, apparently connected by a brown gristle resembling an abortive ligament, and are nearly over the heart. The valves are about 10 mm. long and 1 mm. wide, destitute of epidermis, prismatic or pearly layers. There are no muscular or pallial impressions, no adductors, hinge, or teeth. They resemble in form the exterior of *Gervillia*, as figured by Woodward, and are pure white. As they lie in the body, they diverge at a rather wide angle from the beaks, forward. The embryonic valves are retained like two tiny bubbles on the umbones.

Whatever be its relations to the higher groups, a point to be determined by further study, there can be no doubt that the animal

* Science, iv. (1884) pp. 50-1.

forms the type of a new family, Chlamydoconchæ, and the author gives it the name of *Chlamydoconcha Orcutti*. It is evident already, that the genus does nothing toward bridging the gap between the gastropods and pelecypods, but is simply a remarkably aberrant form of the latter group, and probably derived from some form with an external shell.

Taking-in of Water in relation to the Vascular System of Molluscs.*—E. Ray Lankester, while recognizing that the supposition that water is admitted by pores into the vascular system of molluscs is supported by the commonly received doctrine that water is admitted by the madreporite to mix with the cœlomic fluid of Echinoderms, and that its correlated outpouring is favoured by the undoubted fact that the cœlomic fluid is occasionally shed through the dermal pores of the earthworm, doubts its occurrence in molluscs in consequence of having ascertained the presence of hæmoglobin in the plasma of the blood-fluid of *Planorbis*, and in the corpuscles of *Solen legumen*. In *Solen* no shedding-out of blood-fluid occurs while the surface of the animal is uninjured, and the complete distension of the foot is produced by the simple mechanism of a rapid flow of blood from the mantle and body into the foot. *Planorbis* presents evidence of essentially the same kind.

A distinction must be made between the outpouring of the vascular fluid and the introduction of water through pores on the surface; on the whole there seems to be no sufficient proof that the pericardium of molluscs is in any case (except that of the Neomeniæ) a blood space; and, therefore, the blood cannot escape through it and the renal organs to the exterior.

The view that water is introduced by pores in the foot is not supported by Lankester's observations on *Anodon* or *Solen*, and these pores must be demonstrated, by the supporters of the doctrine, in a way which will satisfy a histologist, and the evidence must not be allowed to rest on experiments made by the diffusion of a soluble colouring matter; it is to be noted that Griesbach, the present leading supporter of the doctrine, has found that finely divided coloured powder cannot be made to enter the vascular system through the surface of the foot.

Eyes and other Sense-Organs in the Shells of Chitonidæ.†—H. N. Moseley, on examining a specimen of *Schizochiton incisus* dredged in the Sulu Sea, was "astonished to remark on the shells certain minute, highly refracting, rounded bodies arranged in rows symmetrically." On further examination they were found to be eyes, and on search being made in other genera, they were detected in the majority, but in each genus they differ more or less in structure and arrangement. These eyes are entirely restricted to the outer surface of the shells on their exposed areas, and do not extend on to the laminæ of insertion; they are mostly circular in outline, and measure from 1/175 to 1/600 in. They are surrounded and set off by a narrow zone of dark pigment, and in the centre of each convex spot

* Zool. Anzeig., vii. (1884) pp. 343-6.

† Ann. and Mag. Nat. Hist., xii. (1884) pp. 141-7.

is a smaller darker area, due to the outline of the iris, but with a brilliant speck of totally reflected light, due to the lens. Numerous longitudinal canals lodge a specially large stem of soft tissue and nerves, which ramifies towards the surface and terminates either in eyes or in peculiar elongated bodies which are, apparently, organs of touch. From these latter the eyes may be supposed to have arisen by modification. The corneæ, which are calcareous, are seen in section to be formed of a series of concentric lamellæ; the pear-shaped cavity of the eye is lined by a dark brown pigmented choroid of a stiff and apparently somewhat chitinous texture. The lens is perfectly transparent and strongly biconvex. At some distance from the eye the optic nerve is a compact strand, but in the very long tube continuous with the choroid its numerous fine fibres are much separated from one another. The retina is formed on the type of that of *Helix*; and not as might be supposed, on that of the dorsal eyes of *Oncidium*; it is not perforated by the optic nerve, but it is composed of a single layer of very short, but extremely distinct and well-defined rods, with their ends directed towards the light. A number of the fibres of the nerve do not enter the retina at all, but terminate in small plugs of tissue corresponding to the minor organs of touch; they appear to form a sensitive zone round each eye. The choroid sacs have a curious open fold which calls to mind the choroid fissure. In some genera—e. g. *Chiton*—eyes are entirely absent, though the small and large touch-organs are present.

The difficult problem of the classification of the Chitonidæ will probably be rendered easier, owing to the differences in arrangement and number of the eyes in different genera; in *Corephium aculeatum* there must be 3000 on the anterior shell alone, counting only those in good condition; and on the remaining shells as many as 8500.

Prof. Moseley has been unable to trace the nerves to their source, but he doubts not that they proceed from the parietal (branchial) nerve. He concludes that the tegmentary part of the shell of the Chitonidæ is something *sui generis*, entirely unrepresented in other Mollusca. Its chief function seems "to be to act as a secure protection to a most extensive and complicated sensory apparatus, which in the Chitonidæ takes the place of the ordinary organs of vision and touch present in other Odontophora." There are some curious resemblances to the Brachiopoda.

The eyes are ordinarily hard to see on a dried shell with a powerful lens; the shell should be wetted with spirit and examined with a lens as powerful as Hartnack's No. 4 objective.

Renal Organs of Embryos of Helix.*—P. de Meuron describes the primitive renal organs of *Helix* as arising from ectodermal invaginations, and not as being mesodermal in origin as are, according to Rabl, the kidneys of the aquatic Pulmonata. The walls of the organ are formed by large cells, with enormous nuclei, which are set in a radiate fashion round the central canal of the tube; some of the cells become of a particularly large size, as in the forms studied

* Comptes Rendus, xcviii. (1884) pp. 693-5.

by the German embryologist. The internal end of the organ is very difficult of detection among the mesodermal cells by which it is surrounded; however, there appears to be an orifice which is provided with vibratile cilia, essentially similar to what has been seen by Fol in the aquatic Pulmonata, and by Jourdain in slugs.

The primitive kidney does not as in *Bithynia* (Sarasin) appear to have any relation to the velum. The permanent renal organ seems to be formed from an ectodermal invagination, and a mesodermal growth. The author suggests that the pericardiac cavity is the cavity of a somite, and that another is indicated by the primitive kidney which is the excreting organ of the anterior, as is the permanent kidney of the posterior somite.

Nervous System of Parmophorus australis.*—M. Bontan describes the nervous system of the Gasteropod *Parmophorus australis*, specimens of which were collected near Sydney, as being similar in its main features to that of *Haliotis*, as described by Lacaze-Duthiers. The line of papillæ between the foot and the first fold of the mantle, is the homologue of the festooned border of the collarette of *Haliotis*. This row of papillæ forms part of the mantle, and cannot be referred to the foot. The study of *Parmophora*, in which the nervous centres are more separated than those of *Haliotis*, leaves no doubt in this respect.

Organization of Haliotis.†—H. Wegmann considers that *Haliotis* has many points in common with the Acephala. Thus:—There is a cœcum between the stomach and the intestine. The digestive tube is ciliated throughout its greater portion. There are the same connections between the liver and the digestive tubes as in the Lamellibranchs.

A series of organs, such as the renal organ, the auricle, and the gill, are in pairs instead of being odd. Two rudimentary gills, with the two that are developed, make up the four of the Acephala. The cardiac ventricle is traversed by the rectum. Two arterial passages arise from the two extremities of the heart. The venous circulation is in its fundamental characteristics that of the Acephala, and the position of the right renal organ between the branchiæ and the system is especially important. The structure and relationships of the renal organs are essentially the same in the two cases. There is also a remarkable simplicity in the genital apparatus; a complete absence of accessory glands and copulative organs; and a singular connection with the right renal organ, as in many of the Acephala.

Absorption of the Shell in Auriculidæ.‡—Crosse and Fischer illustrate and describe the peculiar absorption of the inner parts of the upper whorls of the shell in this family, and also in the genus *Olivella*. These animals appear to have the power of dissolving entirely the internal partitions of the shell, from a point some distance inside the aperture to the very apex. The only exception in the

* Comptes Rendus, xcviii. (1884) pp. 1385–7. † Ibid., pp. 1387–9.
‡ Journ. de Conchyl., xxii. (1883) p. 3. Cf. Science, ii. (1883) pp. 663–4.

family Auriculidæ is the genus *Pedipes*, in which the partitions were found intact. The absorption is not always complete, nor are the same parts invariably missing. Complete absorption was observed in *Melampus*, *Auricula*, *Blauneria*, *Marinula*, *Tralia*, *Alexia*, *Monica*, *Plecotrema*; only partial absorption in *Cassidula* and *Scarabus*. The case of *Olivella* is more remarkable, since the allied groups *Oliva*, *Ancillaria*, &c., do not, according to the authors, present this peculiarity at all. Tryon, however, observes * that in *Oliva reticularis* he has found the walls absorbed away, so that very little of the substance remained, and considers it probable that all shells with close volutions are in the habit of absorbing them internally. It is certainly the case with many of them.

Development of the Digestive Tube of Limacina.†—S. Jourdain, having reminded us that the first indication of the pharyngeal vestibule of the Limacina appears as an invagination of the vitelline mass, and that, later, another invagination, which corresponds to the anal opening, appears in the middle line, between the two external openings of the segmental organs, now tells us that the base of the pharyngeal invagination is continuous with a cavity, the walls of which are mesodermal and are lined by endodermal cells. The digestive tube has, at this period, the form of a sac ending in a spherical diverticulum, which will become the gland that is incorrectly spoken of as the liver. This gland has at first a mesodermal and an endodermal origin; the framework being formed of mesoderm, and the secreting tissue of endoderm. The hepatic tissue is filled with a finely granular fluid, which is coagulated by heat, alcohol, or nitric acid, but does not lose its transparency; it is a kind of secondary yolk, the quantity of which increases rapidly during the early periods of embryonic development, and which fills the digestive tube. It probably arises from the elaboration of the albumen of the egg and is digested by the embryo during its development.

The internal wall of the alveoli of the hepatic sac gives rise to cells by budding; these cells gradually take on the characters of the secreting elements of the liver, so that each alveolus becomes a lobe of the hepatic organ. This organ ought not to be called a liver: it is only a diverticulum of the stomachal portion of the intestinal tract. It performs so many functions that it would be better spoken of as a chylific gland. Moreover, its mode of development may explain the bizarre forms that it sometimes attains, as for example, in the Eolidiæ, where we may suppose that each of the alveoli of the organ became isolated, acquired a great size, and took the form of the varied appendages which are found in those Gastropoda.

Molluscoida.

Simple and Compound Ascidians.‡—W. A. Herdman is unable to find a single satisfactory character by which to distinguish simple from compound Ascidians. Reproduction by gemmation and the

* Man. Conch.: Olivella, p. 64.
† Comptes Rendus, xcviii. (1884) pp. 1553-6.
‡ Nature, xxix. (1884) pp. 429-31.

formation of colonies in the latter group will not hold, since it is possible to pass from *Ciona*—a typical simple Ascidian—to *Distoma* and the very heart of the compound Ascidians through the following series of forms, which shows a perfect gradation of these characters :—*Ciona*, *Rhopalœa*, *Ecteinascidia*, *Clavelina*, *Diazona*, *Chondrostachys*, *Oxycorynia*, *Distoma*. The formation of common cloacal cavities, canals, and apertures cannot be considered as a diagnostic feature of the compound Ascidians, as there are forms considered by all authorities as Synascidiæ, such as *Chondrostachys*, *Diazona*, *Distoma*, and others, in which the atrial apertures of the Ascidiozooids open independently on the surface of the colony, and no common cloaca is formed.

The characters taken from the condition of the test, break down like the others. In the first place, in passing along the series of forms connecting *Ciona* and *Distoma*, we encounter all stages between a distinct test or tunic for each individual, and a common mass in which a number of Ascidiozooids are imbedded. And secondly, the remarkable group "Polystyelæ" presents many of the characters of highly differentiated simple Ascidians (the Cynthiidæ) along with the supposed Synascidian feature of a colony composed of many Ascidiozooids completely buried in a common test.

Digestion in Salpa.*—Dr. C. S. Dolley combats the view of Korotneff as to the existence of a large amœboid cell or plasmodium in the œsophagus or stomach of *Salpa* which carries on a form of parenchymatous digestion of the food passing the resulting chyle into the walls of the intestine by means of its pseudopodia.

Dr. Dolley has observed the appearance in the intestines of *Salpa*, which had been described by the Russian author, but he suggests an entirely different interpretation. In *Salpa* we find a large branchial sac, representing the true pharynx, at the posterior portion of which is the stomach. The endostyle, or thickened bottom of a fold or groove of the branchial sac, throws out a supply of mucus, which covers the surface like a curtain, and in which nutritive particles finding their way into the animal are imbedded. The food is carried back by cilia, and the mucous sheet is wound up into a thread, which can be traced into the œsophagus, and from there to the stomach. This mucous exudation is the amœboid cell of Korotneff.

Fresh-water Bryozoa.†—K. Kräpelin has been able to find, in the neighbourhood of Hamburg, examples of all the genera (except perhaps *Lophopus*) of Bryozoa that are known to inhabit the fresh waters of Europe. In addition to these he found large masses formed by colonies of *Pectinatella magnifica*, described by Leidy as living near Philadelphia. In this genus, in *Cristatella*, and possibly also *Lophopus*, the statoblasts are set free on the death of the colony. The author asks for the assistance of correspondents for the purpose of making a more complete investigation into the biology and geographical distribution of these animals.

* Proc. Acad. Nat. Sci. Philad., 1884, pp. 113–5.
† Zool. Anzeig., vii. (1884) pp. 319–21.

Supposed new species of Cristatella.*—E. Potts describes the discovery of aggregations of colonies of a species of *Cristatella* (*C. lacustris*) apparently differing from *C. mucedo* of Europe and *C. Idæ* and *C. ophidioidia* of America. He considers it to be at least as clearly differentiated from any of the other species as they are from each other, though probably, as the differences existing amongst them are not considerable, all should be merged under *C. mucedo*.

Arthropoda.

a. Insecta.

New Type of Elastic Tissue, observed in the Larva of Eristalis.†—H. Viallanes has directed his attention to the curious movements of the respiratory tube which is found at the end of the body in the larvæ of *Eristalis*. It is formed of a number of cylinders, which can be shortened or elongated at the will of the animal: the elongation is effected by the contractions of the body, by means of which fluid is driven into it, and its shortening by special muscles and internal elastic bands. Each of these elastic bands is formed by a single cell, which is so constructed as to act as a piece of caoutchouc. The cell is fusiform in shape, and, while one of its extremities is attached to the neighbouring integuments, the other is prolonged into a process which is fixed to the inner face of the respiratory tube. The cell and its prolongation are invested in a membrane, which is of some thickness, but is very elastic. At the centre of the cell there is a very large spherical nucleus, which is surrounded by a quantity of protoplasm, which is also found in the prolongation. Within the cell itself there is developed a long elastic fibre, similar in its physical properties to those seen, for example, in the cervical ligament of a mammal; it is folded a large number of times around the nucleus, and passes in a straight line through the prolongation of the cell, to the extremity of which it is attached; by the other it fuses with the protoplasm of the cell. When the cell is drawn out the coiled portion becomes unfolded.

The facts detailed are of interest, as proving the high degree of complexity that may be attained within the limits of a single cell, and as throwing a new light on the morphology of elastic tissue, since they show that this may be, as in vertebrates, developed in the intercellular substance, or, as in *Eristalis*, in the protoplasm itself. It may be noted that striated muscular tissue presents analogous variations.

It would seem, then, that the same tendency obtains in elastic as in muscular tissue; in both cases, perfection is attained by parts leaving the protoplasm of the cells to which they primitively belonged, and, by becoming intercellular, being converted into the undivided property of neighbouring cells.

Submaxillary of the Jaw of Mandibulate Insects.‡—J. Chatin retains the name of submaxillary for the part of the buccal apparatus

* Proc. Acad. Nat. Sci. Philad., 1884, pp. 193-9 (1 pl.).
† Comptes Rendus, xcviii. (1884) pp. 1552-3.
‡ Ibid., xcix. (1884) pp. 51-3.

so named by Brullé, and called the cardo by Kirby and Spence. *Oligotoma Saundersii* is taken as the starting point, and its submaxillary described as being a small transverse piece slightly grooved on its inner surface. *Œdipoda cinerascens* has the same part provided with several deep articular cavities. In *Decticus* the organ is still more modified. In *Gryllus domesticus* it is strongly, and in *Phasma japetus* feebly articulated. In *Mantis religiosa* it is developed in a vertical direction, and has the appearance of some maxillæ. In *Hydrophilus piceus* the different portions of the organ are profoundly modified. The author considers that the descriptions which he gives are sufficient to show the interest which attaches to the morphological study of the submaxillary, and the changes undergone by a part which has been too often misunderstood, but whose correct interpretation is necessary in a comparative study of the appendages of the Arthropoda.

Structure and Function of Legs of Insects.*—F. Dahl ascribes our ignorance of the structure and functions of insects' legs to the fact that on the one hand most entomological works are of a purely systematic character, and that, on the other, anatomists have chiefly busied themselves with the axial parts only; in fact, Strauss-Durckheim, Newport, Burmeister, and Graber are the only authors to whom Dahl makes reference in his introduction.

The constancy of the number of six is probably to be explained as being in relation to the function of the legs as climbing organs; one leg will almost always be perpendicular to the plane when the animal is moving up a vertical surface; and on the other hand we know that three is the smallest number with which stable equilibrium is possible; an insect must therefore have twice this number, and the great numerical superiority of the class may be associated with this mechanical advantage. This theory is not weakened but rather supported by the fact that the anterior pair of legs is rudimentary in many butterflies, for these are almost exclusively flying animals.

The author describes in some detail the arrangements of the muscles of the legs; the nerve-cord supplying them is pretty stout, and the large number of filaments sent to the joints of the tarsus lead to the supposition that these have a tactile function; the nerve-fibres are seen to enlarge into thick spindle-shaped ganglia. There are two tracheal trunks.

The prime function of the legs is locomotor, and insects move through gaseous, fluid, and solid media. The last is seen in fossorial forms, of which *Gryllotalpa* may be taken as the type; here some of the joints are flattened out and provided with teeth, and the muscles are well developed. In some cases legs of a fossorial type are possessed by insects which move on the ground, but the larvæ of which are subterranean in habitat. The water-beetles and aquatic Rhynchota have the legs converted into swimming organs; they are widened out into plates and provided at the sides with movable hairs, which are directed slightly backwards. The median pair of legs in *Corisa* is provided with two very long hooks, the function of which is

* Archiv f. Naturg., l. (1884) pp. 146-93 (2 pls.).

to fix the animal at some depth among the water-plants, and so to prevent its floating upwards.

In the aerial forms we have first to notice those that move on the surface of the water; in these the legs are often provided with considerable enlargements of the tracheal trunk, by means of which they are enabled to float. Others have very long legs by which they can balance themselves and extend over a large surface of the water; the lower surface of the tarsal joints, or that which is in contact with the water, is provided with thick hairs. In some Diptera hairy lobes are developed. Arrangements for climbing are very widely distributed, and are very various in character; the most common are hooks which by their sharp tips are able to enter the smallest depressions and so obtain a firm hold; sometimes they are cleft and are thus adapted to hold on to fine branches; sometimes they are pectinate and enabled to catch hold of fine hairs.

In very many cases there are organs of fixation; in the locust they have their chief mass made up of a large number of free flexible rods (not tubes). The periphery is occupied by scales which correspond in number to the rods, with which they appear to be connected by fibres; the space between the rods is filled with a fluid. Below these are groups of spindle-shaped cells which appear to be glandular in character. The fixing surface of the Hymenoptera, Neuroptera, and Lepidoptera consists of an unpaired lobule placed between the hooks; their structure is most complicated in the first-named order. Observations on *Vespa crabro* did not result in the detection of any space which could be regarded as a vacuum. The lower surface of the lobule is soft and almost smooth; a few short hairs may be developed at its base; below this is a hard chitinous mass with stronger hairs. The upper surface is either covered with hairs or is finely folded. Near the base is a chitinous plate carrying a pair of strong setæ. Within is an elastic bar which is rolled up in a condition of repose; when extended it brings the lobule into contact with the surface on which the insect is standing. There are no well-developed gland-cells. After descriptions of other modes of fixation the author gives the following table.

A. Organs of attachment at the end of the foot.

a. Without fixing hairs	Orthoptera.
β. With fixing hairs	*Forficula.* Coleoptera. *Sialis.*

B. Organs of attachment between the hooks.

a. A distinct median lobe.	
a. The median lobe with chitinous arches.	
1. Secondary in addition to the median lobe	Neuroptera.
2. No secondary lobes	Hymenoptera.
b. No chitinous arches	Lepidoptera. *Tipula.*
β. No distinct median lobe.	
a. The lobes hairy	Diptera.
b. The lobes not hairy	Rhynchota.

The legs may, further, have a sexual function as attaching or holding organs; or, as in *Mantis religiosa*, *Nepa cinerea*, &c., they may be of use in seizing prey; and, finally, they may be used as cleansing organs. The legs in ants may be seen to be pectinate, an admirable arrangement for forms that live in dust and earth; they are often specially adapted for cleansing the proboscis, and for other functions for an account of which we must refer to the paper itself.

Organs of Attachment on the Tarsal Joints of Insects.*—G. Simmermacher first takes up the case of sexual organs of attachment in the Coleoptera, where the males have some of the tarsal joints more or less remarkable on account of their widened form, and for the possession on the lower surface of suckers which are visible to the naked eye. The differences between males and females are best seen in the Dyticidæ, where the first three tarsal joints of the first pair of limbs are distinguished from those that succeed them, on account of their greater breadth; those of the second pair are a little less remarkable. The suckers that are developed belong to the group of modifications which were associated together by Plateau under the head of "cupules sessiles," but the author finds that the large suckers have a stalk, and they are, further, distinguishable from the smaller suckers by the presence of better developed and more numerous ridges. The stalk is traversed by a canal. The disposition of the suckers on the joints is described.

The tarsi are moved by a strong muscle, the long axis of which is parallel to that of the foot; it is attached to the chitinous exoskeleton at every joint, and consists of several muscular fibrils, through which pass branches of the tracheal system; the muscle is attached to the stalk of the sucker, the movement of which is, therefore, under the control of the will. The suckers are to be found on the tarsi of the males of all the twelve genera of Dyticidæ living in Germany; the differences seen are found to be constant in genera and species; such differences as obtain are due to (α) either the tarsal joints of the first and second pair of feet are partly widened out and beset with suckers (*Dyticus*), or there are suckers on the first pair only (*Cybister*); (β) the three tarsal joints on the first pair are very greatly widened and rounded, and those of the second are but little altered (*Dyticus*), or, as in *Hybius*, the first pair of feet are but little altered; (γ) the suckers are either rounded (*Dyticus*), or elongated as in *Cybister*; (δ) the suckers on one and the same joint are either all similar, or they differ in form or size, or in the form of their joints. A systematic description of the organs is given for the different genera.

Simmermacher is of opinion that the grooves on the wing-covers of the female Dyticidæ have no function in copulation, and in this he agrees with the results lately obtained by Dr. Sharp, whose important monograph he did not see till the first part of his own work had been concluded.

The Carabidæ and Cicindelidæ are next dealt with in the same manner.

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 481–556 (3 pls.).

In the second part of the essay climbing organs are dealt with; in the Chrysomelidæ, Hylobiidæ, Telephoridæ, and Cerambycidæ, the tarsi, in both sexes, are provided on their lower surface with chitinous structures which to the naked eye have the same appearance as those which are found in the males only of the families already discussed. The groups just mentioned live either in water or on leaves or stems, where they move about by means of the tubules covering their tarsi, and by the aid of which they can fix themselves in various positions. These chitinous structures are always tubular, and they are never found on more than the first three joints of the tarsi. In the tetramerous forms they are widened out and have a distinct orifice, but in the pentamerous Telephoridæ they end in a sharp point. In most cases the tubules pour out a secretion, and it is probable that we have here to do with the phenomena not of actual attachment by, as it were, glueing, but of adhesion; the orifice of the tubes is directed obliquely, and the tubes are, at this point, extremely delicate and flexible, so as to adhere by their lower surface; in this adhesion they are aided by the secreted fluid.

In the Cerambycidæ there is no secretion, and the tubules are merely sucking organs, analogous to those which are found in the male Silphidæ.

Discussing the Diptera, observations on which have been made by a number of naturalists whose results are here compared, the author describes the ordinary arrangement (such as is seen, for example, in the common house-fly) as consisting of two attaching lobes; between these there is a rod-shaped elongated piece, beset with chitinous hairs. He does not accept the theory by which the movement of the fly along smooth surfaces is ascribed to an alternate fixation and separation, but believes in a process of adhesion, aided by a secretion, just as in the case of the Coleoptera. The attaching lobes closely beset with chitinous hairs are enabled, in consequence of the pressure of the foot, to completely lie along any smooth surface; this expels the air beneath the lobes, which are then acted on by the pressure of the outer air.

There are a few observations on the Hemiptera, Neuroptera, Lepidoptera, Hymenoptera, Orthoptera, and Strepsiptera; and, in conclusion, analogous cases are cited from other divisions of the animal kingdom; sucking tubes are seen in the Acinetæ, ambulacral feet in Echinids and Asterids, sucking organs of attachment in *Chiton* and *Patella*, suckers in the Cestoda and the Hirudinea; Schmidt regards the pectines of the scorpion as having a similar function, and numerous examples are to be found among Vertebrates.

Locomotion of Insects on Smooth Surfaces.*—Dr. J. E. Rombouts writes as follows:—

"I have concluded from my experiments that it is not the pressure of the air nor the power of an adhesive liquid that gives flies the faculty of running over smooth bodies, but that the power should be

* Amer. Mon. Micr. Journ., v. (1884) pp. 99-100. From Pop. Sci. Mon., May 1884.

attributed to the molecular action between solid and liquid bodies; or, in other words, to capillary adhesion.

If we examine the under part of the pulvilli with a Microscope, we shall see distinctly that it is furnished with numerous hairs, regularly distributed. These hairs terminate, at their lower end, in a kind of bulb, the form of which varies, whence flows an oily liquid that dries slowly and does not harden for a long time. The minute drops left on the glass by the hairs may be taken away, even after two or three days have passed, without our having to moisten them, by simply rubbing a piece of fine paper over them.

I have devised an apparatus for collecting these drops by cutting a hole in a piece of board, over which I fix a glass slide. Turning the board over so that the glass shall be at the bottom, I have a little cell with a glass floor. With the aid of a piece of paper gummed to the wings, I introduce a fly into this cavity in such a manner that the pulvilli shall rest upon the floor. Then, putting the board under the Microscope with the glass slide uppermost, we have the fly's feet under our eyes. The insect, struggling for liberty, places his pulvilli against the glass, and leaves after each effort traces that may be observed very distinctly, for they are perfectly visible in a good light.

We may discover, whenever the feet of the fly come again in contact with these tracks or minute drops, that they are composed of a very liquid substance, for they spread quite readily on the glass. We cannot admit, as some naturalists assume, that the liquid can hold the club-shaped hair-ends by suction. If this were the case, the ends would change shape during the suction, and would take the form of a disk. The fly puts its feet down and lifts them up with an incomparable facility that would not exist if the limb were really acted upon by the pressure of the air."

Organs of Flight in the Hymenoptera.*—Dr. Amans has a further paper on flying organs in insects, and in the groups now studied he recognizes as constant factors the following. The general form of the machine must be a more or less elongated oval, with its widest end directed forwards. The framework must have a solid floor with more or less elastic walls, more or less united behind so as to form a fixed transverse pivot-line; the walls must be sustained by a vertical column, and there must be a roof movable on these walls around the pivot-line, from before backwards and below upwards. The rotation is effected by means of the wings.

The "schematic form of the wing" is that of an elastic triangular surface, the breadth of which gradually diminishes from before backwards, and from base to summit, the latter being centrifugal. For its articulation the wing must have a double articular surface at its point of attachment, and the movable roof must articulate with the apex of the angle of the dihedron. The surface in front of the point of attachment must be one of pronation, that behind it of supination. The motors are (*a*) forces that are elevating, retracting, and divari-

* Rev. Sci. Nat., xii. (1884) pp. 482–522 (2 pls.).

cating; (*b*) forces antagonistic to the preceding; (*c*) propulsive, flexing and depressing the anterior plane; and (*d*) forces which depress and propel the posterior plane. The first two of these are inserted into the roof and floor, the last two into the base of the wing. The motor forces are the voluntary muscles, the actions of which are combined with involuntary, that is, elastic forces: of the latter, the chief are the resistance of the roof to the curvature caused by the former when the wing is depressed, and the resistance of the anterior part of the point of support to the flexion due to the muscles of group (*c*).

The author bases these conclusions on what he has seen in the Orthoptera, Pseudo-neuroptera, and Hymenoptera.

Poison of the Hymenoptera and its Secreting Organs.*—G. Carlet, in opposition to previous observers, finds that the venom-producing apparatus of the Hymenoptera is always formed by two distinct systems of glands, one of which has a secretion which is strongly acid, and the other feebly alkaline. The two systems open at the base of the spine, and the combined liquid is always acid. Experiments made on the common house-fly showed that the sting of a venomous Hymenopteron was always followed by the immediate death of the fly, but that the inoculation of the product of either of the glands does not result in death, or only in death after a long interval. The successive inoculation of the two secretions leads to death shortly after the second inoculation, and we may suppose that life ceases as soon as the two liquids have mixed. It is then clear that the union of the acid and alkaline secretions is necessary for the venom to have any fatal effects.

Development of Cerocoma Schreberi and Stenoria apicalis.†—H. Beauregard communicates some facts as to the development of certain insects allied to *Cantharis;* the larvæ appear to be mellivorous, and it is possible that they may live as parasites indifferently in certain Hymenoptera. The larvæ, contrary to the habits of *Epicanta* and *Macrobasis*, as described by Riley, do not live on the eggs of Orthoptera. It has been found that the larva of *Cerocoma* lives on the honey of *Colletes* and of *Osmia*.

Other pseudochrysalids found in the cells of *Colletes signata*, and presenting a very regular ovoid form, of a golden yellow colour, and enveloped in a very fine iridescent pellicle, were watched through the winter, and found in May to commence to undergo a series of metamorphoses which ended in the appearance of the adult *Stenoria apicalis*, which was found by Lichtenstein to be, in its earliest stages, parasitic on *Colletes fodiens*. Here, again, therefore, we have evidence as to the indifference which these parasites exhibit as to their choice of a host. The history of development justifies the separation of *Stenoria* from the true *Sitaris*.

Dipterous Larvæ.‡—Dr. F. Brauer has published a valuable monograph on this subject, the result of ten years' labour.

* Comptes Rendus, xcviii. (1884) pp. 1550–1.

† Ibid., xcix. (1884) pp. 148–51.

‡ Denkschr. K. Akad. Wiss. Wien, xlvii. (1883) 100 pp. (5 pls.). Cf. Amer. Natural., xviii. (1884) pp. 609–11.

After lengthy remarks on the systematic relations of different groups of Diptera, based on the larval characters, he states that the typical, inherited feature in the entire group of Dipterous larvæ appears to be the position of the brain, whether it is contained in a head-capsule, or free, i. e. far behind the mouth or immediately behind the chitinous capsule, supporting some of the mouth-parts, and containing the œsophagus. Less important characteristics are then enumerated. A very unsafe character is the number of visible body-segments.

The characters of the dipterous larvæ in general are laid down and the value of the larval characters in classification discussed. A tabular view of the nervous systems of the larval as compared with the adult Diptera is followed by a section on the character of the sub-orders and families which occupies the greater part of the work. It is succeeded by short descriptions of a few larvæ of the families Tabanidæ, Leptidæ, Dolichopidæ, and Empidæ.

Larvæ of North American Lepidoptera.*—A. Gruber gives a description of the larvæ of some Papilionidæ and Nymphalidæ; scanty as his material seems to have been, he thinks that the larvæ before him give indications of the possibility of making out the genetic relations of the species.

The first stage of the larvæ of the Papilionidæ is distinguished by the constant possession of well-developed warts, on which there are long setæ that give a hairy appearance to the caterpillar. They are longest on the most anterior and the most posterior rings of the body and a correlation is apparent between the thoracic and the three last abdominal segments. After each ecdysis the warts decrease in size, and sooner or later disappear altogether; the smallest, or those on the median segments, are the first to be lost. The function of these warts appears to be that of providing suitable and prominent points of attachment for the setæ; it is to be noted that the warts are rudimentary in proportion to the distinctness of the markings on the caterpillar. It is these markings that have been seized upon by natural selection, and the other characters, which have lost their significance, have been gradually suppressed. When the warts do not interfere with the markings, as in the case of larvæ with black transverse bands, they do not completely disappear until the last ecdysis.

We may, therefore, suppose that the larvæ of the Papilionidæ have been derived from forms which were indifferently coloured and not strongly marked, and which possessed strong setigerous warts; all the larvæ in their first and even in their second stage, resemble this hypothetical primitive form. Numerous intermediate conditions are to be observed between it and the conspicuously marked forms found at the present time, and each larva more or less completely repeats, at its ecdyses, the phylogenetic history of its species.

Further than this, we may suppose that those larvæ which retain their warts longest are the oldest forms, or those that stand nearest to the primitive form.

The Nymphalidæ present arrangements which are the opposite

* Jenaisch. Zeitschr. f. Naturwiss., xvii. (1884) pp. 465-87 (2 pls.).

of what are seen in the Papilionidæ, for, in the first stage, the setæ are set on inconspicuous elevations of the integument; in the second there are conical warts, and these increase in size with each ecdysis: the warts of the Nymphalidæ are, therefore, not inherited, but acquired structures; their armature becomes of great importance and affects their external form.

The most primitive setæ appear to be those which are long, slightly curved, and finely toothed on their margin; in the course of development they become simply smooth or swollen at their base.

The author hopes that the suggestions he puts forth will be examined by those who have access to a larger number of examples, and justly remarks that the investigation would be very valuable and interesting.

Drinking Habit of a Moth.*—E. D. Jones describes a remarkable drinking habit of a yellow and black Brazilian moth (*Panthra pardalaria*). He found these moths sitting on the wet stones in small streams near San Paulo, sucking up the water in a continuous stream, and letting it escape in drops from the abdomen. These drops fell at the average rate of 50 per minute, and as near as he could judge of their size, the total quantity of water which must thus pass through the body of the moth in three hours must be a cubic inch, or about 200 times the bulk of its own body. Mr. Jones speculates on the possible meaning of this and asks—"Can it be that the moth extracts nourishment from minute particles of organic matter contained in the water?" He remarks, however, that the water of the streams appears very clear and pure, and notes that the moths seem specially adapted for this habit. The tibiæ of the hind legs are very thick, and are armed with long hairs, which by their capillary action prevent the moth being immersed in the water "I have often," he adds, "seen one of them knocked down by a little spurt of water splashing over the stone on which it was standing, and it recovered itself almost immediately without being wetted in the least."

γ. Arachnida.

Michael's British Oribatidæ.†—It would be difficult to say too much in praise of this book which the Ray Society are fortunate in being able to publish as one of their invaluable series, while this Society may congratulate itself in numbering among its active members an author who has produced a work which has required so much labour and skill and so much perseverance, and which will rank as one of the not too numerous standard works in the English language devoted to sections of the Invertebrata. The author's tribute to the assistance rendered him by his wife, is an additional justification (if any is required) for the resolution which he recently moved for the admission of lady Fellows to the Society.

The classification of the Oribatidæ is fully dealt with, followed

* Proc. Lit. and Phil. Soc. Liverpool, xxxvii. (1883) pp. lxxvi.–vii.

† Michael, A. D., 'British Oribatidæ,' xi. and 336 pp. (3 pls.) 8vo. Ray Society, 1884.

by a chapter on their development and immature stages, the observations necessary for which were the most laborious part of the author's undertaking, involving the rearing of a large number of the microscopic animals in confinement, and their careful watching and the regulation of their hygrometic conditions every day for months! They had indeed to be carried about with him on any journeys. Amongst the habits of the Oribatidæ are enumerated their avoidance of light, which increases so much the difficulties of observation, their habit of carrying a portion of their cast skins and piling up dirt and rubbish on their backs to form an artificial covering, or investing themselves with a white substance. From the chapter which gives very detailed directions on collecting and preserving, we have already made some extracts.*

The remainder of the book deals with the anatomy of the exoskeleton and internal anatomy (pp. 110–190) and with the description of genera and species (pp. 191–327). 31 plates, mostly coloured (some of which have appeared in this Journal in connection with Mr. Michael's various papers), illustrate the text.

A type series of slides has been deposited by Mr. Michael in the Society's cabinet.†

δ. Crustacea.

Stomach of Podophthalmate Crustacea.‡—In this important contribution to our knowledge of the anatomy of the higher Crustacea, F. Mocquard, after the ordinary historical review, points out that in the Decapoda there are important differential characters, distinguishing the Brachyura from the Macrura, but that, as is already known, the so-called Anomura belong, some to the brachyurous and some to the macrurous type. When we review all the families we find in every natural one that the gastric apparatus is arranged on a special and characteristic type.

In the Brachyura the mesocardiac piece is narrow and triangular, while the pterocardiac ossicles are elongated and directed horizontally; in the Macrura, on the other hand, the former occupies the whole of the transverse line of the superior cardiac wall, while the latter are ordinarily shorter than in Brachyura and are set almost vertically. Although it is true that the short-tailed forms never present the characters seen in the gastric ossicles of the long-tailed, the converse proposition does not hold good, for in such Macrura as have undergone some degeneration, the ossicles are formed on almost the same type as in the Brachyura. The more detailed account of the differences between these two groups are set forth in the paper.

In passing from the normal Brachyura to the abnormal (or apterurous Anomura), we observe a certain number of characters intermediate between what are seen in the Brachyura on the one hand, and the Macrura on the other; and it is to be noted that, on a consideration of nothing but the arrangements of the parts of the gastric skeleton, we should ascribe to them that intermediate position which

* See this Journal, *ante*, p. 635. † Ibid., p. 500.
‡ Ann. Sci. Nat. (Zool.), xvi. (1884) 311 pp. (11 pls.).

is commonly ascribed to them, after a study of their characters in general.

Notwithstanding the numerous differences presented by different groups, in the successive series of degradations which are to be detected, it is possible to show that the gastric skeleton is never modified except by change in the form or relations of its parts, by their coalescence and disappearance; nothing new is ever added, and even when most degraded, the homology of the different parts can be asserted almost with certainty. In other words, the gastric skeleton of all the podophthalmate Crustacea is constructed on the same plan.

The author makes some remarks from a systematic point of view, and urges that the importance of the characters of the stomach is to be explained by the fact that it is not directly subjected to external influences, and is much less exposed to the changes which result from adaptations to environment than are the external organs. These characters then, are of great value in determining the relationships of genera with a different external appearance.

Mocquard describes the arrangement of the muscles which move the various ossicles, and facilitates the comprehension of his description by his figures; he finds that, at the moment when the gastric muscles contract the median tooth moves forwards, and the anterior ends of the lateral teeth approach one another; when the gastric muscles relax the apparatus is brought back to its position of equilibrium, by the elasticity of its articulations, and by the action of the cardio-pyloric muscle. When the gastric apparatus is acting, the food tends to be driven upwards, but its passage is prevented by the projections on the urocardiac ossicle. The medio-inferior tooth, though with the form, has not the function of a tooth; its conformation has no relation to that of the median tooth, and one of the two may vary in form, without the other doing so likewise.

The author agrees with Cuvier in thinking that the gastric muscles are voluntary in nature.

The concluding chapter deals with the stomatogastric nervous system, the knowledge of the distribution of which is thought to throw a new light on its physiological activity. While some authors, such as Meckel and J. Müller, have compared it to the great sympathetic of vertebrates, others, such as Newport and Blanchard, have compared it to the pneumogastric nerve. The latter view can only be justified by showing that the stomatogastric system presides over the functions of general sensibility and involuntary movement; as a matter of fact, however, in the Crustacea, the fibres that pass to the muscles of the œsophagus and labrum are clearly voluntary, and the same is almost certainly true of the branches that go to the motor muscles of the gastric apparatus, and possibly also of those that supply the dilatators and constrictors of the stomach; some of those that go to the labrum seem, moreover, to have a gustatory function. It is possible, however, that the different roots of the stomatogastric have different functions, and that, when united, they form a mixed trunk more complex even than that of the vagus after its union with the internal branch of the spinal. No observations on this point have as yet been made.

Significance of the Larval Skin in Decapods.*—H. W. Conn discusses the phylogenetic significance of the peculiar structure inclosing embryos of Crustacea known as the larval skin. This skin being probably of no physiological importance, is therefore particularly valuable in its morphological significance.

A number of new types of larval skin are described (*Callinectes*, *Sesarma*, *Pinnotheres*), and it is shown that there is a complete and graduated series beginning with a form like *Panopeus*, where the larval skin is a highly complex structure with many feathered spines, and ending in a form like *Pinnotheres*, where the cuticle is nothing more than a larval covering with no spines. In general also it is found that the more complex larval skin is found in crabs, which stand low in classification, while the simple larval covering is found in more highly organized Brachyura; a condition of things just as we should expect from the consideration that this structure represents the ecdysis of some stage in the crab development earlier than the zoea. It is further shown that such an earlier stage was probably a protozoea and that we, therefore, have here strong evidence that this stage was formerly included in the ontogeny, and therefore in the phylogeny of the Brachyura. Finally it is argued that evidence is here obtained tending very strongly to show that the Decapod zoea is simply a larval form which has never been represented in the phylogenetic history of the group, contrary to what has been claimed by Müller, and later in a different form by Balfour.

New or Rare Crustacea.†—In his 34th article on this subject M. Hesse describes five new Crustacea belonging to the order which he has called that of the Rostrostomata; like the Siphonostomata, they are found on the skins of the Squalidæ, but, unlike them, they have not a rigid tubuliform mouth by means of which they can penetrate the thick skin; the mouth is rather obtuse and soft, and the animals, therefore, make their way into the branchial cavity, where they are sheltered and early obtain a rich supply of food.

The new species, of which the females are alone known, are called *Kroyeria galei vulgaris*, *Eudactylina squatinæ angeli*, *Eudactylus musteli lævis*, *E. charchariæ glauci*, and *Pagodina charchariæ glauci*. The author concludes with some observations on the systematic position of these species.

Vermes.

New Type of Hirudinea.‡—MM. Poirier and A. T. de Rochebrune describe a new type of Hirudinea which they found attached not only to the mucous membrane of the mouth of *Crocodilus vulgaris*, *Cataphractus*, and *Leptorhynchus*, but also on the lingual papillæ of *Cymnoplax ægyptiacus*, and in the pouch of *Pelicanus* and *Onochrotalus*. In external appearance it has a general resemblance to *Branchiobdella*. Attached to the very delicate rectum are four pairs of very sinuous

* Stud. Biol. Lab. Johns-Hopkins Univ., iii. (1884) pp. 1–27 (2 pls.). Cf. this Journal, *ante*, p. 226.

† Ann. Sci. Nat. (Zool.), xvi. (1884) 18 pp. (3 pls.).

‡ Comptes Rendus, xcviii. (1884) pp. 1597–1600.

tubes, which are set between the dorsal surface of the animal and the cæca. The appendages of the digestive tube are continued into the branchiæ, and the tract is also remarkable for the possession of large unicellular glands with finely granular contents; these form the salivary glands.

The male generative apparatus is composed of four pairs of ovoid testicles, which are placed in the last four branchiate segments; the efferent ducts unite, on leaving the epididymis, into a short azygos spermatic canal, which passes into a large muscular pouch, into which the very large penis can be retracted. The female organs consist of a pair of very long pyriform ovaries, and of two delicate oviducts which pass into an inconspicuous uterus. The circulatory system presents some remarkable characters. There is no dorsal vessel, but there are two pairs of lateral vessels, which are superposed and send branches into the branchial outgrowths; the superior lateral vessels, which may be considered as being arterial, communicate with one another in each ring by an annular vessel which sends fine ramifications to the surface of the skin; posteriorly, these two lateral canals bifurcate and unite by the branches thus formed; they here give off a number of ramifications which extend over the lower surface of the sucker, and pass into a double circular vessel which extends round the edge of the sucker. There is a median ventral vessel which envelopes the nervous system and gives rise anteriorly to a ring which communicates with the lateral vessels, and posteriorly to a number of branches which open into the vessels of the sucker. The nervous system has a close resemblance to that of *Clepsine;* there are two very large, cup-shaped orange-coloured eyes. The integument, especially in the anterior region, is very rich in glandular cells.

The new genus to be instituted is called *Lophobdella*, and the species *L. quatrefagesi;* it is found in Senegambia and the rivers of Africa. Its peculiarities require the formation of a new family, to be called the Lophobdellidæ, and placed near the Rhynchobdellidæ.

Structure of the Branchiæ of Serpulaceæ.*—Dr. L. Orley gives a detailed account of the histology of the gills in the Serpulaceæ. His results may be stated as follows:—

In *Serpula* the gill-threads are borne upon two curved lamellar processes, one on either side of the head; these are united by a cross piece; one or two of the gill-threads are modified into a stalked opercular plate; this latter in some species serves as a chamber for the development of the ova, and is generally regarded as serving to close the tube of the animal when it is retracted. Its structure, however, points to the conclusion that it may also serve as a respiratory organ (the other gill-filaments with which it is homologous being chiefly tactile). It receives a vast number of capillaries which branch repeatedly towards the distal end of the "cup," and end in ampulla-like dilatations; the advantage of such a structure to the animal must be great, since it is enabled to protect itself by closing the operculum, and at the same time the process of respiration

* MT. Zool. Stat. Neapel, v. (1884) pp. 197–228 (2 pls.).

can go on; the operculum may perhaps have been formed by the concrescence of a series of gill-branches arranged in a circle round the tip of the gill-filament.

In *Sabella* the gill-filaments differ from those of *Serpula* by the presence of a cartilaginous rod and a portion of the longitudinal muscle-layer of the body which is prolonged into them in close connection with this skeletal rod.

The paper concludes with a discussion concerning the homologies of the gills in Serpulaceæ with the gills of Vertebrata, which is believed to exist by some; the author, however, does not consider that there is any homology or even analogy between the two structures.

Structure and Development of Fresh-water Dendrocœla.*—The studies of J. Jijima are based chiefly on *Dendrocœlum lacteum*, *Planaria polychroa*, and *Polycelis tenuis* (n. sp.). Commencing with a description of the cilia, he states that, in adult forms, these are not developed over the whole surface of the body, but are absent from certain regions; they are particularly well developed at two points at the anterior margin of the head, where they form a tuft of long and constantly moving hairs; their function would appear to be sensory. Some shorter immobile cilia are found on the median portion of the cephalic margin, and among these there are some which are twice as long, and either stand separately or arise from a common base; they may be regarded as comparable to setæ. The absence of cilia from the sides of the body may be ascribed to the influence of parasitic Protozoa. It would seem that the cilia on the back of the *Geoplana* and other terrestrial Triclades, are more delicate than those on the ventral surface, and are, therefore, more easily destroyed in the process of preservation.

The author was, like Kennel, unable to detect the unicellular epidermal glands seen by Moseley, and is led to doubt their presence; a certain relation was observed between the rhabdites and the characters of the cells of the epidermis; the smaller size or number of the former being associated with a greater wealth of finely glanular protoplasm in the latter. Jijima finds that there is a very remarkable relation between the cells and the basal membrane on which they are placed; for the former give off a number of fine processes; these are best studied in *Planaria polychroa*, where they appear to be formed by fibrils, which are nothing else than direct protoplasmic processes of the cells of the epidermis; there is little doubt that there is an organic connection between the epithelium and the interior of the body.

The rhabdites, which are described in some detail, do not seem to be imbedded in the epithelium, but in the peripheral cells of the mesenchym. Each cell gives rise to several rhabdites, which are at first small and round, but which soon elongate. When they have reached their definite size they break through the cell-wall, which appears at last to be absorbed, and wander through the connective

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 359–464 (4 pls.).

tissue and the basal membrane, either separately or by groups, into the epidermal cells, where they take up their definite position. There appear to be a larger number of rhabdites in more sensitive than in less sensitive parts of the body. The basal membrane is more or less well developed in all Turbellarians. The characters of the musculature are discussed in detail, and the differences between the three species examined are pointed out.

The mesenchym contains imbedded in itself unicellular glands, which are most numerously developed behind the brain, and above and below the enteric canal. Their function is either mucous or salivary; but it is by no means certain that the latter are comparable to the similarly named glands of higher animals. In young embryos the space between the epidermis and the enteric epithelium is occupied by a solid mass of connective-tissue cells, which are partly massed into syncytia, and are partly separated by cell-boundaries. In the adult the arrangement is very different, owing to the appearance of a larger number of pseudo-cœlomic spaces, which communicate with one another, and force the nuclei away from one another, and so give rise to branching cells of connective tissue and a general appearance of reticulation. In the living animal the lacunar spaces are probably filled with the so-called perivisceral fluid, which possibly serves as a carrier for the nutriment prepared within the enteric cells. *Dendrocœlum lacteum* has, as its name implies, none of its connective tissue pigmented, as is the case in a number of other forms.

The author confirms in many points the descriptions given by his predecessors as to the characters of the digestive organs; in *D. lacteum* he finds that there are 26–34, in *Pl. polychroa* 22–28, and in *Pol. tenuis* 15–19 pairs of lateral branches to the intestine, of which 10–15, 9–13, and 4–6 respectively belong to the primary trunk of the gut. All but those at either end branch dichotomously. His account of his own observations on the excretory organs is prefaced by a statement of what has been done by recent observers; the point to which he himself directs express attention is the undoubted fact of the presence of cilia in the lumen of certain capillaries; in the median part of the body they are best developed, and take a coiled course; their movement is definite in direction, and these ciliated vessels have nothing to do with the ciliated infundibula. Many of these vessels are so fine that, were it not for their cilia, they would be invisible. The ciliated infundibula are not numerous in, at any rate, young specimens, and are often widely separated from one another. The presence of excretory vacuoles was recognized, and they were seen to be, like the vacuoles of the Protozoa, clear during life; they give some indications of containing products of uric excretion.

After a very detailed description of the generative organs, the nervous system is taken up. This was studied by the light of Lang's investigations, the general results of which are fully confirmed. Jijima had no difficulty in convincing himself of the existence of a plexus of fine nerves on the dorsal surface, lying just beneath the inner longitudinal fibres of the dermal musculature. As in other

Platyhelminths, there are two longitudinal nerve-trunks which unite posteriorly, after gradually increasing in size. The transverse commissures go directly from one trunk to the other, and often branch and anastomose with their neighbours. Both the commissures and the lateral nerves give off a number of fine branches ventrally. The brain of *Planaria polychroa* stands at a lower level than that of *D. lacteum* or *Pol. tenuis*, owing to the want of concentration of the sensory nerves into anterior cerebral lobes. The eye of *P. polychroa* is described as consisting of a pigment-goblet, an optic cone, and an optic ganglion. The first is formed of compact pigment-granules, and has its orifice directed outwards and upwards. Anteriorly to this opening there is a collection of nervous substance, surrounded by a number of nuclei, which appear to belong to ganglionic cells.

The author was unable to observe the impregnation of the ovum, and thinks it likely that the spermatozoa are to be found in the albuminous fluid of the cocoon. Directive corpuscles were not detected, probably because the ova have no investing membrane, so that their presence was obscured by the contents of the cocoon. The layer of fused cells, which early becomes developed, seems to be due to the metamorphosis of the peripheral cleavage-spheres. The embryonic pharynx is formed by the elongation of some of the endodermal cells, which become converted into muscular cells, and surround a central group of cells, which soon afterwards begins to make its way to the surface; clefts appear in this mass and lead to the gradual appearance of a lumen. This pharynx is only provisional, and is at about the twentieth day replaced by the one which is possessed by the adult. The author has, unfortunately, no observations to record on the mode of development of the excretory organs, or of the finer parts of the nervous system.

Classification of the Rotifera.*—Dr. C. T. Hudson points out what seem to him to be the chief faults in the systems of Ehrenberg, Dujardin, Leydig, and Bartsch, and proposes the following arrangement of the Rotifers in well-marked and fairly natural groups.

ORDER I. RHIZOTA.

Fixed forms; foot attached, transversely wrinkled, non-retractile, truncate.

Fam. 1. Floscullariadæ.

Mouth central; ciliary wreath a single half-circle above the mouth; trophi uncinate.

Fam. 2. Melicertadæ.

Mouth lateral; wreath two marginal curves nearly surrounding the head, with mouth between; trophi malleo-ramate.

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 335–56 (15 figs.).

ORDER II. BDELLOIDA.

That swim and creep like a leech; foot retractile, jointed, telescopic, termination furcate.

Fam. 3. Philodinadæ.

Trochal disk two transverse circular lobes; wreath two marginal curves on each lobe with mouth between; or trochal disk of one lobe ventrally furred with cilia; trophi ramate.

ORDER III. PLOÏMA.

That only swim.

* *Illoricated.*

Fam. 4. Hydatinadæ.

Trochal disk transverse with ciliated prominences; wreath double; trophi malleate; brain small, not sac-like; foot furcate.

Fam. 5. Synchætadæ.

Trochal disk rounded; wreath of interrupted curves, surrounding the head; trophi virgate; foot absent, or minute.

Fam. 6. Notommatadæ.

Trochal disk oblique; wreath of interrupted curves and clusters; trophi virgate or forcipate; brain large, sac-like; foot furcate.

Fam. 7. Triarthradæ.

Trochal disk transverse; wreath single, marginal; trophi malleo-ramate; foot absent.

Fam. 8. Asplanchnadæ.

Trochal disk rounded; wreath single, marginal; trophi incudate; intestine, anus, and foot absent.

** *Loricated.*

Fam. 9. Brachionidæ.

Trochal disk transverse with ciliated prominences; wreath single, marginal; trophi malleate; lorica entire, simple; foot transversely wrinkled, wholly retractile, two-toed or absent.

Fam. 10. Pterodinadæ.

Trochal disk two transverse circular lobes; wreath on each double, marginal; trophi malleo-ramate; foot transversely wrinkled, wholly retractile, ending in a ciliated cup.

Fam. 11. Euchlanidæ.

Trochal disk rounded; wreath in interrupted curves and clusters; trophi sub-malleate or virgate; lorica in two parts, meeting in a furrow, or entire with additional pieces: foot jointed, feebly retractile, not telescopic or transversely wrinkled—furcate or stylate.

ORDER IV. SCIRTOPODA.

That swim with their ciliary wreath, and skip by means of hollow limbs with internal locomotor muscles.

Fam. 12. Pedalionidæ.

Trochal disk transverse; wreath two marginal curves with mouth between; trophi malleo-ramate; foot replaced by two posterior ciliated processes.

GENERA.*

1.	Floscullariadæ ..	*Flosculària, Stephanoceros.*
2.	Melicertadæ ..	*Melicerta, Limnias, Œcistes, Cephalosiphon, Lacinularia, Megalotrocha, Conochilus.*
3.	Philodinadæ ..	*Philodina, Rotifer, Callidina.*
4.	Hydatinadæ ..	*Hydatina, Rhinops.*
5.	Synchætadæ ..	*Synchœta, Polyarthra.*
6.	Notommatadæ ..	*Notommata, Diglena, Furcularia, Scaridium, Pleurotrocha, Distemma.*
7.	Triarthradæ ..	*Triarthra.*
8.	Asplanchnadæ ..	*Asplanchna.*
9.	Brachionidæ ..	*Brachionus, Noteus, Anurœa, Sacculus.*
10.	Pterodinadæ ..	*Pterodina, Pompholyx.*
11.	Euchlanidæ ..	*Euchlanis, Salpina, Diplax, Monostyla, Colurus, Monura, Metopidia, Stephanops, Monocerca, Mastigocerca, Dinocharis.*
12.	Pedalionidæ ..	*Pedalion.*

Echinodermata.

Constitution of Echinoderms.†—C. Viguier, after a reference to the belief that Echinoderms are radiated animals, discusses the view propounded by Duvernoy and forcibly enunciated by Häckel, against which he has already raised some objections, and side by side with which he now pits the doctrine of Perrier taught in his work on 'Colonies Animales.' According to the view of Perrier, the Echinoderm is indeed a colony, but, instead of being formed of five equivalent individuals (antimeres), it consists of five reproductive individuals grouped around a nutrient individual; these may coalesce in various proportions. All Asteroidea are fragile, and all enjoy the power of

* "The principal ones; several of Ehrenberg's are omitted for various reasons that cannot here be detailed, and the genus *Notommata*, though the name is retained, is here supposed to have lost a large number of Ehrenberg's species."

† Comptes Rendus, xcviii. (1884) pp. 1451–3.

repairing broken arms; this rupture is often followed by a process of reproduction, numerous cases of which are already known. These facts may be as easily explained by the theory of Häckel as by that of Perrier, but there are others which can only be explained by the latter.

The hard parts around the mouth are, it is well known, very difficult to homologize with the ambulacral and adambulacral ossicles of the arms; but it is necessary to do this, if we regard the disk as nothing more than a fused part of each of the arms. On the other hand if either disk is an independent piece no homology is possible.

We sometimes find specimens in which a broken arm becomes bifurcated at its free end; if the buccal angles were merely formed by the union of the pieces of two neighbouring arms (as ought to be the case on Häckel's theory) it is difficult to see why the angle of bifurcation should not be formed in just the same way. On the other hand, if the peristomial skeleton belongs to a central individual it is evident that an arm could not produce along its own course pieces similar to those of the central piece—the odontophors or the teeth. Between the oral angle and the angle of bifurcation at the free end differences may be observed in the spines, which in the latter are exactly like the adambulacral and different from the longer ones found at the angle of the mouth; the brachial angle is formed by adambulacral pieces, which are very different from the large truncated teeth of the peristome; and, lastly, the odontophor which is so characteristic a part of the disk, is altogether wanting at the angle of the brachial bifurcation. The author adduces photographs in support of these statements.

Pourtalesia.*—Professor S. Lovén, the veteran author of the 'Etudes sur les Echinoidées,' has made another important contribution to the morphology of the Echinoidea, based on a study of the characters of the remarkable deep-sea genus *Pourtalesia*.

The first chapter deals with the general form of the skeleton, which, as in all Echinids, is a hollow sac inclosing the visceral organs, and constituted by three distinct systems—ambulacral, perisomatic or interradial, and calycinal or apical. The mode of numbering suggested in the 'Etudes' is here again made use of. Whenever this skeleton has been accurately studied it has been found that its constituent elements are, in reality and fundamentally, arranged bilaterally and symmetrically on either side of the mesial plane, indicated by its antero-posterior axis. The archæonomous or old-fashioned type of the Clypeastridæ as well as the neonomous or new-fashioned Spatangidæ give distinct indications of the bilateral form of the adult. Though more difficult to detect, this bilaterality obtains also in the ancient Cidaridæ, and we have here "another instance of the validity of one of the laws more than once ascertained to underlie evolution, namely, that structures which are to be gradually but forcibly worked out during the course of geological ages into specialized and highly characteristic features, are virtually present within the fabric of the

* K. Svenska Vet. Akad. Handl., xix. (1883) 95 pp. (21 pls.) (written in English).

earlier forms, though dormant, and, as it were, lying in abeyance, and to be detected only by a close scrutiny."

The general form of *Pourtalesia* is unlike that of any other known Echinid; it has the form of an inverted short-necked bottle; from the side the anterior line is seen to be bluntly truncated, while the dorsal surface is marked posteriorly by a deep depression, behind which there is a truncated caudal prolongation. Anteriorly the test is suddenly bent inwards and backwards, so as to form a deep ovoidal recess leading to the mouth. It would seem as if "this anomalous configuration" were due to "the dorsal portion of the body having moved forwards beyond the normal measure, and so as to leave behind the subanal part of the ventral portion, and as though its forepart produced into a rostrum projecting ventrally and compressed from both sides, had been drawn, by invagination, into the peritoneal cavity."

The perisomatic portion is next dealt with, and here perhaps we have the most anomalous condition of parts, for it is found that two of the interradii unite in the middle line and so form a continuous broad ring passing round the middle of the body; this arrangement appears also to be found in *Spatagocystis*, but it is only seen in *P. jeffreysi* and *P. laguncula* among the species of the genus *Pourtalesia* as defined at present. Lovén makes the interesting remark that "once before, early in Mesozoic time, for a while and not unlike a trial soon given up, a structure resembling this was seen in the Collyritidæ, but imperfect, the ring being open ventrally and closed dorsally only." As it obtains in *P. jeffreysi*, the author thinks that the radiate disposition of the skeletal elements is destroyed in an essential degree, "and a tendency betrays itself towards an annular differentiation of the bilaterally symmetrical constituents of the cylindroid skeleton."

The peristome likewise presents us with some very extraordinary characters; the structure of which leads us to think "that what is going on here may be looked upon as the first move, so to speak, towards forming a rudimental mouth, a *cavum oris*, the invaginated parts of which, if they were flexible and provided with muscles, might be protruded like a proboscis." Without here going into details we can only say that the author establishes his proposition that the joint participation of the ambulacra in the formation of the peristome, and the uninterrupted sequence of their plates does not obtain in the genus under consideration.

The characteristic sensory organs (sphæridia) first detected by Lovén in the region of the mouth of Echinids, are not, as in most, arranged in *Pourtalesia* in all the five ambulacra, but are absent from No. III., or that which is anterior and odd. In *Pourtalesia*, however, the ambulacrum in question is raised above the level of the peristome, so that we see that "of whatever nature the special changes in the surrounding water may be that their ciliated epithelium has to watch for, these changes seem to be of essential moment to the animal, solely when they take place in the vicinity of the mouth, or between the under surface and the ground on which the animal has to find its food."

The author next enters on an elaborate account of the structure of the pedicels of the Echinoidea, into the details of which our space prevents us following him.

The next chapter deals with the important subject of the calycinal system, which he defines as consisting of a central ossicle, five costals, and five radials; he urges with much point the value of using these terms, and says truly that, when we know more "the final terminology will come of itself." The differences between the Crinoid and the Echinoid organization are sharply pointed out, and it is shown that in the latter the system "is rendered, to no small extent, a disputed ground, each of these (generative, water-vascular, anal) organs tending to penetrate its substance and gain access to the surrounding water." *Tiarechinus*, with its enormous calyx, appears to be the most antique of Echinoids. While a number of forms retain a stable relation of the parts we find that, when this is disturbed, the anal orifice is the first to alter its position; it is followed by the madreporite and generative pores, but the eyes remain stationary. The various stages of changes are traced in the most interesting and instructive manner, and the whole history thus philosophically summed up. "A large and powerful structure, closely specialized for a function of fundamental importance in the economy of some remote ancestral type, is inherited, in an early state, by a descendant in which, from a total change in the mode of life, the very purpose no longer exists for which it was originally contrived, and to which its parts were adapted. It long retains certain marked features which even to this day reveal its origin, but, unlike its crinoidean sister-structure which, with functions unaltered, multiplies its components—it remains simple as from the beginning, and, superfluous as it has become, gradually declines in intrinsic vigour, and is given up to subserving activities that had no share in its previous existence. Invaded by contending organs and yielding to their various tendencies it has its parts deeply modified and even to some degree suppressed, and, although still true to its type, and asserting, so to say, its unimpaired independence by redintegrating its injured frame, it dwindles, nevertheless, from age to age in every succeeding form, and is seen to fall into decay and dismemberment and to lose one by one its characteristics, till at last little remains of its original constitution.

In trying to sum up the characters of the Pourtalesiadæ the author feels the difficulty that the species which he has been able to study most completely, *P. jeffreysi* is of a more advanced character than the rest, but justly remarks that "this is not the first occasion, nor will be the last, when a species that chances to be the most familiar to us is put forward as the type of its kind." The general form of the skeleton is subcylindroid, truncated anteriorly, tapering posteriorly; there is a deep infrafrontal recess and a rudimentary buccal cavity. Bilateral symmetry is highly developed; the perisomatic system predominates, while the calycinal is verging on decay. The breach of continuity in two of the ambulacra is without parallel among the members of the class. Like the Echinoneidæ they are

alone among the neonomous Echinoids in having homoiopodous pedicels, none of which are disciferous or converted into respiratory leaflets. The spines are Spatangean in characters. They do not attain to the level of the Spatangidæ owing to the frequent loss of the organ of vision as well as by the simplicity of their pedicels. By some of their characters they point, though remotely, towards animals of another and higher type, animals of annulose differentiation. They are found in all oceans, and, on the average, at a depth of 2900 metres.

As to the origin of the deep-sea fauna Prof. Lovén utters these pregnant sentences: "In the adult state most of the marine Evertebrates remain at their native station, wandering within its precincts. Their embryonic and larval age is their period of dispersal. Of numerous littoral forms, of different classes, tribes, and orders, currents must occasionally carry away the free-swimming larvæ . . . . far into the sea, and during the course of succeeding generations early stages of many a species will in this way have reached the wide ocean. There they will have sunk, their development accomplished all through depths full of danger and more and more uncongenial, and a few of them will have settled on the bottom of the abyss, and fewer still will have come to thrive there. Among these some will long have their original character, and but slowly been modified, while others will have exhibited a latitude of variation unknown or rarely seen where they came from, but upon the whole there will be reasons for assuming the less altered forms to be new comers, the more deviating to be old inhabitants of the deep."

Anatomy of Larval Comatulæ.* — Dr. P. Herbert Carpenter closely criticizes some of the results lately published by Perrier.† He expresses his doubts as to the single curved water-tube of the "cystid-phase" opening to the exterior by a pore on the wall of the body, and inclines rather to Ludwig's exact account of the primary water-tube as a dependence of the water-vascular ring opening into a section of the body-cavity, into which the primary water-pore, which pierces the oral plate, also opens. He doubts also the continuity of the pore and tube in later stages of the larva.

"The most startling statement" on the part of Perrier is that the plexiform gland of Crinoids corresponds, not with the ovoid gland of Star-fishes and Urchins, but with the stone-canal of these echinoderms. The ground for this statement can hardly be histological, and it is difficult to imagine what it may be. The relations of the axial organ to the cirri can hardly be seriously maintained, unless Perrier will show that the cirrus-vessels are radial and derived from the cavities of the chambered organ. Dr. Carpenter reiterates the expression of his hope that Perrier will publish more complete accounts and illustrate them by a number of figures.

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 319–27.
† See this Journal, *ante*, p. 389.

Cœlenterata.

Notes on Medusæ.*—C. Keller has some observations on *Coty lorhiza tuberculata*, which appears at certain periods in the Mediterranean, and the habits of which invite the question, what are the causes of its regular migration, and whence does it come? From the series of observations which the author was able to make he was led to conclude that it is highly probable that this Medusa is a true deep-sea form, which only comes to the surface for a time, and spends most of its life in its sessile condition on the floor of the sea. The cause of the migration appears to be associated with reproduction, the nurses being littoral, the young Medusæ deep-sea forms, so that the sexually mature animal rises to the surface and lives pelagically. With reference to the theories that may be based upon these facts Keller quotes Carl Vogt, who has lately expressed his belief that the class Hydromedusæ has arisen from two different stocks, one of which has produced the Acraspedota and the Scyphostomata, the other the Craspedota, Siphonophora, and hydroid polyps, and who, further, has expressed his belief that fixed and parasitic creatures are always produced by special adaptation from forms that were primitively free. Though this, of course, is not true of *Comatula*, yet we must remember how infinite are the powers of adaptation, and not summarily reject it as not applicable to the Medusæ.

The yellow cells of *C. tuberculata* are next discussed, and the author declares his agreement with the views of Geddes and of Brandt that the bodies are algar in nature, and thinks that the symbiosis is explicable on the supposition that the cells in question are found only in the pelagic generative forms, which demand a larger supply of oxygen.

A new Medusa—*Orchistoma agaraciforme*—the first species of the genus found in Europe (Mediterranean), is next described. As the development of the Orchistomidæ is as yet altogether unknown, it is interesting to learn that Keller has found some young specimens; it was found that the gonads are only apparently canular, and that they really arise from a gastric outgrowth, a condition as yet unique among the Thaumantidæ or Leptomedusæ. There appears to be a considerable amount of metamorphosis; the most important changes obtaining in the radial canals, which increase in number; in the gastric cavity, which diminishes in size; and in the proportionately late development of the large gastric stalk.

Revision of the Madreporaria.†—Prof. P. M. Duncan gives a revision of the families and genera of the Sclerodermic Zoantharia, Ed. & H. or Madreporaria (M. Rugosa excepted). Since Milne-Edwards and Haimes' work of 1860, no systematic revision of the Madreporaria has appeared, while since then a great number of new genera have been founded; hence the necessity for a revision has arisen, and more especially in consequence of the morphological researches of Dana, Agassiz, Verrill, Lacaze-Duthiers, and Moseley.

* Recueil Zool. Suisse, i. (1884) pp. 403–22 (1 pl.).
† Journ. Linn. Soc. Lond. (Zool.), xviii. (1884) pp. 1–204.

In the present revision the sections Aporosa and Perforata remain, but shorn of some genera; the old family Fungidæ becomes a section with three families, two of which are transitional between the sections just mentioned. The section Tabulata disappears, some genera being placed in the Aporosa, and the others are relegated to the Hydrozoa. The Tubulosa cease to be Madreporarian. Hence the sections treated are Madreporaria Aporosa, M. Fungida, and M. Perforata. The nature of the hard and soft parts of these forms is considered in relation to classification, and an appeal is made to naturalists to agree to the abolition of many genera, the author having sacrificed many of his own founding. The criticism of 467 genera permits 336 to remain, and as a moderate number (36) of sub-genera are allowed to continue, the diminution is altogether about 100. The genera are grouped in alliances, the numbers in families being unequal. Simplicity is aimed at, and old artificial divisions dispensed with. There is a great destruction of genera amongst the simple forms of Aporosa, and a most important addition to the Fungida. The genera *Siderastreæ* and *Thamnastreæ* are types of the family Plesiofungidæ, as are *Microsolenia* and *Cyclolites* of the family Plesioporitidæ. The families Fungidæ and Lophoseridæ add many genera to the great section Fungidæ. There is not much alteration in respect of the Madreporaria Perforata, but the sub-family Eupsamminæ are promoted to a family position as the Eupsammidæ.

Prof. Duncan also describes * a new genus of recent Fungida, Family Funginæ Ed. and H., allied to the genus *Micrabacia*, and which he names *Diafungia*. There is one species, *D. granulata*.

Porifera.

New Gastræades from the Deep Sea.†—Prof. E. Häckel has found among the collections of the 'Challenger' organisms which agree in the following characters; they live at the bottom of the sea (in rare cases littorally, in the majority at great depths) and have a firm skeleton formed of the substance there found, which they unite into a solid cement by means of a small quantity of organic cementing matter; some of these skeletons formed quite a museum of Radiolaria, consisting as they did of the most delicate shells of several hundred species. The skeletons are either external or internal; the former being due to the secretion of mucus from their outer surface, while in the latter the foreign bodies were taken into the ectodermal cells. In the former the secretion contains no cell-nuclei, in the latter they consist distinctly of protoplasm, in which a few, or in rare cases, a number of nuclei were to be found; we have then here to do with a more or less modified syncytium. The organisms vary much in form and size, the smallest being from 1–3 mm. in diameter, the largest from 80–120. The organisms that form the cemented skeleton may be either Protozoa or Metazoa; the former are, in a few cases, colossal *Lobosæ*, allied to *Difflugia;* in many cases they are true Rhizopoda, and the majority Thalamophora.

* Journ. Linn. Soc. Lond. (Zool.), xvii. (1884) pp. 417–9 (1 pl.).

† SB. Jenaisch. Gesell. f. Med. u. Naturwiss., 1883 (1884) pp. 84–9.

The cemental Gastræades fall into two groups, which have the same relation to one another as have the Ascones to the Leucones among the Calcispongiæ. In the simple and phylogenetically older forms, the wall of the gastric tube is thin and solid, but in the further developed it is thicker and traversed by gastric canals. The former, allied to the already described *Haliphysema* and *Gastrophysema*, are either branched (*Dendrophysema*) or plexiform (*Clathrophysema*). The latter belong to a new group called the Cæmentaria; resembling many Dysidiidæ, they are distinguished by the complete absence of ectodermal pores, so that the water only enters the irregular canal-system (the spaces of which are completely or partly invested by endodermal flagellate epithelium) by the mouth-orifices. In the endoderm there are scattered ovarian cells. *Cæmentascus* forms simple tubes, with a single oral orifice; *Cæmentoncus* has several orifices and is irregular in form; *Cæmentissa* forms flat lobate crusts; *Cæmentura* branched creeping or dendriform masses with several mouth-openings. Häckel thinks that the Orthonectida are allied to the Cyemaria, and that the *Trichoplax* of F. E. Schultze is a permanent *Discogastrula* form.

Siliceous Spicules of Sponges.*—J. Thoulet has examined the structure and other characters of the spicules of various sponges collected during the last cruise of the 'Talisman.' They were separated by treating the sponge with hydrochloric acid. The acicular spicules lost 13·18 per cent. of weight on heating to redness for ten minutes in a platinum crucible. Before the blowpipe they were whitened, or became slightly ochreous in colour, without a trace of fusion. Stellate spicules of five rays lost 12·86 per cent. on calcination. The specific gravity, obtained by flotation in a solution of iodides, was 2·032. But the spicules have a delicate tube along the centre generally less than ·001 mm. in diameter; and allowing for this, the author obtained by calculation, 2·0361 as the true specific gravity—which is that of opal.

The spicules are easily attacked by different chemical agents, so that they ought to be very readily dissolved in sea-water on the death of the animal. They were analysed after calcination by Boricky's process, by means of pure hydrofluoric acid, after first boiling in nitric acid and calcining, and they were proved to be pure silica. When not previously calcined, but simply washed, the process yielded a residue of hydrofluosilicate of soda in hexagonal prismatic crystals, the origin of which it is hard to explain unless it be that the minute tube of the spicules contains sea-water.

Fresh-water Sponges and the Pollution of River-water.†—E. Potts has examined the sponges found in the forebay of the Philadelphia waterworks when the water was withdrawn, and considers that the sarcode of fresh-water sponges does not slough off at the approach of winter, so that these organisms do not ordinarily pollute

* Bull. Soc. Mineral. France, April 1884. Cf. Amer. Journ. Sci., xxviii. (1884) p. 76.

† Proc. Acad. Nat. Sci. Philad., 1884, pp. 28-30.

the water unless torn to pieces by violent freshets. He believes that the whole of the sarcode retires into the statoblasts, from which it issues again in spring.

Protozoa.

New Infusoria.—Dr. A. C. Stokes describes * a new genus and six new species of fresh-water Infusoria.

Hymenostoma n. gen., *H. hymenophora* resembling *Lembadion. Trachelophyllum vestitum* with needle-shaped objects scattered throughout its substance which may be trichocysts, but their form and the action of the light suggest that they may be crystals. They closely resemble the acicular raphides of *Lemna* and other plants. *T. tachyblastum*, the specific name of which ("sprouting quickly") was suggested by the rapidity with which the animal repaired an injury it sustained by a collision with an *Oxytricha*. *Litonotus pleurosigma* resembling *L. fasciola* but differing from it and all other species of the genus in the multiple contractile vesicles. *L. helus* and *Petalomonas disomata.*

A new species of *Vorticella* (*V. Lockwoodii*) is also described † by the same writer. The characteristics by which it may be distinguished from all *Vorticellæ* are the existence and structure of the cuticular prominences and the undoubted presence of *two* contractile vesicles.

J. P. McMurrich describes ‡ *Metopus striatus* which he considers to be sufficiently distinguishable from the other species (*M. sigmoides*) to justify its being treated as a distinct species.

J. G. Grenfell records § four new Infusoria from Bristol; *Zoothamnium Kentii* differing from *Z. dichotomum* and all other species of the genus in the characteristic covering of flocculent matter; *Pyxicola annulata* ‖ very like *P. Carteri*, but differing in dimensions and undulations; *Platycola bicolor*, so named "from the two colours of the lorica" (lorica dark yellow, with a colourless neck)—it has a very delicate membranous hood which has a large oval opening, is retractile, and projects backwards from the top of the ciliary disk covering the opening; *P. aurita* (n. sp. ?).

C. L. Herrick describes ¶ *Ophridium problematicum* and an infusorian closely related to *Paramœcium*, but differing in several interesting particulars from it and its allies. In form this animal is linear lanceolate (about 0·2 mm. long), tapering posteriorly to an almost acuminate point. Anteriorly is a long vibratile proboscis, or flagellum, which exceeds, when extended, the whole length of the body. The mouth is situated at the base of this proboscis, and opens into a very short infundibulum. The whole surface of the body and proboscis is covered with minute cilia, which are inserted in rows,

* Amer. Mon. Micr. Journ., v. (1884) pp. 121–5 (9 figs.).
† Amer. Natural., xviii. (1884) pp. 829–30 (2 figs.).
‡ Ibid., pp. 830–2 (1 fig.).
§ Journ. of Micr., iii. (1884) pp. 133–8 (1 pl.).
‖ But see Dr. Leidy, this Journal, iii. (1883) p. 77.
¶ Science, iv. (1884) p. 73.

giving the body a punctate appearance. Longer cilia surround the mouth. The sarcode is transparent, and, apart from a few greenish food-balls, contained only a large number (over a dozen) of oval bodies of a similar character (endoplastules in an unobserved coiled endoplast?). The motions of the animal are very quick, and are occasioned chiefly by the whip-like motions of the proboscis, which is extremely vigorous in movement, and alters its form greatly. Apart from this rapid motion, it can propel itself slowly by means of the cilia covering the entire surface. It is the type of a new genus, and is named *Phragelliorhynchus nasutus*.

Parasitic Peridinian.*—G. Pouchet has met with a Peridinian which in its early stage is parasitic on *Appendiculariæ*. These parasites are pear-shaped, about 170 to 180 μ long, with a nucleus large in proportion. In colour they are a deep brown; they are enveloped in a thin cuticle which they keep on becoming free, whilst they abandon their pedicel. These detached individuals float in great abundance on the surface of the sea and there undergo *free* or *independent segmentation*, subdividing after the manner of a fecundated vitellus into uninucleated spheres dwindling in size and growing paler in colour as the process continues; but the products of this segmentation always remain independent. A very thin cuticle is thrown off as they divide. The spheres finally resulting, measuring no more than 10–13 μ, develope a long flagellum and a crown of cilia, and become minute Peridinians allied to *Pulvisculus* of Ehrenberg (*Gymnodinium pulvisculus* of Bergh). The whole process occupies about 24 hours.

Observations on Flagellata.†—F. Blochmann commences with some notes on *Trichomonas vaginalis*, at the anterior end of which there are three flagella, from the base of which an undulating membrane extends to about the middle of the body; this membrane, never hitherto observed, may be best seen if the creature is allowed to die gradually. The *T. batrachorum* of Perty (the *Cimœnomonas batrachorum* of Grassi) is next considered, and here also an undulating membrane was detected. If the monad is allowed to remain for some time under the pressure of the cover-glass the whole margin of the animal is seen to exhibit an active undulatory movement, though, of course, this is not so regular as that of the membrane. A similar phenomenon is to be observed in *Trichomastix lacertæ*, a species lately detected by Bütschli in the cloaca of *Lacerta agilis;* it has four flagella, one of which is half as long again as the animal and is directed backwards. *Oxyrrhis marina* is the last form described; within their bodies a large number of fat-drops, often of considerable size, are to be detected; they take in solid nutriment. The author was able to observe their multiplication by a mode of transverse division.

Geometry of Radiolaria.‡—Prof. E. Häckel points out that the four orders of the Radiolaria are distinguished by their geometric

* Comptes Rendus, xcviii. (1884) pp. 1345–6.
† Zeitschr. f. Wiss. Zool., xl. (1884) pp. 42–9 (1 pl.).
‡ SB. Jenaisch. Gesell. f. Med. u. Naturwiss., 1883 (1884) pp. 104–8.

form; in the Acantharia we have the quadrate octohedron, where twenty radial spines are arranged in five sets of four spines each, which are set quite regularly in meridional planes. In the Nassellaria or Monopyleæ there is at first a monaxial form, which is in many cases rendered bilaterally symmetrical; this is true also of the Phædoria or Tripyleæ. Stereoscopic forms are seen in the Spumellaria.

The Sphæroida, which may be regarded as the stem-form of all Radiolaria, ordinarily retain the spherical form of the central capsule, and frequently give rise to the endosphæric polyhedron; from these, more complex forms arise by the development of spines along certain rays. The Prunoidea are at first monaxial ellipsoids, and they finally produce the much more complex Zygartidæ. The Discoidea arise from the Sphæroida by the shortening of the vertical primary axis, and they at first have the form of biconvex lenses. The Larcoidea begin with simple ellipsoid shells, and become complicated by the development of further systems of network.

Polythalamian from a Saline Pond.*—E. v. Daday describes a new genus—*Entzia*—of Polythalamians from saline waters, which have been studied by Prof. Entz, who finds that the infusoria living therein are new forms, or have as yet been found in the sea only, or are common to both fresh and sea water, while a fourth of the whole number are only known as fresh-water forms. The new genus is characterized by having a multicamerate imperforate shell, which contains a large number of siliceous plates; the chambers are coiled from left to right, and are only completely visible from the convex side; at the outer partition of the terminal chamber there are larger orifices, which are oval and tubular, and two smaller which are circular. *Tetrastomella* is proposed as the specific name.

In the form of its shell *Entzia* resembles *Rotalia*, and belongs to the group of the Helicostegia; the largest of the 16-chambered individuals measured 0·42 mm., while the smallest 6-chambered shell measured only 0·08 mm. As in *Rotalia*, the partitions between the chambers were formed of two lamellæ, one belonging to the chamber in front and the other to that behind, but there is not here any interseptal space; in all, as in the last partition, there are two large and two smaller holes. As the siliceous plates are completely imbedded in the substance of the shell, the surface of the latter is, notwithstanding their presence, quite smooth; they cannot, therefore, be regarded as foreign bodies, but must be supposed to have been formed by the protoplasm. On the whole, an investigation into the characters of the shell shows that it unites peculiarities which are separately characteristic of chitinous and arenaceous Rhizopods, and the close allies of the form are to be found not so much in *Rotalia*, which it resembles in appearance, as in *Difflugia* and the arenaceous Mono- and Polythalamia. The author sums up his views as to the systematic position of *Entzia* in the

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 465–80 (1 pl.). Cf. Gruber's note, this Journal, *ante*, p. 580, which should have followed the above.

following terms: It is the only as yet known continental Polythalamian, and in the form of its shell resembles that of the sub-family Rotalinæ of the group Globigerinæ; in structure the shell resembles that of *Trochammina;* in the structure of its partitions it agrees with the perforate Polythalamia; in that of the orifices of these partitions with the Lagenidæ; the chemical constitution is that of *Difflugia*, *Trochammina*, and some of the Globigerina, and it closely connects the last with the Lagenidæ by means of *Trochammina* and the Rotalinæ.

Nuclear Division in Actinosphærium eichhornii.*—R. Hertwig concludes from his observations on the resting nucleus that the coloured constituents of the nucleus (chromatin or nuclein) are not spongy bodies; all the nuclein is contained in nucleoli, which are stained by reagents. A subject of greater difficulty is presented by the parts which are formed in addition to the nucleoli within the nucleus. These are (1) the granulation which becomes visible on the addition of reagents; (2) the paranuclear pieces which in the fresh condition are seen to have various forms; (3) the highly refractive corpuscles; and (4) the nuclear membrane. The first three appear to be referable to a common structure of colourless substance, which may be called paranuclein or achromatin, and which fills up the interspaces between the nucleolus and the nuclear membrane. It may be regarded as due to special thickenings of the achromatic network. The author is acquainted with essentially similar phenomena, which have presented themselves in the nuclei of insects, and of which he will give an account at a later period.

The mode of division of the nucleus, as seen in *Actinosphærium*, is intermediate in character between what is seen in plants and animals on the one hand, and in Protozoa on the other; in the latter, which approach most nearly the diagrammatic scheme, the biscuit-shaped constriction of the nucleus is most apparent; internal differentiations of the nuclear substance are either completely wanting, or are nearly fibrillar. (An exception to this is seen in the paranuclei of the Infusoria.) On the other hand, in plants and animals the biscuit-shaped constriction is obscure, the limits of the nuclear substance and protoplasm disappear, and there is a mixture of the two substances. The whole division of the nucleus appears, therefore, as a complicated and extremely regular rearrangement of the nuclear particles, which lead to the important differentiation of achromatic nuclear filaments and of chromatic elements; the two substances are so sharply separated that they might be taken for elements which had nothing to do with one another.

In *Actinosphærium* we have, as in the other Protozoa, those changes in form which the whole nucleus undergoes during division; but as to its internal structure there are many points in which the nucleus resembles that of animal ova; a nuclear plate is formed, which divides into lateral plates that separate from one another and the parts of the lateral plates give rise to achromatic filaments. Before the appear-

* Jenaisch. Zeitschr. f. Naturwiss., xvii. (1884) pp. 490–517 (2 pls.).

ance of the nuclear plate there is a stage in which it resembles that of the Infusoria; as in them, bands, which may be coloured for their whole extent, reach from pole to pole. This would seem to show that in *Actinosphærium* the achromatic filaments contain particles of chromatin throughout their whole extent, and the same is probably true of the Infusoria.

In addition to the interest which surrounds the nucleus of *Actinosphærium* in consequence of its intermediate position, the mode of formation of the lateral plates is also of interest. The view of Flemming that in animal cells these plates are primitively laid down separately does not apply to *Actinosphærium*, where the first rudiment of the nuclear plate is a single row of granules. The nucleus is also distinguished by the possession of polar plates, or aggregations of homogeneous substance which are interpolated between the striated part of the nucleus and the homogeneous protoplasmic cones; they appear to be derivatives of the cell-nucleus, formed by the clearing up of its peripheral parts. The nuclear filaments are distinguished from those of animal and vegetable cells by their finely granular condition; they appear to consist of paranuclein, together with minute remnants of colourable nuclein.

Parasite of the Wall of the Intestine of the Horse.*—M. Flesch gives an account of a parasite which he has proposed to call *Globidium leuckarti*, and which was found particularly in the connective tissue of the intestinal villi of the horse, where its presence may give rise to subacute inflammation. It ordinarily has a spherical or ellipsoid body sharply marked off by its capsule; in most cases its wall is hollowed by a special fusiform or semilunar cavity, which is completely filled by a granular body or, as the author calls it, the accessory body. In position it resembles the remains of the yolk in the ova of *Tænia*. In another form the refractive spherules in the interior of the parasite were solely parietal in position, and the central space was occupied by a protoplasmic mass, which was very uniformly granular. The author describes the stages in development that he was able to observe, and then addresses himself to the question as to whether he had here to do with a phase in the alternation of generations of a higher organism, or whether the parasite was a Sporozoon. He next gives a list of the known parasites of the horse, which, as being fuller than that of Linstow, may be of use for other purposes, and discusses the probabilities of his new form being a stage in the life-history of any one of these; this view being rejected he addresses himself to the Sporozoon-view, against which it seems there is nothing to be said, but in favour of which there is almost as little; in fact it is, at present, impossible to assign a definite position to the parasite. The relatively large capsules, and their position in the connective tissue are against its being a Sporozoon; the part played by the accessory body is unknown, and the evidence as to its being expelled from the organism is incomplete. The author hopes to be able to make further and more complete investigations and meanwhile proposes

* Recueil Zool. Suisse, i. (1884) pp. 459–89 (1 pl.).

to speak of this obscure and abnormal parasite by the name he originally suggested of *Globidium leuckarti*.

Sutherlandshire "Eozoon."*—Prof. M. F. Heddle, after a careful examination of the Eozoon-like structure that occurs in the marbles of Assynt, recalls his previously expressed opinion as to its non-mineral character and attributes to it a purely inorganic origin. The greater part of this structure is formed of dark serpentine with some magnetite, whilst in the calcareous layers are imbedded fibres apparently of wollastonite. Prof. Heddle states in a footnote that having unravelled the Scottish Eozoon, he entered upon an inquiry into the Canadian, in which he finds nothing he did not see in the Scotch specimens; at the same time the specimens examined were possibly not good examples.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Continuity of Protoplasm.†—P. Terletzki has investigated this question with a view of determining what organs and what tissues in the same plant display the phenomenon. For this purpose he has taken in the first place *Pteris aquilina*, and has found a distinct protoplasmic connection, in the rhizome, between the parenchymatous cells, the conducting cells, and the sieve-cells, in each case among one another, and between the sieve-cells and the conducting cells. On the other hand, he could detect no connection in the following cases:—between the cortical cells among one another, between the cortical and parenchymatous cells, the cells of the supporting bundles among one another, the supporting bundles and the parenchyma, the cells of the protecting sheath among one another, the protecting sheath and the parenchyma, the protecting sheath and the conducting cells, the bast-cells among one another, the bast-cells and the conducting cells, the bast-cells and the sieve-cells, the conducting cells and the scalariform vessels, the conducting cells and the tracheids (annular or spiral conducting cells). These remarks apply to the mature condition of the plant, and it is possible that in the cambial condition the protoplasm of the whole of the cells may be in connection.

The general facts were the same in other organs of *P. aquilina*, and in other ferns.

Protoplasm was found in the intercellular spaces, especially in the parenchyma of the rhizome, also in the parenchyma of the leaf-stalk; and this intercellular protoplasm was in connection with the cellular protoplasm.

* Mineral. Mag., v. (1884) pp. 271-324 (11 figs.).
† Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 169-71.

Continuity of Protoplasm.*—G. Schaarschmidt believes that all vegetable cells inclosed in a cell-wall and combined into a tissue are placed in uninterrupted connection by means of threads of protoplasm.

With regard to the occurrence of protoplasm in intercellular spaces, he finds intercellular masses of protoplasm in *Liriodendron tulipiferum*, also in the bud-scales of *Æsculus Hippocastanum*, in *Solanum Pseudocapsicum*, *Viscum album*, &c. They occur especially where the cells themselves contain no great quantity of protoplasm, and can convert themselves into true cells by becoming invested with a cell-wall; secondary intercellular spaces are then formed between these and the older cells. This intercellular protoplasm the author believes to be derived from the threads which pass from cell to cell.

Osmotic Power of Living Protoplasm.†—By an ingeniously contrived apparatus M. Westermaier claims to have proved that the pressure of the parenchymatous cells of the root-system, and the osmotic suction of the protoplasm in the parenchyma of the stem, acting together, are capable of raising a column of water to any given height from the soil.

Structure of Pollen-grains.‡—J. Vesque points out that the pores in the pollen-grains are so arranged that, no matter in what position the grains fall on the stigma, one at least of the pores is ordinarily in contact with the moist membrane of the stigmatic papillæ. The larger the grain the greater the number of pores (or of folds), and their number, therefore, cannot be considered of great taxonomic value. M. Vesque has found pollen-grains of *Hieracium* having three to four pores, and that in the same anther.

The disposition of the external ornamentation of the pollen-grain does not appear to depend on its mode of development, but on a fixed geometrical law—that of phyllotaxy. Thus the complex pollen-grain of the Chicoraceæ, were it completely spherical, would be a pentagonal dodecahedron; but as it is slightly ellipsoid, hexagonal network is combined with the pentagonal. In the simplest case, that which obtains in *Scolymus*, three hexagonal faces furnished with pores are seen on the equator of the grain, the twelve remaining faces being pentagonal. It is evident that the number of hexagonal faces increases the more the grain approaches the cylindrical form. Thus in *Sonchus*, *Helminthia*, and *Lactuca* it has twenty-one faces, three hexagonal ones with pores, six without, and twelve pentagonal ones.

Seeds of Abrus precatorius.§—W. Tichomiroff classifies the seeds of Papilionaceæ hitherto examined into three classes, according to the nature of their reserve material, viz.:—(1) Seeds containing a fatty oil, starch, glucose, and aleurone, such as *Arachis hypogœa* and *Dipterix odorata*; (2) those containing starch and aleurone only, as

* Magy. Növ. Lapok, viii. (1884) pp. 17–20. See Bot. Centralbl., xviii. (1884) p. 162.

† Ber. Deutsch. Bot. Gesell., i. (1883) pp. 371–83.

‡ Comptes Rendus, xcvi. (1883) pp. 1684–6.

§ SB. Vers. Russ. Naturf. u. Aerzte, Aug. 25, 1883. See Bot. Centralbl., xviii. (1884) p. 189.

Pisum sativum, *Phaseolus multiflorus*, and *Physostigma venenosum*; (3) those containing coarsely granular aleurone and a fatty oil, as *Lupinus mutabilis* and *Trigonella Fœnum grœcum*. Those of *Abrus precatorius* constitute a distinct type; they contain a fatty oil and albuminoids in the form of finely granular protoplasm, but neither aleurone nor starch. Another characteristic is the persistence of the nucleus and nucleoli in the peripheral parenchymatous layers of the cotyledons. The crystals sometimes found in the parenchymatous cells destitute of nucleus may consist of stearic acid or hesperidin. The cell-wall is thickened in a porous manner, is not doubly refractive, and consists of pure cellulose. The testa is composed of four layers, viz.:—(1) rods, colourless in the red part of the seed, while in the black spot they are of a purple-violet colour; (2) palisade-cells, distinguished by their length, their branching, and by the folding and small diameter of their lower end; (3) parenchyma, composed of cells elongated in the tangential direction; (4) albumen, the cellular nature of which is clearly defined in the first layers, while the cells at a greater distance lose their individuality by becoming flattened radially, and at length coalesce into a homogeneous pellicle, which cannot be decomposed into its separate cells even by maceration in chromic acid. In caustic potash this pellicle swells up strongly, and forms local projections. The hilum has two of the layers of rods, but no palisade-cells, these being replaced by sclerenchyma. With the exception of the albuminous layers the cell-walls display distinct cellulose-reaction. By chloride of iron the presence of tannins can be recognized in the albuminous layers and rods.

Comparative Anatomy of Cotyledons and Endosperm.*—J. Godfrin states, as a general result of a comparison of the structure of the embryo and the endosperm, that those embryos the cotyledons of which contain starch, whether alone or together with aleurone, are never accompanied by endosperm. Those, however, which contain no aleurone, even when thick (as *Amygdalus*, *Armeniaca*, *Prunus*, *Corylus*, *Juglans*, *Carya*, &c.), may contain an endosperm, which is however always very small. Embryos with thin or foliaceous cotyledons, are not necessarily accompanied by endosperm, as witness *Hedysarum sibiricum*, *Casuarina quadrivalvis*, *Grevillea robusta*, *Hakea saligna*, and *Acer*.

The author classifies cotyledons under two heads: thick or tubercular, and thin or foliaceous. The former, when mature, have a simple epidermis without stomata or hairs, and in the interior a thick parenchyma with large globular cells, between which are a number of air-cavities. On germination very little modification of the tissues takes place. Foliaceous cotyledons have, when mature, a simple epidermis, often provided with stomata more or less developed; the parenchyma is much smaller in mass, but is always divided into two distinct layers. They vary greatly in their mode of development during germination. In those which contain aleurone its absorption is the first indication of germination.

* Bull. Soc. Bot. France, xxxi. (1884) pp. 44–51.

Underground Germination of Isopyrum thalictroides.*—This species presents one of the few examples of underground germination among flowering plants. A. Winkler has examined the process in its various stages, and points out that it exhibits a difference from the similar phenomenon in *Anemone nemorosa* and *ranunculoides* belonging to the same natural order. While in *Anemone* the unstalked cotyledons project from the testa of the seed, and, as in typical dicotyledons germinating above the surface of the soil, are opposite to one another, in *Isopyrum* they remain inclosed within the testa, and are placed on tolerably long stalks.

Stomata of Pandanaceæ.†—R. F. Solla has closely studied the stomata in the leaves of a large number of species of *Pandanus*, and distinguishes three types:—(1) the simplest and most common form, represented by *Pandanus inermis*, in which the cells contributing to its formation are only two in number; (2) the type of *P. graminifolius*, which occurs only in a few Pandanaceæ; the auxiliary cells, eight in number, are all thickened, their apices thus forming a protuberance which rises above the level of the epidermal cells, the walls of the latter being also thickened; (3) the type of *P. utilis*, resembling the stomata of *Aloe* and other allied plants; the thickening here extends from the auxiliary cells to the epidermal cells to such an extent as to form little lumps on the surface, completely concealing the outline of the stoma. A number of measurements are given of the size of the stomata in different species, and of the relative number found on a unit of superficies.

Changes in the Gland-cells of Dionæa muscipula during Secretion.‡—According to W. Gardiner there are four periods in the process of digestion by the leaves of the Venus's fly-trap, viz. the resting, the secreting, the absorbing, and the period of recovery.

In the resting stage the gland-cells exhibit the following structure:—In each cell the protoplasm is closely applied to the cell-wall, leaving a large central vacuole, which is filled with the usual pink cell-sap. The protoplasm is very granular, especially round the nucleus, which is situated at the base of the cell, and is large and well defined. At the end of the secreting period, which appears to be about twenty-four hours after stimulation, movements of the protoplasm have taken place, in consequence of which the nucleus now occupies the centre of the cell; numerous strands of protoplasm radiate from the nucleus to the parietal protoplasm, dividing the vacuole into several smaller ones. The protoplasm is now nearly homogeneous, clear and hyaline, and the nucleus has become much smaller. In the ordinary leaf-tissue special cell-contents make their appearance after the absorption of the food. About thirty-six hours after feeding the cells contain a large number of tufts of crystals in the vacuole, which adhere to the inner surface of the protoplasm. They consist of fine acicular crystals, which crystallize out with great regularity, and radiate from a central point. They are of a

* Flora, lxvii. (1884) pp. 195–8 (1 pl.).
† Nuov. Giorn Bot. Ital., xvi. (1884) pp. 171–82 (2 pls.).
‡ Proc. Roy. Soc., xxxvi. (1884) pp. 180–1.

yellow-green colour, insoluble in alcohol, in 1 per cent. acetic acid, and in 1 per cent. hydrochloric acid, soluble with difficulty in 5 per cent. solution of potash. After forty-eight hours the cell-contents are of a different nature. The cells now contain numerous bodies which present the appearance of flat sphærocrystals. They are usually perfectly circular in outline, and are clear and colourless, insoluble in alcohol, but extremely soluble in water.

In *Drosera* similar changes take place, but much more rapidly.

Septal Glands of Monocotyledons.*—P. Grassmann describes the nectar-glands found in the septa of the ovary, which are peculiar to Monocotyledons, and in them occur only in the series of Liliifloræ and Scitamineæ. They occur one in each septum, and therefore almost invariably three in each ovary. The gland forms in the septum a fissure of varying size and form, visible even to the naked eye. It usually occupies the greater part of the septum, and is bounded on each side by a secreting layer, consisting of from two to three rows of cells. In the same family they are very constant in form and size. The glands are filled with nectar, which escapes by means of a narrow canal to the receptacle, the mode of escape varying according as the ovary is superior, half-inferior, or inferior.

The glands are formed by the incomplete cohesion of the carpels in the septa; they are recognizable at a very early stage of development, and are then quite destitute of nectar, and the stages of cohesion can be very readily followed. Their object is unquestionably the attraction of insects to assist in fertilization. They are found only in species with conspicuous flowers; the nectar always contains grape sugar, and, when it flows out of the glands, either collects on the receptacle or unites with the juice flowing from nectaries in other parts of the flower. It begins with the opening of the flower, and usually lasts several days. The canal is also surrounded by secreting cells which pour out nectar.

Secretory System of Compositæ.†—According to P. Van Tieghem, the secretory system of Compositæ presents itself in three different forms—as oleiferous canals, as anastomosing laticiferous cells, and as long, isolated resiniferous cells. Disregarding some transitional forms, the first of these types is characteristic of the Radiifloræ, the second of the Liguliflorae, and the first and third of the Tubuliflorae. The present paper is devoted especially to the situation and structure of the laticiferous network of the Liguliflorae, which he finds to be situated in the layer of cells previously denominated by him the *pericycle*, situated between the endoderm and the first sieve-tubes of the fibrovascular bundles of the central cylinder. This network does not belong to the liber, being separated from the sieve-tubes which constitute the outermost portion of it by the entire thickness of the sclerenchymatous bundle. From here it may extend right and left, and may even penetrate between the liber and the sclerenchyma, the

* Flora, lxvii. (1884) pp. 113–28, 129–36 (2 pls.).
† Bull. Soc. Bot. France, xxx. (1884) pp. 310–3.

internal cells of the pericycle remaining for a time in a merismatic condition, and then becoming differentiated here and there into laticiferous cells.

The isolated resinous cells of the Tubulifloræ, which contain a laticiferous and resiniferous secretion, occupy precisely the same position, differing from them only in their form and in their mutual relations.

Chemical Constituents of Plants.*— M. Ballo is of opinion that oxalic acid has a much more important function in vegetable physiology than is generally supposed; the carbohydrates being formed from the reduction of this and other vegetable acids rather than by direct synthesis from carbonic acid and water. Tartaric acid, on the other hand, is a product either of the oxidation of carbohydrates or of the reduction of oxalic acid, as is also the glycolic acid which occurs in unripe grapes and in the leaves of the wild vine. As regards all other products of oxidation, the less the amount of oxidation, the more complicated is the product and the more nearly related to the original substance; while, when oxidation is carried on further, we get the original substances by which the plant is nourished. The vegetable acids are the most common products of oxidation in the plant. A portion of the oxalic acid is used in the decomposition of calcium sulphate, the rest as the raw material for the production of glycolic, tartaric, malic, succinic, and other acids.

If formic acid is heated with nitric acid, it is oxidized into carbonic acid and water, the nitric acid being reduced to nitrous oxide; but at the commencement of the process oxalic acid is formed; and the author believes that this process takes place in nature, according to the equation:—

$$2\,H_2\,CO_2 + O = H_2\,C_2\,O_4 + H_2\,O;$$

and that this is one of the reasons why nitrates are so valuable to the growing plant. In the living plant a portion of the nitrates is used in the production of ammonia and other substances nearly related to it, and another in the conversion of amide-compounds into alcohol-compounds. The greater part is reduced to the state of nitrous oxide; and from this nitric acid is again formed through the agency of oxygen and water. Hence a small quantity of nitrates can bring about the formation of a large quantity of oxalates.

Electric currents exist without doubt in the living plant, and it is possible that in some cases these may be converted into chemical work consisting in the decomposition not merely of water but also of salts. The products of decomposition of these salts may cause the formation of metal-derivatives at the negative pole, of derivatives with negative radicals at the positive pole. Elsewhere these substances may again combine with one another, and the same process be then again repeated. Hence the comparatively small quantity of inorganic salts found in plants.

* Ber. Deutsch. Chem. Gesell., xvii. (1884) p. 6. See Naturforscher, xvii. (1884) p. 123.

Structure of Leaves.*—E. Mer has studied the cause of the different forms of cells in terrestrial and in aquatic leaves. The structure of a leaf with a well-developed blade and petiole, in which the normal position of the former is horizontal, is due to its situation. The upper face receives a large amount of light, and is in consequence well nourished, and the cells of the upper parenchyma acquire a great increase in length, or become palisade-cells. The epidermal cells of the upper surface, well nourished in consequence of their vicinity to the assimilating parenchyma, increase actively and regularly, and acquire polyhedral forms, with thick walls and a still thicker cuticle; the active development of which they are the seat prevents the accumulation in them of food-materials and the formation of stomata. The parenchyma of the lower surface receives less light and is in consequence less well nourished. Its cells grow transversely, and finally separate, leaving between them larger or smaller lacunæ; their walls sometimes become slightly wavy. The cells of the hypodermal layer of the lower surface do not increase in length transversely nearly so much as those of the upper surface, and even become rounded.

The hairs originate in the bud, and chiefly on the lines of maximum nourishment, the veins. The stomata always make their appearance at the end of the hyponastic or commencement of the epinastic period, during that phase of development included between the commencement of the increase in length of the palisade-cells, and the appearance of the waviness in the epidermal cells of the lower surface.

In the submerged leaves of aquatic plants the sinuosity of the walls of the epidermal cells is due to insufficiency of nutriment.

Transparent Dots in Leaves.†—P. Blenk has made an exhaustive examination of the transparent dots in the leaves of a very large number of plants belonging to a great variety of natural orders, from the point of view of their structure and mode of development, and especially of their value in classification. He considers that too little account has hitherto been taken of their presence or absence by systematists, the anatomical structure which results in the formation of these dots being often a point of great importance, which may even be made use of in dried specimens. For example, cells with mucilaginous cell-wall in the interior of the leaf occur only in Anonaceæ and Laurineæ, and may possibly indicate a close relationship between these orders.

The various causes of transparent dots or lines in leaves are the following:—Secreting cells, round intercellular secreting spaces of either lysigenous or schizogenous origin, secreting passages, epidermal or parenchymatous cells with mucilaginous cell-walls, cells containing mucilage, raphides-cells, cells with single crystals or clusters of crystals, cystoliths, spicular cells, branched sclerenchymatous bundles, groups of sclerenchymatous cells, depressed pits with or

* Bull. Soc. Bot. France, xxx. (1883) pp. 110–30.

† Flora, lxvii. (1884) pp. 49–57, 97–112, 136–44, 204–10, 223–5, 275–83, 291–9, 339–49, 355–70, 371–86.

without hairs, crevices in the tissue, stomata. The secreting cells, spaces, or passages may contain resin, gum-resin, balsam, or an essential oil.

Secreting cells are an extremely common cause of transparent dots, and are usually characteristic of whole families or at least of genera. Round intercellular secreting spaces may be lysigenous, as in Rutaceæ, or schizogenous, as in Hypericineæ, the two kinds showing no difference in the mature condition. Both kinds are of great importance from a systematic point of view, furnishing distinguishing characters for entire families. Thus lysigenous secreting spaces occur in the Rutaceæ, Myoporineæ, and Leguminosæ; schizogenous are constant in the Hypericineæ, Myrsineæ, Samydeæ, and Myrtaceæ. Intercellular secreting passages of schizogenous origin cause transparent lines in a number of Guttiferæ, and in some species of *Hypericum*.

Epidermal cells in which the inner wall next the parenchyma of the leaf is strongly thickened and mucilaginous cause pellucid dots in a number of families and genera. Cells in the interior of the leaf with all the cell-walls strongly mucilaginous occur in Anonaceæ and Laurineæ, but not in all the species. Cells with mucilage in the interior are found in the Ampelideæ, and especially in the American species of *Cissus*.

Raphides-cells are of great importance systematically. They are sometimes replaced by cells with single very long prismatic crystals. Transparent dots caused by cystoliths occur in *Ficus*, *Momordica*, and some Acanthaceæ.

Of sclerenchymatous elements the most common are spicular cells. Round groups of sclerenchymatous cells also occur, and elongated sclerenchymatous bundles; but all these forms are of comparatively small value systematically. Stellately branched sclerenchymatous bundles, the so-called "internal hairs," are constant in *Nymphœa* and in the genus *Ternstrœmia*.

The following are only occasional causes of transparent or pellucid dots, of but little systematic importance:—Depressed pits in some Capparideæ and in *Victoria regia;* depressed glands in some Meliaceæ; rupture of the tissue in some Burseraceæ, in *Nyssa capitata* and *Placodiscus leptostachys;* cells with sphærocrystalline deposits of calcium sulphate, sodium oxalate, or of an organic substance of unknown nature; the meshes of the network of vascular bundles in some Capparideæ and Portulaceæ, and finally stomata.

Secretory System of the Root and Stem.*—In pursuance of previous investigations P. Van Tieghem continues his examination of the structure and position of the secretory system in the following natural orders:—Umbelliferæ, Araliaceæ, Pittosporeæ, Compositæ, Clusiaceæ, Hypericaceæ, Ternstrœmiaceæ, Dipterocarpeæ, Liquidambareæ, and Simarubaceæ. In the Umbelliferæ and Araliaceæ the system, which occurs in the roots, tigellum, and cotyledons, is

* Bull. Soc. Bot. France, xxxi. (1884) pp. 29–32, 43–4, 112–6, 141–51, 247–56.

continued indefinitely from the cotyledons into the stem and leaves, in the pericycle, more or less near to the liber of the vascular bundles, but not in the liber itself. The same is also the case in the Pittosporeæ. In the root of Ligulifloræ (Compositæ) the laticiferous network occupies the internal edge of the liber within the sieve-tubes, while in the stem it is situated in the pericycle outside the sieve-tubes. In those Tubulifloræ which possess a secreting system, its position in the roots is the same as in the Ligulifloræ. The root of the Radiatæ and Ligulifloræ is altogether destitute both of a laticiferous network and of isolated resiniferous cells, although possessing an endodermic oleiferous system.

In the Clusiaceæ the only regions in which secreting canals are not found are the pericycle, which forms in the stem a sclerenchymatous ring, and the primary or secondary xylem of the vascular bundles. The Hypericaceæ resemble the Clusiaceæ in the constant presence of secreting canals and in their general disposition, but differ from that order in their presence in the pericycle. The Ternstrœmiaceæ present in this respect a close resemblance to the Clusiaceæ. The Dipterocarpeæ differ, not only from these orders, but from all other angiosperms, in the presence of secreting canals in the xylem. In the complicated arrangement of the vascular bundles in the petiole they approach Malvaceæ.

Liquidambar and *Altingia* have their entire vegetative structure traversed by a system of oleiferous canals belonging to the primary liber in the roots, to the primary xylem in the stem and leaves. They may be said to combine the root of Anacardiaceæ with the stem and leaves of Dipterocarpeæ. The Simarubeæ have canals only in the stem and leaves, not in the root. The Dipterocarpeæ, Liquidambareæ, and Simarubeæ have this in common, that the stem and leaves have secreting canals localized in the primary xylem; they are distinguished from one another by the position of the canals in the root; in the Dipterocarpeæ these are in the primary xylem, in the Liquidambareæ in the primary liber; in the Simarubeæ there are none. In the only other order which has secreting canals in the xylem, the Coniferæ, they occur only in the root and stem.

Anatomical Structure of the Root.*—J. Constantin points out the great uniformity in the structure of the root as compared with that of the stem in the great divisions of the vegetable kingdom; but this he attributes to the much greater uniformity in the nature of the environment. In differing external circumstances he finds the structure of the root to vary in precisely the same directions as that of the stem.

When a root is fully exposed to the action of light, the thickness of the bark is less than in an underground root, while the central cylinder is, on the other hand, more developed. The endodermic punctations, so clear in underground roots, become indistinct in roots exposed to the light; all the fibrous tissues are more developed, both in the central cylinder and in the bark; and lignification has advanced considerably further.

* Bull. Soc. Bot. France, xxxi. (1884) pp. 25–8.

In roots entirely submerged in water, there is a well-developed intercellular system, while the vascular system is less developed. When an aquatic plant is transported on to dry land, the intercellular system diminishes, while the vessels become more numerous, and lignification is carried on further.

Growth of Roots.*—R. v. Wettstein thus states the laws which govern the growth of roots:—

1. In the first periods of development the growth is uniform; afterwards, from the period of germination, it is localized; the position of the zone of maximum growth varying. It begins at the collar, advancing gradually towards the apex, where it ceases.

2. The nearer the growing region approaches the apex of the root, the less rapidly does it advance.

3. The length of the growing region increases as it approaches the apex of the root, attains a maximum, and then decreases.

4. Neither the nature of the environment nor variations in temperature exercise any influence on the law of growth; even decapitation may not essentially alter the course of growth, at least at first.

5. As long as the region of most vigorous growth has not approached within about 4 mm. of the apex, the growth of the young root depends only on the elongation of the cells already formed in the seed. The first stage of growth is the result of this elongation taking place in fresh layers of cells, and the growing region thus advancing towards the apex.

6. When the zone of maximum growth has advanced to within 4 mm., or less, of the apex, cell-division and elongation of cells go on *pari passu*. In the second stage of growth the cells freshly formed near the apex contribute to the growth of the root by their elongation.

7. The first stage of the growth of roots is independent of the conduction of reserve-materials from the cotyledons or endosperm.

8. "Sachs's curvature" depends on a difference in the growth of the two sides of the root. This fact is in harmony with Wiesner's explanation of the occurrence of spontaneous phenomena of nutation in other organs.

Growth in length of decapitated and uninjured Roots.†—H. Molisch confirms Wiesner's statement that roots when deprived of their growing point grow less in length than uninjured roots under similar conditions of growth; and that this difference of growth in length depends greatly on temperature, being inconsiderable when the temperature is low. He further believes that the reasons why Kirchner has come to a different conclusion are probably that he worked at too low temperatures; that he removed too small a quantity from the apex of the root; and that the number of experiments performed was not large enough to arrive at definite conclusions.

* Anzeig. K. Akad. Wiss. Wien, Feb. 14, 1884. See Bot. Centralbl., xvii. (1884) p. 359.

† Ber. Deutsch. Bot. Gesell., i. (1883) pp. 362–6.

Geotropism and Hydrotropism of Roots.*—A. Tomaschek maintains that the degree of geotropism in a root does not depend on the rapidity of growth; nor is it affected even by severe injuries, provided the apex of the root is left uninjured. He regards the view of Darwin as fully established that the receptivity for the influence of gravitation resides in the apex of the root only, and moreover that the apex is susceptible to psychometric differences in the environment (hydrotropism), and that this susceptibility is conveyed to the adjacent parts.

Water-glands and Nectaries.†—W. Gardiner confirms Sachs's view that the exudation of water from water-glands is entirely due to root-pressure, and never takes place with cut organs; although in some cases (*Fuchsia globosa*) an abundant exudation from hairs in the vicinity of the water-glands gives the appearance as if it proceeded from the latter. Light retards very considerably the exudation of water both from water-glands and from those secreting epidermal structures which are not dependent on root-pressure. Water-glands are, as a rule, much more fully developed in Dicotyledons than in Monocotyledons, which may be due to the latter being of a more generally aquatic habit. The chief function, both of water-glands and of thin-walled epidermal cells placed in connection with a vascular bundle, is to allow of the escape of superfluous water, which would otherwise cause injection of the intercellular spaces, and even rupture of the tissue.

Nectaries, i. e. structures of whatever morphological value designed to secrete a saccharine fluid, do not, as Sachs has pointed out, discharge their nectar in consequence of root-pressure, but from the activity of the cells of the nectary themselves.

Folds of Cellulose in the Epidermis of Petals.‡—E. Köhne describes a number of different ways in which the lateral cell-walls of the epidermal cells of the petals are thickened and folded in a variety of plants. He discusses the purpose of these foldings, and believes it to be merely mechanical, in strengthening the epidermal layer of cells.

Anatomical Structure of Cork-woods.§—A. Gehmacher gives a detailed account of the anatomical structure of several extremely light woods from the tropics known as "cork-woods," viz. *Alstonia scholaris* from India, *Bombax Buonopozense* from Senegal, *B. Ceiba*, *B. pentandrum* from India, *Eriodendron anfractuosum* from India, *Kerminiera Elaphroxylon* from the White Nile, and the very beautiful Chinese "cork-wood," which comes apparently from the root of a Conifer. They all belong to the wood itself, and not to the bark.

"Filiform Apparatus" in Viscum album.‖—W. Scrobischewsky describes the "filiform apparatus" of the embryo-sac as very con-

* Oesterr. Bot. Zeitschr., xxxiv. (1884) pp. 55–9.
† Proc. Camb. Phil. Soc., v. (1884) pp. 35–50 (2 pls.).
‡ Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 21–9 (1 pl.).
§ Oesterr. Bot. Zeitschr., xxxiv. (1884) pp. 149–55.
‖ SB. Vers. Rus. Naturf. u. Aerzte, Odessa, Aug. 24, 1883. See Bot. Centralbl., xviii. (1884) p. 156.

spicuous in the mistletoe. The division of the nucleus in the embryo-sac takes place in the ordinary way. At each end of the embryo-sac three cells are formed, three antipodals, two synergidæ, and an oosphere. The seventh nucleus lies within the protoplasm near the oosphere, and is remarkable for its size and its elongated form; this is the nucleus of the embryo-sac. At this period a small vesicle is formed in the wall of the embryo-sac in close proximity to the synergidæ, into which vesicle the two synergidæ project, destroying its wall at two spots; the cell-wall which is thus destroyed assumes a mucilaginous character, in the form of very slender threads, arranged in the form of a cone, and constituting the peculiar "filiform apparatus." The synergidæ then also begin to exercise a destructive effect on the outer part of the split wall of the embryo-sac; at two points, corresponding to the apices of the synergidæ, openings appear through which the pollen-tube can project free into the interior of the sac. By careful pressure the "filiform apparatus" can often be separated from the synergidæ. The threads of the latter coalesce, after fertilization, into long homogeneous semi-fluid masses.

The function of the synergidæ is therefore to facilitate the access of the pollen-tube to the oosphere (germinal vesicle) by absorption of the wall of the embryo-sac. All stages in the division of the nucleus can very easily be followed out in the formation of the endosperm of *Viscum album*; they agree with those described by Strasburger in the case of *Hyacinthus orientalis*.

Action of Heat upon Vegetation.*—A short note upon this subject by A. Barthélemy deals with (1) the action of heat upon the development and direction of growth of roots, (2) the action of heat upon the phenomena of heliotropism.

1. One experiment was made upon hyacinths growing in vessels of water; it was found that they invariably grew *towards* a heated brazier placed in their vicinity, whereas the leaves grew away from the source of heat and towards the window which was brightly illuminated. In another experiment a vessel of water was divided by a glass partition into two compartments, one of which contained hot water while in the other were placed hyacinth roots floating in cold water; the roots always grew towards the glass plate, and applied themselves closely to it. When the water was coloured by means of lampblack it was found that the growth of the roots towards the heated compartment was checked—possibly on account of the increased conductivity causing the temperature round the roots to become more uniform, or by the lessening of the diathermancy of the water which would hinder the action of the heat upon the roots.

2. The experiment made to show the action of heat upon heliotropism is described by the author as follows:—A pencil of solar rays was made to fall either directly or by a mirror upon a *Dipsacus* placed in a vase in a dark room; the stalk rapidly bent towards the

* Comptes Rendus, xcviii. (1884) pp. 1006-7.

source of light, but rapidly recovered as if by a rebound as soon as the light was removed and the roots of the plant watered.

Relation of Heat to the Sexes of Flowers.* — T. Meehan referring to his former communication † as to male flowers entering on active growth at a much lower temperature than the female, exhibited catkins and flowers of the European hazel (*Corylus avellana*), which, for the first time in several years, had perfected themselves contemporaneously. The past winter had been distinguished by a uniform low temperature the entire season. In other years a few warm days in winter would advance the male flowers so that they would mature weeks before the female flowers opened: hence the females were generally unfertilized, and there were few or no nuts. Under this law, it was evident, amentaceous plants could not abound to any great extent in countries or in localities favourable to bringing forward the male flowers before there was steady warmth enough to advance the female. He thought this was likely to be the reason why so many coniferous trees under culture in the vicinity of Philadelphia bore scarcely any fertile seed in their cones—a fact which had often been remarked in connection especially with the Norway spruce. The male flowers would mature before the female had advanced far enough to be receptive of the pollen.

Influence of Light on the Structure of the Leaves of Allium ursinum.‡—C. Musset has investigated the truth of the statement that light has an influence on the leaves of certain plants, and finds that, in *Allium ursinum*, at any rate, there is no change in structure which can be ascribed to the action of light.

Effect of Light and Shade on Pine-leaves.§—E. Mer describes at length the difference in the development of the "needles" of *Abies excelsa*, according to their position on the tree or the branch, and according to whether the tree stands alone or is closely surrounded by others, depending therefore on the amount and the direction of the light which falls on the leaves.

Movement of Water in Plants.‖—As a contribution towards our knowledge of the causes of the movement of water in plants, J. Dufour has made a series of observations of the relation between the size of the cell-cavity and the thickness of the cell-walls in a number of woody plants, with the following approximate results:—*Sambucus nigra*, cell-cavities (without vessels) 16–18·8 per cent., walls of wood-cells, 81·2–84 per cent.; *Fagus sylvatica*, diameter of vessels 7·4, cell-cavities 7·5, xylem-parenchyma 17·0, cell-walls 68·1 per cent.; *Hæmatoxylon campechianum*, cell-cavities 4·8–23·0, cell-walls 77–95·2 per cent.; *Cæsalpinia echinata*, cell-cavities 4·2–14·0, cell-walls 86–95·8 per cent.; *Alnus incana*, cell-cavities 43·5–

* Proc. Acad. Nat. Sci. Philad., 1884, pp. 116–7.
† See this Journal, iii. (1883) p. 532.
‡ Comptes Rendus, xcviii. (1884) pp. 1297–8.
§ Bull. Soc. Bot. France, xxx. (1883) pp. 40–50.
‖ Arbeit. Bot. Inst. Würzburg, iii. (1884) pp. 36–51 and Arch. Sci. Phys. et Nat., xi. (1884) p. 15. Cf. this Journal, *ante*, p. 414.

51·6, cell-walls 45·8–56·5 per cent.; *Buxus sempervirens*, cell-cavities of wood-cells 7·9, cavities of vessels 9·8, walls of vessels and cells 82·3 per cent.; *Morus alba*, cell-cavities (without vessels) 10·6–25; cell-walls 75–89·4 per cent.

The author retains his opinion that the cell-cavities and vessels of wood are in no way necessary for the transport of the sap. This movement takes place entirely in the cell-walls, in consequence of a little-known property belonging to their internal nature. It is, no doubt, to a certain extent influenced also by transpiration.

Movement of Water in the Wood.*—Both the prevalent theories with regard to the causes of the ascent of the sap in woody plants—that of imbibition, that it ascends through the porous walls of the vessels, while the cell-cavities are filled with air, and that of gas-pressure, that at the time of greatest transpiration the vessels are filled partly with sap, partly with bubbles of rarefied air—depend on the hypothesis that the cell-cavities or vessels of the wood contain air under normal conditions. M. Scheit throws grave doubts on the elementary fact on which both these theories are founded. The air-bubbles constantly found in the vessels in microscopical sections have probably entered in the process of dissection, and those said to have been observed in sections under oil are certainly in some cases bubbles of aqueous vapour. There are only two possible ways in which air can reach the tracheids, through the stomata or through the root. The first hypothesis is excluded by the fact that there is no direct connection between the stomata or the intercellular spaces and the vessels; the second is very improbable; it is difficult to understand how air could pass through the fluid which permeates the parenchyma and collect in bubbles. By a number of actual experiments on *Abies balsaminea* and *excelsa*, *Taxus baccata*, *Acer platanoides*, and *Pteris aquilina*, Scheit also determined the impermeability to air of moist wood and of the closing membrane of pits; the water-conducting organs contain nothing but water either in the liquid or gaseous state.

The author believes that the passage of water from the parenchyma into the tracheids is greatly facilitated by the bordered pits. The water is absorbed from the soil by the youngest parts of the roots and the root-hairs by means of osmose; the osmotic pressure is greatest at the thinnest spots of the cell-wall, the pits; and, as far as the elasticity of the closing membrane of the pits permits, this membrane is pressed in towards the cavity of the adjoining vessel, and brought into a position for filtration, so that water can now readily pass into the vessel. The manometer indicates that this root pressure may amount to as much as one atmosphere. The water thus pressed into the empty vessels rises through capillarity, and the root pressure has thenceforward nothing more to do than to place the closing membrane of the pits in a position for filtration; a continuous column of water being thus formed in the plant. The whole plant is permeated by a system of capillary tubes having its lower end in a tissue which absorbs water, the parenchyma of the root; its upper end in a

* Bot. Ztg., xlii. (1884) pp. 177–87, 193–202.

tissue which gives off water, the spongy parenchyma of the leaf; in the other parts of the plant this system is accompanied by the parenchyma of the wood and medullary rays, which latter convey to the cortex the water required by it; while in the stem the whole conducting apparatus is also enveloped by cambium.

Measurement of Transpiration.*—Under the name Potetometer J. W. Moll describes an instrument invented by him for the purpose of exactly measuring the quantity of water given off, in any space of time, by the foliage of plants.

Exhalation of Ozone by Flowering Plants.†—A series of experiments conducted by Dr. J. M. Anders go far to prove that flowering plants, especially odoriferous ones, give off ozone under the influence of sunshine. Schönbein papers suspended in glass cases with flowering plants showed under favourable conditions marked blue shades, and though Dr. Anders does not wish to say dogmatically that all the changes seen in the test-papers were produced by ozone, he considers it incontestable that this substance was the chief agent in their production.

With regard to the probable mode of its production, Dr. Anders concludes that "during the formation of the seeds there is a rapid metastasis of phosphorites, in the form of phosphoric acid, and the phosphates to that organ of the plant, and it may be reasonably supposed that in the chemico-vital changes going on in the ovules, phosphorus is liberated and acted upon by the moisture which the leaves and petals are so actively transpiring." Under these circumstances it not improbably follows that those flowers which produce the most seed are the largest generators of ozone, so that the sunflower may have other than æsthetic claims to our admiration.

Acids in the Cell-Sap.‡—G. Kraus has examined the relative proportion of acid in different plants, in different parts of the same plant, and in the same part at different times of the day. As a rule, in most woody and herbaceous plants, the leaves contain the largest, the root the smallest quantity of free acid, though there are exceptions to the rule. In the stem the acidity increases from above downwards, or, in other words, increases absolutely with age. He regards the acids as not mere products of excretion in metastasis, but as playing an important part in the processes of life. In geotropic curvatures the amount of free acid is both relatively and absolutely less on the convex side.

The formation of acid is, as a general rule, hindered by light. As regards periodicity, the maximum of free acid is found in the early morning; the amount then decreases steadily till the evening, when it reaches its minimum, increasing again gradually during the night.

* Arch. Néerl. Sci. Exact. et Nat., xviii. (1883) pp. 469–78 (1 pl.).

† Amer. Natural., xviii. (1884) pp. 337–44, 470–7. Cf. Engl. Mech., xxxix. (1884) pp. 313–4.

‡ Abh. Naturf. Gesell. Halle, xvi. (1884). See Bot. Centralbl., xviii. (1884) p. 100.

The most abundant acid in the sap is malic, occurring either free or as calcium malate; the amount of this salt appears to remain nearly constant by day and by night.

Kraus regards the vegetable acids as secondary products of respiration, occurring especially in those parts which contain abundance of protoplasm, the medium of respiration. He does not support the view that they are products of assimilation.

New Colouring Substance from Chlorophyll.*—R. Sachsse distinguishes two varieties of the derivative from chlorophyll previously described by him as phyllocyanin, but which he now prefers to call phæochlorophyll, viz.:—*a* phæochlorophyll, almost insoluble, and *β* phæochlorophyll, soluble with difficulty in alcohol. The latter substance is, when dry, nearly black, insoluble in water, soluble in alcohol, from which it separates on cooling in amorphous flakes, and in benzol. It is distinguished by its peculiar brown-yellow-green colour, and its formula is $C_{27}H_{33}N_3O_4$.

By heating *β* phæochlorophyll with baryta water or fusing with soda, it is deprived of carbonic acid, and a new substance obtained with the composition $C_{26}H_{33}N_3O_2$, which, when dry, is of a dark red-brown colour. Its solution in alcohol is dark red, which a few drops of sulphuric acid change to light red-violet. The colour itself and the spectrum are very similar to those of an alcoholic extract of violets. Saturation of an acid solution with alkali gives, however, a yellow or, in very concentrated solution, a red colour instead of green. Dry distillation with soda gives a crystalline sublimate soluble in alcohol and extremely soluble in ether.

Crystalline Chlorophyll.†—J. Borodin believes that he has obtained the long-desired result of pure chlorophyll in a crystalline form by slow evaporation of an alcoholic solution, though he has not as yet been able to isolate the crystals. They are doubly refractive, giving a beautiful green sheen in polarized light. Their physical properties differ from those of the dark-green crystals of hypochlorin hitherto obtained.

Crystals and Crystallites.‡—By the term crystallites A. Famintzin designates structures which agree neither with crystals nor with the organized products of living cells. They may be arranged under four different types, connected by transitional forms.

The mode of formation of crystals was illustrated by artificial crystals of potassium phosphate and magnesium sulphate. From these the author established the following points: (1) The original form of the crystal is not always its permanent form. (2) Crystals are formed constituting the half or even the fourth of a double rhombic pyramid. (3) Crystals do not always grow with flat surfaces,

* SB. Naturf. Gesell. Leipzig, x. (1883) pp. 97–101.

† SB. Vers. Russ. Naturf. u. Aerzte, Odessa, Aug. 25, 1883. See Bot. Centralbl., xviii. (1884) p. 188.

‡ SB. Vers. Russ. Naturf. u. Aerzte, Odessa, Aug. 24, 1883. See Bot. Centralbl., xviii. (1884) p. 158.

growth frequently taking place by means of irregular prominences. (4) Crystals exhibit a splitting both transverse and longitudinal.

Sphærocrystals.*—A. Hansen's extended paper on this subject is now published. A preliminary notice of it was given *ante*, p. 416.

Formation and Resorption of Cystoliths.†—Continuing his previous investigation of cystoliths, J. Chareyre has examined chiefly those of *Urtica Dodartii*, *U. pentandra*, *Cannabis sativa*, *Acanthus mollis*, *A. lusitanicus*, *Thunbergia alata*, and *Andrographis paniculata*, grown in different soils, in darkness and in light. He finds all the seeds of Urticaceæ examined before germination to contain reserves of food-materials composed entirely of aleurone-grains, in each of which is a globoid; and this is also the case with the seeds of Acanthaceæ, except those of *Acanthus* and of *Hexacentris coccinea*, which have no cystoliths, and in which the reserve food-material consists for the greater part of starch-grains. No portion of these reserves contributes to the formation of deposits of calcium carbonate, whether as cystoliths or in any other form. Nor are they employed in the formation of crystals of calcium oxalate, which do not occur in the plants under examination during or in the period following germination. When grown in pure silica the cystoliths do not attain full development; the pedicle is formed, but does not develope cellulose at its apex, and always dies away when entirely deprived of lime. Ordinary soil and soil formed of pure calcium carbonate are about equally favourable to the formation of cystoliths. When grown entirely in the dark, the seeds contain only rudimentary cystoliths in which is no calcium carbonate.

In reference to the influence of the death or etiolation of the leaf on the quantity of lime contained in the cystoliths, the author found that in the Acanthaceæ etiolation, and even death, has no effect on their formation. Among the Urticaceæ, and especially *Ficus elastica*, darkness causes, after from 10 to 15 days, complete disappearance of calcium carbonate in the cystoliths, this disappearance being connected chiefly with the cessation of the function of the chlorophyll. The carbonate is not converted into bicarbonate; and a disappearance takes place of calcium oxalate as well as carbonate. The lime has entered into combination with some other acid, which is probably pectic acid; it disappears from the leaves, and passes into the stem, at least partially, in the form of calcium pectate.

Development of Raphides.‡—A. Poli has investigated the formation of the raphides contained in the cellular tissue of the bulb of *Narcissus intermedius*, where they are always accompanied by a strong development of mucilage. They occur in longitudinal rows of cells, and in older examples are always imbedded in mucilage resulting from the deliquescence of the transverse walls, which mucilage escapes

* Arbeit. Bot. Inst. Würzburg, iii. (1884) pp. 92–122 (3 figs.).

† Bull. Soc. Bot. France, xxx. (1883) Sess. Extr., pp. viii.–xii. Cf. this Journal, iii. (1883) p. 389.

‡ Nuov. Giorn. Bot. Ital., xvi. (1884) pp. 56–9 (1 pl.).

from the plant in great quantities when wounded. In the young state only a single bundle of raphides is found in each cell, later they are much more numerous.

Here and there, in specimens preserved in alcohol, applied to the walls of the cells which contain the raphides were found solid spherical bodies of a yellowish colour and finely granular structure. The formation of these bodies was unquestionably due to the alcohol; and they probably arise from some gummy modification of the mucilage.

New Vegetable Pigment.*—A Rosoll finds in the involucral bracts of several species of *Helichrysum* a hitherto undescribed colouring substance, to which he gives the name helichrysin. It tinges the protoplasm, is soluble in water and alcohol, and is turned a purple-red by both acids and alkalies.

The same writer also describes methods for detecting saponine and strychnine in vegetable tissues. The first is easily recognized by the action of sulphuric acid, which it colours first yellow, then red, and finally reddish-violet. It occurs in the living cells dissolved in the cell-sap. Strychnine is coloured an intense violet-red by potassium bichromate and sulphuric acid. It occurs in all the cells of the endosperm of *Strychnos nux-vomica* and *S. potatorum* dissolved in a fatty oil.

Fish caught by Utricularia.†—G. E. Simms has discovered that newly hatched fish are caught and killed by the bladder-traps of *Utricularia vulgaris*. They are mostly caught by the head, which is pushed as far into the bladder as possible until the snout touches its hinder wall. The two dark black eyes of the fish then show out conspicuously through the wall of the bladder. By no means a few of the fish, however, are captured by the tail, and in several instances a fish had its head swallowed by one bladder-trap and its tail by another.

Prof. H. N. Moseley ‡ thinks it probable that the fact described by Darwin (that the larger of the two pairs of projections composing the quadrifid processes by which the bladders are lined project obliquely inwards and towards the posterior end of the bladder) has something to do with mechanism by which the fish become so deeply swallowed. The oblique processes, set all towards the hinder end of the bladder, look as if they must act, together with the spring-valves of the mouth of the bladder, in utilizing each fresh struggle of the captive for the purpose of pushing it further and further inwards.

* Anzeig. K. Akad. Wiss. Wien, 1884, Nos. 7, 9. See Bot. Centralbl., xviii. (1884) p. 94.

† Nature, xxx. (1884) pp. 81 and 295–6 (3 figs.).

‡ Ibid., p. 81.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Anatomy of Vascular Cryptogams.* — P. Van Tieghem has studied several points in the anatomy of vascular cryptogams, recent and extinct. The secondary tissues of cryptogams, like those of phanerogams, proceed normally from two concentric generating layers; an external one in the cortex, forming bark outwardly, and secondary cortex inwardly; an inner one in the central cylinder, intercalated in the liber and in the xylem of the primary vascular bundles, producing secondary liber outwardly, and secondary wood inwardly. The normal subero-cortical generating layer is well developed in the stem (*Botrychium*, *Helminthostachys*), root (*Botrychium*, *Helminthostachys*, *Angiopteris*, *Marattia*), and leaves (*Botrychium*, *Angiopteris*, *Marattia*). The normal libero-ligneous generating layer is developed both in living ferns (*Botrychium*, &c.) and in extinct vascular cryptogams, as *Sphenophyllum* and *Sigillaria*. In addition to these normal layers we find in certain species two other abnormal generating layers: one external to the primary vascular bundles (*Isoetes*), and one interior to the primary vascular bundles (*Botrychium*).

The author also describes several anomalies in the primary structure of the root, viz. in the principal trunk and in the branches of a dichotomous root.

Fertilization of Azolla.†—E. Roze has studied the structure of the androspores (microspores) and gynospores (macrospores) and the mode in which fertilization is effected in *Azolla filiculoides*, but without adding anything fresh of importance to what is already known. He observes that the barbed hairs attached to the "massulæ" as they escape from the androsporangium do not occur throughout the whole genus, being wanting in *Azolla pinnata* and *nilotica*. The internal membrane of the gynosporangium, which remains attached to the gynospore in the form of a funnel, appears to play an important part in fertilization in facilitating the access of the antherozoids.

Muscineæ.

Male Inflorescence of Mosses.‡—H. Satter confirms the observations of Leitgeb and Kühn in the case of *Fontinalis* and *Andreæa*, that the axil of the shoot is used up in the formation of the antheridial receptacle, Leitgeb regarding this to be the rule with mosses. The author shows that this is also the case with many Bryineæ, also with *Phascum* and *Archidium*, which display apparent exceptions to the rule.

In *Phascum cuspidatum* the last three segments and the apical cell

* Bull. Soc. Bot. France, xxx. (1883) pp. 169–80.
† Ibid., pp. 198–206 (1 fig.).
‡ Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 13–9 (1 pl.).

form antheridia; behind the three leaves which are formed earlier lateral shoots arise, or more often behind the youngest of them only, and always behind the cathodal half of the leaf-forming segment. After the formation of usually only three whorls of leaves, these pass over to the formation of archegonia. In the leaves behind which the shoots arise the formation of a midrib is suppressed, and they are subject also to a variety of displacements in their insertion. The first of the archegonia is formed out of the apical cell, the three or four others out of the youngest segments. When the sexual organs are mature, the female branch projects only slightly above the male inflorescence; it is only after impregnation that any considerable elongation takes place, by which the male inflorescence is pushed to one side, or comes to stand in the fork, and is then surrounded by two involucral leaves.

The process is the same in *Archidium phascoides*, only that there is no considerable elongation of the female shoot; and hence the archegonia and antheridia are apparently inclosed in a common perichætium composed of involucral leaves.

The same relative position of the sexual organs is exhibited by *Pottia subsessilis*, *P. cavifolia*, *P. truncata*, *P. minutula*, *P. Heimii*, *Distichium inclinatum*, *Desmatodon obliquus*, *D. Laureri*, and *Oreas Martiana*. There is in these cases no doubt that the antheridial receptacle is the termination of the main axis, and that is pushed aside and overgrown by the elongation of the female branch.

A modification of this arrangement is exhibited by many species, as *Orthotrichum crispulum*, *O. Hutchinsiæ*, *Bartramia Halleriana*, *B. pomiformis*, *Amblyodon dealbatus*, &c., where the lateral shoots do not arise immediately beneath the male inflorescence, but in lower whorls of the male shoot. Either these lateral shoots form archegonia at once, or antheridia are again formed through several generations of shoots, archegonia only in a later generation. In *Amblyodon* these last branches are not always exclusively female, but have often sexual organs of both kinds united in the same inflorescence. The author considers that such a hermaphrodite inflorescence consists of two independent shoots, the female one being formed immediately beneath the antheridium-bearing segments, without producing any vegetative segments, proceeding directly to the formation of archegonia; this view being confirmed by transitional forms.

Lesquereux and James's Mosses of North America.*—This book includes all the mosses which are known on the North American continent within the limits of the United States and northwards. 900 species are dealt with, a very large portion of them being European. The classification does not differ materially from that of Bruch and Schimper (used in Wilson's 'Bryologia'). The definitions of species and genera are commendably full and clear, and the authors have avoided establishing or admitting species upon a slender foundation of differential character.

* Lesquereux, L., and T. James, 'Manual of the Mosses of North America,' 447 pp. and 6 pls. 8vo, Boston, 1884.

Fungi.

Supposed Absorption and Disengagement of Nitrogen by Fungi.* —G. Bonnier and L. Mangin detail a series of experiments by which they claim to have proved that the statement that fungi both absorb and give off nitrogen while in a state of vegetative activity is founded on error. The process of respiration consists solely in a disengagement of carbon dioxide.

Fungus parasitic on Drosophila.†—The Rev. J. L. Zabriskie describes *Appendicularia entomophila* Peck, a new fungus parasitic on the fly *Drosophila nigricornis* Loew. It is closely related to the Sphæronemei of the Coniomycetes. Like *Sphæronema*, the fruit has a bulbous conceptacle, surmounted by a long beak perforated at the apex, where the spores ooze out in a globule; but, unlike any described *Sphæronema*, this has the conceptacle seated upon the broad summit of a pedicle as long as the conceptacle itself; and also on one side of the summit of the pedicle and at the base of the conceptacle, it has an erect, leaf-like appendage, with strongly serrate margins, like a white-elm leaf folded along its midrib. The pores are slender, pointed at each end, and divided by a septum into two unequal cells, one cell being twice as long as the other. The total length of the fruit is from ·02 to ·03 in., and that of the spores from ·001 to ·002 in. The conceptacles of the fungus project directly from different points of the surface of the fly; so that they are found in all positions—erect, horizontal, and dependent. They grow sometimes singly, but oftener in clusters of two, three, or more, and are found most frequently on the tibiæ of the hind legs, but also springing from the inner posterior surfaces of the abdominal rings, from the costal vein of the wing, from the head, and from the thorax. One fly had about fifty of these conceptacles on various parts of the body and limbs.

Peronosporeæ.‡—M. Cornu gives (1) a monograph of the parasite of the lettuce, *Peronospora gangliiformis*, (2) an important memoir on the *Peronospora* of the vine. In both memoirs the best modes of treatment are discussed for checking or warding off the disease.

Vine-mildew.§—E. Prillieux has observed on *Peronospora viticola* reproductive bodies of a peculiar kind which he regards as probably intermediate between the ordinary conidia and oogonia. They appear in the same position as the conidia, emerging from the stomata of the leaf, and consist of short filaments terminating in pear-shaped bodies considerably larger than the ordinary conidia and separated from the pedicel by a septum. Their germination has not been observed.

The author is of opinion that the ordinary "rot" or "grey rot" of the American vines is produced by *Peronospora viticola*, and not by

* Bull. Soc. Bot. France, xxxi. (1884) pp. 19–22.

† Science, iv. (1884) p. 25.

‡ Cornu, M., 'Observations sur le Phylloxera et sur les parasitaires de la vigne.' See Bull. Soc. Bot. France, xxx. (1883) pp. 36–8.

§ Bull. Soc. Bot. France, xxx. (1883) pp. 19–24, 228–9.

Phoma uvicola, as had previously been supposed; although the latter fungus undoubtedly makes its appearance in the berries or seeds which have already been attacked by the *Peronospora*, but it plays only a secondary part.

The germination of the oospores of *P. viticola* has further been observed by Prillieux. On germinating the oospore gives rise to a branching tube which bears a number of conidia.

New Theory of Fermentation.*—E. Cocardas propounds the strange theory that all the different kinds of fermentation—which are as numerous as the different kinds of protoplasm—are due to the action of a single organism, *Penicillium*, which appears, according to its vital conditions, in the various forms of *Bacterium*, *Bacillus*, *Spirillum*, *Zooglœa*, *Hygrocrocis*, *Leptomitus*, *Torula*, *Byssus*, *Mucor*, *Aspergillus*, *Penicillium*, *Micrococcus*, *Microderma*, *Saccharomyces*, &c.

Microbes in Human Saliva.†—A. F. Rasmussen has made a careful examination of the micro-organisms found in the saliva of healthy men, with the following results.

The sources of these microbes—mould spores, ferment-fungi, and bacteria—are the air and the food; some disappear immediately, while others remain and undergo further development. The temperature of the mouth, 36°–37° C., is very favourable for their development, nutrient substances and oxygen being also always present in great abundance. The organisms are especially abundant at the outer side of the base of the back teeth, especially in the upper jaw, where a thick layer of tough mucilage is always found in the morning, and for some time after a meal. Carious teeth also breed large quantities of these organisms.

The author found none of the methods previously used for the culture of these organisms satisfactory; culture on a solid substratum he always found the most advantageous. The gelatine used for the purpose was placed in bulbs with a large bottom, so as to give as large a surface as possible. The staining employed was sometimes Koch's method, sometimes potassium biniodide, which however caused great changes in the size of the objects. Thus the sporiferous segments of *Clostridium polymyxa* measured 4–6 μ before, 2·2 to 2·4 μ after staining. The reagent for *Leptothrix* employed was potassium biniodide with a small quantity of hydrochloric acid.

The bulbs and test-tubes used were purified by concentrated sulphuric acid and distilled water, or with dilute (0·1 per cent.) solution of corrosive sublimate; and the wad-plugs used to close the apparatus were sterilized by a temperature of 110–120° C. For culture in nutrient fluids the author used the bulbs recommended by Salomonsen; various fluids were used, as human urine diluted with water and boiled for ten minutes, then filtered and neutralized with sodium carbonate, bouillon, solution of peptone, beer-wort, solution of

* Bull. Soc. Bot. France, xxxi. (1884) pp. 12–8.

† Rasmussen, A. F., 'Om Dyrkning af Mikroorganismen fra Spyt af sunde Menesker' (Danish) 136 pp. (2 pls.). See Bot. Centralbl., xvii. (1884) p. 389.

potassium albuminate, prepared by Lieberkühn's method, &c. For conveying bacteria from one vessel to another, finely drawn-out glass capillaries were used, first sterilized in a flame.

The author describes the culture of the microbes on potatoes, turnips, and on rye-bread; and rules are given for the preparation of the nutrient substance, the method of Koch and Brefeld being essentially followed. After a longer or shorter time small patches, dots, elevations, cushions, and similar structures arise, due to the microbes propagated from the saliva. These may be either (1) white moist opaque elevations—micrococci and bacteria, or (2) grey, dry, somewhat transparent patches—bacilli, colonies of a leptothrix-ferment, or oblong cells; torula and round saccharomyces-cells constitute a transition between the two; *Penicillium glaucum*, *Oidium lactis*, and a few species of *Mucor* were also met with, but the colonies of these forms are very easily confounded with those named before.

Culture on nutrient gelatine closely resembles that on potatoes; but many of the cultivated organisms deliquesce on the surface of gelatine; this is the case with the chromogenous bacteria, the sporiferous bacilli, *Penicillium*, and *Cladosporium*. In the gelatine-culture other phenomena also present themselves. Some forms grow downwards towards the bottom of the vessel, and form wedge-shaped figures; torula puts out lateral branches from these wedges; other forms spread out horizontally over the bottom; *Micrococcus luteus* forms delicate pellicles, from which threads branch vertically downwards; *Bacillus Ulna* forms a kind of diffuse infiltration, which descends into the gelatine and decomposes it on the surface. Culture upon gelatinized serum presented no very distinct peculiarities.

As regards the systematic position of the microbes observed, the author speaks first of the Zygomycetes, *Mucor racemosus* and *stolonifer;* also *M. spinosus*, new to Denmark, but observed only once. In all cases they had the faculty of forming torula-cells. Among Ascomycetes, *Penicillium glaucum* and *album* were observed, and among Hyphomycetes, *Cladosporium herbarum*, and *Oidium lactis*, the latter being one of the most frequent of the saliva-organisms. *Torula* was also found abundantly in nutrient fluids, and on gelatine and potato; when transferred to solutions of grape-sugar or to diluted urine, it exhibited no power of fermentation or of inverting. Under the name "torulose cells" (*hefeähnliche Zellen*) the author describes colourless or reddish cells, either roundish or elongated, and also peculiar species of *Saccharomyces*, which are only stages of development of higher fungi. One of these flesh-coloured species appears to be allied to Cohn's *Saccharomyces glutinis;* a second unnamed form was 9–11 μ long, 4 μ broad, with drops of oil imbedded in the protoplasm; a third consisted of round and elongated cells arranged in colonies, 11 μ long, and 3 μ broad, with no drops of oil. *Saccharomyces apiculatus* was not observed.

With regard to the Schizomycetes, the author considers that the view of Zopf that the different forms are stages of development of the same organism is true only of *Leptothrix*, which may go through all the various forms, while all the other Schizomycetes have one form

only. Of these constant forms he finds *Bacillus Ulna, Clostridium butyricum, C. polymyxa*, and several others not named, but no constant bacterium, and only once a coccus.

Of *Leptothrix* three distinct forms are described in detail, one of them chromogenous. Two of these he regards as comprised under *L. buccalis*, which together with spirillum, vibrio, and *Spirochæte denticola*, causes the mucilage of the teeth.

Of other chromogenous forms the author finds *Micrococcus luteus*, two unnamed, and *Bacillus Hansenii*, a new species. Cultivated on potato, this form grows with extraordinary rapidity, almost to the exclusion of all others.

Experiments are described which lead to the conclusion that the fluid in some cases contains micro-organisms when it enters the mouth from the ductus stenonianus; but that the air expired from the lungs is free from them.

Microbia of Milk.*—F. Hüppe has made a detailed examination of the microbia of milk, which can, he states, be completely sterilized by a temperature of 75°–100° C. He describes in detail the bacteria connected with the fermentation of milk, their biological relationships, and their chemical action on the milk. The bacilli of butyric fermentation are also described, the organisms of blue milk, other pigment-forming bacteria, mucilaginous milk, and *Oidium lactis*. The author holds very strongly the view of the constancy of the bacteria of milk.

Microbe of "Morbillo."†—M. Lanzi has investigated the microbe characteristic of this infection which he finds especially in the desquamated scales of the skin and in the urine. He considers it to be a species peculiar to this complaint, to which he gives the name *Bacterium morbilli* with the following characters:—Cells round or elongated, colourless, motile, isolated or united into chains of various lengths, composed of two or more cells, straight or more often curved, and even spiral: cells, 0·8–1·0 μ in diameter, with the length varying from this to double as much; no zoogloea-form was observed; propagation by fission in one direction, and then forming spores. Occasionally a large bacillus-form was assumed. The best staining reagent was found to be methyl-violet. *Bacterium morbilli* has no power of causing fermentation in the urine like *Micrococcus ureæ*. Without considering the question decided, the author leans to the opinion that it is the cause, and not merely the accompaniment of the disease.

Bacillus of Cholera.‡—T. R. Lewis denies the validity of Dr. Koch's conclusions as to the "comma-shaped" bacillus being the cause of cholera, as bacilli identical in size, form, and in their reaction with anilin dyes with those found in choleraic dejecta are ordinarily present in the mouth of perfectly healthy persons.

* MT. K. Gesundheitsamtes, v. p. 309. See Naturforscher, xvii. (1884) p. 251.

† Bull. Accad. Med. Roma, ix. (1883) No. 7.

‡ Nature, xxx. (1884) pp. 513–5.

Rabies.—The Government committee appointed to inquire into the experiments of M. Pasteur, report that his statements have been entirely borne out. Inoculation with the attenuated virus of hydrophobia gives a dog immunity from the disease, just as similar treatment preserves a sheep from charbon. All the 23 dogs submitted by M. Pasteur as having been thus inoculated have resisted the strongest virus on inoculation, whereas the majority of the 19 non-inoculated dogs have succumbed. Of the latter, six were bitten by mad dogs, three of them becoming mad, eight were subjected to intravenous inoculation, all becoming mad, and five to inoculation by trepanning, all becoming mad. The result is decisive; but the committee will now inoculate a large number of fresh dogs, and will compare these with an equal number of dogs not inoculated. It will likewise investigate the question whether, after a dog has been bitten, inoculation with the attenuated virus will prevent any consequences from the bite.

Etiology of Tuberculosis.*—Dr. G. N. Sternberg has repeated Koch's inoculation experiments, and is able to confirm him as to the infectious nature of tuberculosis; also as to the presence of the bacillus discovered by him, in tubercle nodules in the lungs and in tuberculous glands of inoculated rabbits and guinea-pigs (inoculated with sputum containing the bacillus from a phthisical patient). The experiments of Formad of Philadelphia, by which he claims to induce tuberculosis in rabbits as a result of the introduction into the cavity of the abdomen of finely powdered inorganic material, have also been repeated, with an entirely negative result so far as the production of tuberculosis is concerned.

The conclusion is therefore reached that the bacillus of Koch is an essential feature in the etiology of the infectious disease, tuberculosis.

Bacteria and Minute Algæ on Paper Money.†—J. Schaarschmidt, in consequence of Prof. Reinsch's discovery ‡ of bacteria and algæ on coins, has examined Hungarian bank and State notes and Russian one-rouble notes, and finds schizomycetes and algæ on all of them even upon the cleanest.

The vegetation of paper money is, as the result of his researches, composed of the following: *Micrococcus*, *Bacillus*, *Leptothrix* (various forms), *Bacterium termo*, and *Saccharomyces cerevisiæ*. Also, very rarely, Reinsch's *Chroococcus monetarum* and *Pleurococcus monetarum*.

Grove's 'Synopsis of the Bacteria and Yeast Fungi.' §—This book reaches us too late to say more than that it is a very handy and well-arranged synopsis of the Schizomycetes and Saccharomycetes, which cannot fail to be of invaluable assistance to microscopists

* Abstract of paper read before Section F (Biology) of the Amer. Assoc. Adv. Sci., Philadelphia, Sept. 9, 1884.

† Nature, xxx. (1884) p. 360.

‡ See this Journal, *ante*, p. 428.

§ Grove, W. B., 'A Synopsis of the Bacteria and Yeast Fungi and allied species.' 8vo, London, 1884. vi. and 112 pp. (87 figs.).

interested in its subject, and not the less so that our knowledge regarding these organisms is at the present time in so scattered and undigested a condition.

Protochytrium Spirogyræ, a new Myxomycete (?).*—A. Borzì describes a parasitic organism of very low organization, which he finds in the cells of *Spirogyra crassa* and of a few other nearly allied species of algæ, rapidly destroying the contents of the cells and causing complete disintegration of the filaments, the cell-walls themselves ultimately entirely perishing. The minute masses of protoplasm of which it is composed are completely destitute of cell-wall, and display amœboid motions, but without any pseudopodia. They derive their nutriment directly from the surrounding protoplasm, and may be regarded as plasmodia of very reduced dimensions. They are composed of homogeneous protoplasm, within which are very fine granulations, and have, therefore, all the characters of an organization the simplest that can be imagined. They compose a true *jaloplasm* in the sense of modern histologists, constantly altering its form in consequence of its amœboid motions. The granulations are frequently disposed round a small transparent central areole, which represents a true vacuole. It is, however, entirely destitute of true nuclei, the minute granulations wanting all the characteristic structure of these organisms. The central vacuole is constantly altering its position, and alternately contracting and expanding. The principal, if not the sole, agent in these amœboid movements appears to be the superficial protoplasmic layer. The growth of these organisms is rapid, and they attain a diameter of about 40 μ in twelve hours.

The process of nutrition may be divided over two distinct periods. In the first the nutriment, derived from the surrounding substratum, passes directly into the body of the parasite. In the second period, the substances, already ingested and deposited, become somewhat elaborated and digested. These two phases can be well followed under the Microscope.

When one of the plasmodia comes into contact with a band of chlorophyll, it slowly penetrates into its interior. A small portion of the nutrient substance, consisting of protoplasm containing chlorophyll and of starch-grains, becomes at length entirely imprisoned in the mass of the plasmodium. The ingested substance retains for a very short time its original properties. The chlorophyll soon loses its green colour; the granules of starch are the last portion to be completely absorbed. An excretory portion which is not digested is finally expelled.

The vegetative activity of the plasmodia ceases on the commencement of the reproductive period; they attain a state of quiescence, and the formation of zoosporangia commenecs. The peripheral layer of protoplasm becomes thinner and tends to merge in the internal portion; its motility at the same time disappearing altogether. After numerous internal changes in the structure of the protoplasm, the contents divide by successive bipartitions, either a

* Nuov. Giorn. Bot. Ital., xvi. (1884) pp. 5-32 (1 pl.).

portion or the whole of the protoplasm being used up in the formation of zoospores, which process is a very rapid one. On escaping from the zoosporangium these bodies are minute pear-shaped or ovoid masses of protoplasm, containing granulations, and not invested with a cell-wall, provided at one end with a flagelliform cilium, and also with a contractile vacuole. In some cases the zoospores are unable to escape from their parent cell, and transform themselves directly into new zoosporangia. Either the ordinary zoospores or those derived from these secondary zoosporangia, after moving about actively for half an hour, lose their cilium, and become transformed into an ordinary amœboid mass of protoplasm, with movements due to contractions and dilations, in which condition they may be described as *myxamœbæ*. In this state they not unfrequently come together and coalesce, the two vacuoles remaining for a time distinct, but finally uniting. The original plasmodia are formed either from a single myxamœba, or result from a fusion of several; and these may then propagate themselves for several generations before the formation of zoospores.

Instead of the production of zoospores, the period of vegetative activity of *Protochytrium* is frequently closed by the formation of *cysts*, or true encysted plasmodia, especially at the period when the host naturally dies. These are cells with double walls, and with a considerable space between the outer and inner walls; this space is filled with a transparent fluid, often containing small remains of nutrient substance not completely digested. The ordinary diameter of the cyst itself is from 15 to 25 μ, that of the external envelope from 30 to 40 μ. This external envelope displays many of the properties of fungus cellulose. The internal contents consist of a dense finely granular protoplasm. These cysts are formed within the cells of the host, and when they decay, fall to the bottom of the water, where they germinate after a period of rest, and develope into myxamœbæ. These again enter the cells of the host by penetrating through the cell-walls, in the same manner as the germs of many Chytridiaceæ.

As regards its systematic position, *Protochytrium* displays on the one hand affinities with the Myxomycetes, and on the other hand with such genera of Chytridiaceæ as *Woronina*, *Rozella*, and *Olpidiopsis*; but the author considers the entire absence of a cell-nucleus to be a point of so great morphological importance that it must for the present be referred to Klein's family of Hydromyxaceæ, along with the forms of *Monas* described by Cienkowski and Häckel, and also *Vampyrella*, *Monadopsis*, and *Protomyxa*.

Lichenes.

Substratum of Lichens.*—O. J. Richard, besides combatting the theory of an algo-lichenic association, holds that the nature of the substratum, whether calcareous, siliceous, metallic, organic, or neutral,

* Actes Soc. Linn. Bordeaux, 88 pp. See Bull. Soc. Bot. France, xxx. (1883) Rev. Bibl., pp. 105-7.

is of small consequence to the lichen, which derives no nutriment, but merely support therefrom. Nor does the author agree that the chemical composition of the thallus varies according to the nature of the substrata.

Hymenolichenes.*—This section of lichens was established by Mattirolo † from the genus *Cora*, and depends on the symbiosis of an alga with a fungus belonging to the class of Hymenomycetes. F. Johow has critically examined the group in its native country of Venezuela and the West Indies, and includes in it the four following genera:—*Cora*, *Rhipidonema*, *Dictyonema*, and *Laudatea* gen. nov. The first three genera must be regarded, from their habit and the lamination of their thallus, as heteromerous foliaceous lichens, but differing from all other genera in the entire absence of a solid cortex and in the unusually complete investment of the algæ which perform the function of gonidia. *Laudatea* is distinguished by its peculiar cæspitose habit, and by the segmentation of the thallus connected with it into a saprophytic mycelium and green stems composed of bundles of gonidia invested by fungus-hyphæ.

The systematic position of the Hymenolichenes is among the Thelephorea, and in near relationship to *Thelephora*, *Corticium*, and *Hypochnus*. The only organs of reproduction which they possess are sporiferous basidia growing on the under side of unilateral pilei, or on crustaceous receptacles (*Laudatea*). Nylander's statement of the presence in *Cora* of apothecia has not been confirmed. The saprophytic mycelium and crustaceous receptacle of *Laudatea* find their analogue in numerous species of *Thelephora* and *Corticium*. The green foliaceous thallus of *Cora* is homologous to the receptacle of *Thelephora*.

Algæ.

Fresh-water Phæospore.‡—Under the name *Lithoderma fontanum*, E. Flahault describes a fresh-water phæosporous alga from the neighbourhood of Montpellier. It agrees with other species of the genus in having the zoosporangia naked and superficial. The thallus is closely adherent to the substratum, recalling that of *Melobesia* or *Coleochæte*. The zoospores are ovoid, unequilateral, with a red eye-spot and two unequal cilia inserted on the concave side of the zoospore, and directed one forwards, the other backwards. They germinate directly, without conjugation.

Nostoc.§—C. Flahault has had the opportunity of examining the structure of the rare *Nostoc flagelliforme*, growing in the neighbourhood of Montpellier, described by Berkeley and hitherto known only from Texas. He regards it as identical with the *Nematonostoc rhizomorphoides* of Nylander, which genus must therefore disappear. Spores were not observed, but hormogonia frequently. *Nostoc flagelli-*

* SB. K. Preuss. Akad. Wiss. Berlin, 1884 pp. 113–28; also Pringsheim's Jahrb. f. Wiss. Bot., xv. (1884) pp. 361–409 (5 pls.).

† See this Journal, ii. (1882) p. 542.

‡ Comptes Rendus, xcviii. (1884) pp. 1389–91.

§ Bull. Soc. Bot. France, xxx. (1883) pp. 89–96 (1 pl.).

forme must also disappear as a species, being merely a variety of *N. ciniflorum* Vauch.

Flahault further identifies *Nostoc coriaceum* Vauch. as a form of *N. ciniflorum*.

New Chromophyton.*—M. Cornu describes an alga coloured by a yellow pigment found in a spring of fresh water, in company with *Navicula*, and possessing a siliceous coat similar to that of diatoms. He regards it as nearly allied to Woronin's *Chromophyton Rosanoffii*,† differing from that species in its siliceous envelope, and in the possession of stalked bodies which may be sporangia. He proposes for it the provisional name *Chromophyton Woronini*.

Wolle's Desmids of the United States.‡—The Rev. F. Wolle's work on the desmids of the United States will be found useful by English cryptogamists who are not in possession of Ralfs' work. Eleven hundred coloured figures are given illustrating all the species and varieties described in the text.

New Diatoms.—Diatoms from Stomachs of Japanese Oysters.§—F. Kitton describes some new diatoms taken by Mr. G. Sturt from the stomachs of some "tinned" oysters from Japan, sent to the Fisheries Exhibition, viz., *Aulacodiscus Sturtii* and *Amphipleura pellucida* var. *rectus*. Nearly 90 other marine species as well as a considerable number of fresh-water species from the stomachs were identified by Mr. E. Grove.

Mr. Sturt's directions for examining the stomachs of oysters, &c., are as follows:—"After opening the tin and pouring off the liquid contents, I empty out the oysters and pick out the stomachs (which look like dark little sacs, and as a rule are free, or only partially surrounded by a little fatty matter, which is easily taken off). I then heat in a glass to boiling point five or six ounces of nitric acid, in which I drop one by one the stomachs, waiting until each is dissolved before adding another. After all have been dissolved I add an ounce of hydrochloric acid, and continue the boiling for five minutes, dropping in at intervals a little bichromate of potash. I now fill up the flask with hot water and empty the whole into a large beaker, filling up with the hot water (the fat rises to the surface, and on cooling congeals on the top, and is easily skimmed off). I wash away the acid, using hot water, and boil in soap and water according to Prof. H. L. Smith's directions. If this does not get rid of the organic matter, I boil in sulphuric acid and chlorate of potash." The water used for washing must be filtered rain or distilled water and free from all trace of acid.

Mr. Kitton also describes, from other localities, the following new species:—*Surirella carinata* and *Sceptroneis* (?) *clavus*.

* Bull. Soc. Bot. France, xxx. (1883) Sess. Extr., pp. xciii.–v.

† See this Journal, i. (1881) p. 100; iii. (1883) p. 108 and 863.

‡ Wolle, F., 'Desmids of the United States and list of Pediastrums.' 168 pp. and 53 pls. 8vo, Bethlehem, Pa., 1884.

§ Journ. Quek. Micr. Club, ii. (1884) pp. 16–23 (1 pl.).

Structure of Diatoms.*—According to L. Reinhardt a form of valve similar to that described by Müller in *Triceratium*, occurs in many, if not all forms with areolated cell-wall.

The formation of the pedicel and of gelatinous colonies are phenomena altogether analogous to those which occur in the palmelloid algæ. In the *Mastoglœa* colonies it is easy, when the formation of jelly has not advanced beyond a certain extent, to observe a similar system of intercalation of cell-walls as in *Glœocystis*. In the cell-wall of *Mastoglœa* and other similar forms, two layers can be distinguished, an outer gelatinous, and an inner layer which retains its consistency and structure. In the formation of the pedicel the outer layer becomes locally mucilaginous. In those forms where an entire group of individuals is attached to a single pedicel (as many species of *Synedra* and *Licmophora*) longitudinal striæ make their appearance on the thick pedicel corresponding to the separate cells; these are made distinctly visible by staining with hæmatoxylin.

The author also describes the formation of auxospores in *Cocconeis communis*, *Achnanthes longipes*, and *A. brevipes;* in the first species their development was followed out in several hundred specimens. The auxospores are always formed by the conjugation of two individuals, never by rejuvenescence, as stated by Schmitz. The conjugating cells often open at different times, and the formation of the mucilaginous bladders begins only with the coalescence of the conjugating masses of protoplasm. The nuclei of the conjugating cells move slowly in the direction of the movement of the protoplasm towards the anterior margin of the masses of protoplasm, and, a short time after these commence to coalesce, a single much larger nucleus is seen in the place of the two. Conjugation of the nuclei therefore takes place here. The author further describes the formation of the perizone and of the cell-wall of the auxospore, the growth and bipartition of the chromatophores, and the division of the auxospores into two primary cells. In *Achnanthes longipes* the conjugation always takes place in a very interesting way between two cells which are not equivalent. One of these has always a long pedicel, whilst the other is attached by a gelatinous disk to the upper end of the pedicel of the first. When the protoplasmic masses of two cells coalesce, a mucilaginous bladder is formed, which is connected only with the lower valve of the stalked cell. Since this bladder is formed essentially from the protoplasm of the stalked cell, it follows that that of the other cell passes into the bladder of the first. The phenomena in this species justify the regarding of the formation of auxospores by conjugation as a process of sexual reproduction. In *A. brevipes* the process is the same in its general features. The formation of auxospores without conjugation is regarded by the author as a kind of apogamy.

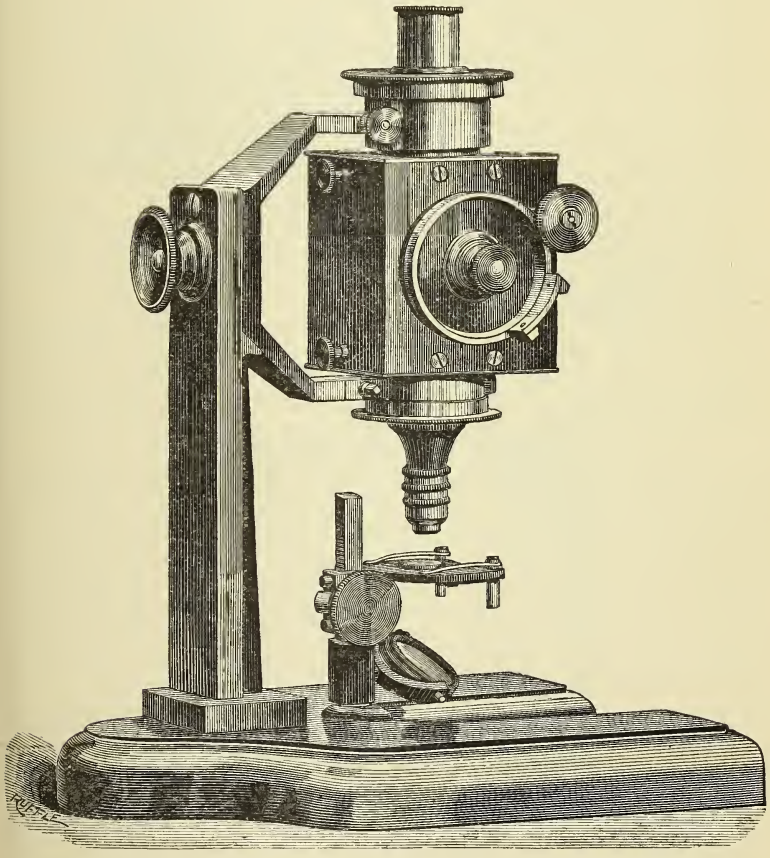
* SB. Vers. Russ. Naturf. u. Aerzte, Odessa, Aug. 27, 1883. See Bot. Centralbl., xviii. (1884) p. 191.

MICROSCOPY.

a. Instruments, Accessories, &c.

Albertotti's Micrometer Microscope.*—Dr. G. Albertotti, jun., has designed the instrument shown in fig. 123, for the purpose of measuring microscopic objects more satisfactorily than can be done with either eye-piece or stage micrometer.

Fig. 123.



If the diverging plates of Helmholtz's ophthalmometer are interposed between the eye-piece and objective of a compound Microscope in such a way that the axis of the plates is at right angles to the axis of the Microscope, the effect of the plates on the apparent

* Ann. di Ottalmologia, xi. (1882) pp. 29–30 (1 pl.).

position of an object seen through the Microscope will be the same as when they are used without a Microscope, i. e. so long as the plates are in one plane the image is unchanged in its position, but as soon as the plates cross at an angle it will be separated into two images of equal size, which are displaced in opposite directions. By turning the plates through a sufficient angle the displacement can be so arranged that the margins of the two images which are turned to each other shall coincide, and a compound image is formed which, in the direction of the displacement is twice as large as the original one. For the same eye objective and eye-piece and for a constant distance of both from the axis of the plates, the angle of inclination to be given to the plates, in order to double the image, bears a fixed relation to the size of the object and may therefore be used to measure it.

If a table is prepared showing the values in mm. of the angles of inclination of the plates, it is only necessary in measuring an object to turn the plates until the image is doubled and ascertain the angle between them, and the table will then give the dimensions.

In fig. 123 the square box between the eye-piece and objective holds the Helmholtz plates which are rotated by the outer milled head, the angles of inclination being read off on the large graduated drums on each side.

It is claimed that by the use of this instrument those errors are avoided which arise in the use of the eye-piece micrometer if the image of the object does not exactly fall in the plane of the micrometer divisions. The angles can moreover be read with greater precision than the micrometer divisions.

Baumann's Callipers with Movable Microscope and Fixed Micrometer.*—T. Baumann's instrument (fig. 124), in which the Microscope is movable and has a fixed micrometer in the eye-piece, is not intended for such minute measurements as the preceding, but was devised for cases for which a vernier is not sufficiently exact, while a screw micrometer is too fine or not sufficiently rapid. It will read to 0·04 mm. In a base plate A A, 200 mm. long, a central groove is cut, along which moves the cylinder *a*. The upper edges of the groove are bevelled off by a cylinder of the same diameter as *a*. The cylinder moves freely along these without attachment of any kind, to avoid errors of tension, &c. To one end of the cylinder is attached a glass plate C, another glass plate B being fixed exactly parallel at the end of A, the two plates forming the jaws of the callipers. The cylinder is moved by the ivory handle at *h*. A plate *u u* is attached to the former on one side, to which plate are fastened the two supports *g* which carry the socket of a compound Microscope *l o* (78 mm. high and magnifying 50–60 times). The supports *g* rest on the base plate. The socket is divided and the two halves are clamped by the milled head *m*. The inside of the socket has a worm so that by turning the ring *k* the Microscope is moved up or down for focusing.

The edge of the base plate is divided on silver for 150 mm. into

* Zeitschr. f. Instrumentenk., iv. (1884) pp. 149–52 (2 figs.).

0·2 mm. The centimetres are numbered with large figures and the millimetres by microscopic figures from 0 to 9. The approximate position of the Microscope is read off by a pointer. One of the smaller figures is always in the field of the view, which is 1·5 mm. in diameter. At *l* is a micrometer which can be rotated in azimuth.

Fig. 124.

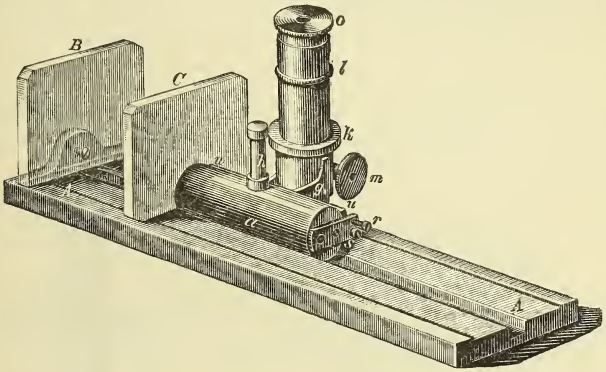
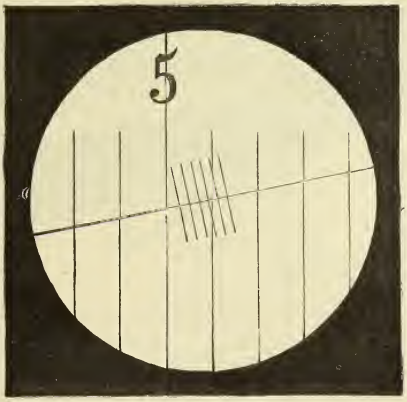


Fig. 125.

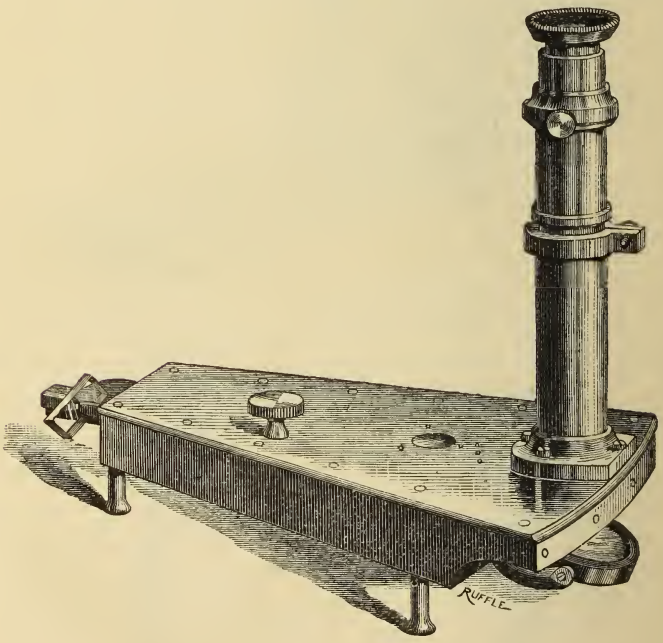


Its five divisions coincide with one of the scale as seen through the Microscope, and each is therefore equal to a fifth of 0·2 mm. or 0·04 mm. The divisions are preferably inclined, as shown in fig. 125. The reading in this case is 4·936 mm. as the last line of the micrometer (reading from right to left owing to the inversion of the image) is 3·4 divisions from the 4·8 mm. point of the scale. As each division is 0·04 mm., 3·4 of these divisions = 0·136 mm. The

coincidence of the 0 point of the scale with that of the micrometer is obtained by the screws *r* and *s* acting on the plate *u u*, which is not rigidly fixed to the cylinder *a*, but slightly movable.

Geneva Co.'s Microscope Callipers.—In the instrument, fig. 126, (made by the Société Genevoise pour la construction d'Instruments de Physique), a compound Microscope is made use of for measuring minute thicknesses such as cover-glass, &c. It consists essentially of a lever at one end of which are the jaws for holding the object to

Fig. 126.

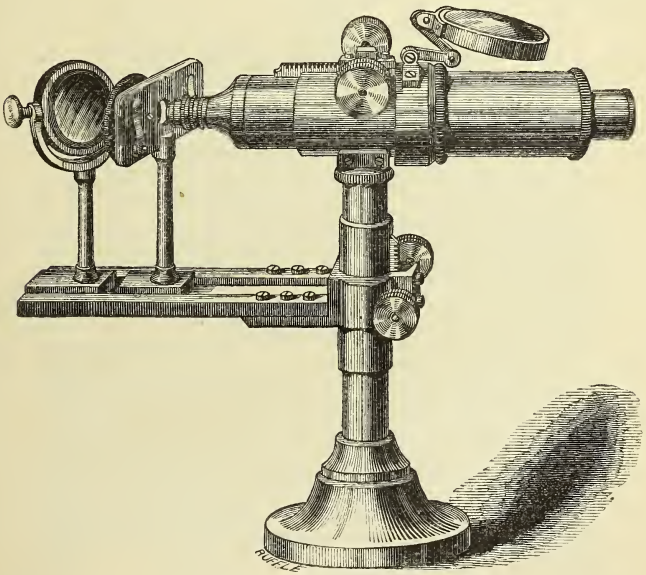


be measured (shown in the figure with a piece of glass between them), and the movement of which is amplified twelve times. At the other end the lever carries a glass plate ruled with 120 divisions, which is observed through a Microscope having a fixed micrometer in the eye-piece with 30 divisions. The jaws are opened by the milled head on the box, and the extent of movement is indicated by a scale with 120 divisions (corresponding to the glass plate), which passes under the aperture seen at the top of the box. By the eye-piece micrometer the principal divisions may be further subdivided. When open the jaws are 3 mm. apart; each of the principal divisions represents therefore 1/40 mm., and the subdivisions 1/1200 mm. The mirror illuminates the divisions of the glass plate.

Griffith's Club Microscope.— Mr. E. H. Griffith writes us that he has further improved the 'Griffith Club Microscope' * as follows: "The bar that holds the clips has a stiff spring over it. The front of the bar is flattened. The clips may be turned back out of the way, and when needed again the spring holds the clips down (or the bar in position). Some have been made with an arrangement to push the bar either way, letting the bar pass through the stage-holder but above it a nut gives the double clips a lateral motion and the spiral spring keeps the bar steady. The double clips clasp the slide and carry it with them. The lamp attachment has been improved also."

Nachet's Class Microscope.—This (fig. 127) was intended by M. A. Nachet to be passed round amongst the students in a class, being at the same time very steady on the table. It can only be used in a

Fig. 127.



horizontal position. The body-tube is focused by the rack and milled heads at the top, while the stage and mirror, which slide on the horizontal bar, are raised or lowered by the milled heads at the side of the standard. The shifting of the object from right to left is effected by the hands.

Nachet's Microscope with Large Field.†—A. Gravis describes a new Microscope by M. A. Nachet, of which the speciality appears to be that it affords a larger field of view than usual in Continental

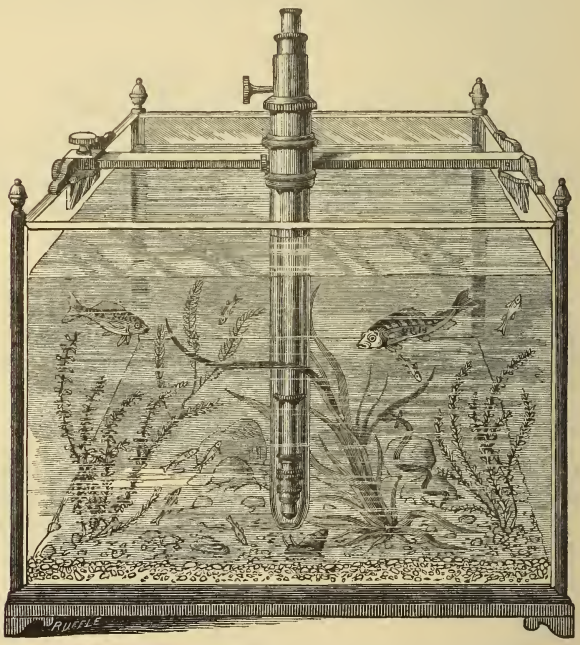
* See this Journal, iii. (1883) p. 113.

† Bull. Soc. Belg. Micr., x. (1884) pp. 194–7.

Microscopes, and is thus specially adapted for dissecting, examining large sections, &c. The tube has an interior diameter of 29 mm., and the apparent diameter of the field measured at a distance of 250 mm. by means of the camera lucida is 200 mm. With the ordinary Nachet No. 1 eye-piece this diameter is only 135 mm., and with No. 1 Prazmowski 110 mm. There is a variable objective, which when shortened gives a magnifying power of 15 with a working distance of 28 mm. and real diameter of 13 mm. When extended these figures are 23, 7 mm. and 8·5 mm. respectively.

Stephenson's Aquarium Microscope.—This Microscope (fig. 128) was designed by Mr. J. W. Stephenson for the examination of living objects in an aquarium.

Fig. 128.



A brass bar is laid across the aquarium, as shown in the woodcut. To adjust it to aquaria of different widths the support on the left is made to slide along the bar, and it can be clamped at any given point by the upper milled head. The milled head at the side, by pressing on a loose plate, fastens the bar securely to the aquarium.

Between the ends of the bar slides an arm carrying a sprung socket, and the arm can be clamped at any given point of the bar. Through the socket is passed a glass cylinder, cemented to a brass collar at the upper end and closed at the lower by a piece of cover-

glass. Into this cylinder is screwed the body-tube of the Microscope with eye-piece and objective, which are thus protected from the water of the aquarium. The Microscope is focused by rack and pinion (milled head just below the eye-piece), and in addition the objective is screwed to a draw tube so that its position in the cylinder may be approximately regulated.

The arm of the socket is hinged to allow of the Microscope being inclined in a plane parallel to the sides of the aquarium. The lower milled head clamps the hinge at any desired inclination. The socket also rotates on the arm so that the Microscope can be inclined in a plane parallel to the front of the aquarium. Thus any point of the aquarium can be reached.

Swift and Son's Oxyhydrogen Microscope. — This (fig. 129) is suitable for use with ordinary objectives from 4 in. to 1/4 in. The gas jet can be regulated for either parallel or convergent light without the necessity of opening the lantern, it being mounted on

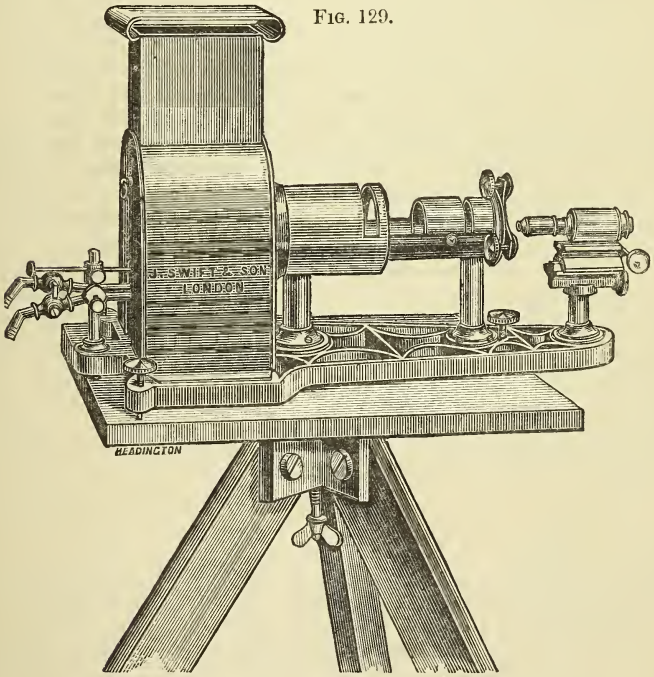


Fig. 129.

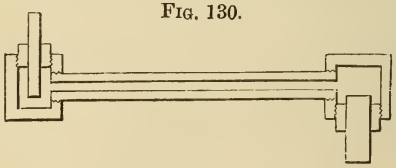
an independent pillar 2 in. from the back, and fitted to adjust to or from the condensing lenses as occasion may require. The perforated metal base renders it very light, and also allows the passage of a free current of air, so that the lantern is kept as cool as possible. There are three screws, upon which the whole is supported to finally adjust

the disk of light. The tube into which the convergent lenses, polariscope, and spot-lens fit, is cut open for the purpose of easily dropping these pieces into position; this opening is covered with a revolving segment of tube similar to the breech action of the Martini rifle.

The stage has rectangular motions by cams which are moved by the milled heads at the back of the stage, and the clip holding the object will equally clamp the thinnest slide or a thick zoophyte trough, the clip is lifted by turning the milled head. The coarse focusing is by rack and pinion, and the fine adjustment is similar in construction to that of the ordinary Hartnack Microscope. The alum trough for stopping the heat-rays can be used behind the condensers for convergent rays, or inserted in the opening in front when parallel light is required, the opening being covered by a revolving segment of tube when not used.

Nelson's Hydrostatic Fine Adjustment.*—E. M. Nelson considers that "the growing increase in the use of wide-angled object-glasses calls for an improvement in the fine adjustments of Microscopes. This is especially the case when it is remembered that depth of focus is inversely proportional to N.A. Also the Microscope is used in a far more scientific manner than the rough and ready way of former days. Among the best workers critical pictures are now the only ones accepted. A vast improvement has taken place in the construction of object-glasses, but the fine adjustments are pretty much the same as they were twenty-five years ago. The following diagrams illustrate a method that has occurred to me, and which, if adopted, would, I think, effect an improvement in this direction. It is simply an iron chamber filled with mercury, with a plunger and a ram. The fine adjustment screw works on the plunger, and the ram on a stud fixed to the nose-piece, which is kept pressed against it by a spring. Fig. 130 shows the arrangement as adapted to a bar movement. Here there are two chambers connected by a pipe, the

Fig. 130.



plunger being in one, the ram in the other. Fig. 131 shows the same thing adapted to a Jackson-Lister. It will be observed that the fine adjustment screw may be on either side or behind the bar. Fig. 132 shows it as arranged for the Continental or medical student's model, which has the direct-acting, non-geared-down, screw fine adjustment. The application of this contrivance to these Microscopes would be invaluable, as their present fine adjustments preclude the possibility of any fine work being done with them. As drawn, the

* Paper read at Quek. Micr. Club. Cf. Engl. Mech., xxxix. (1884) p. 576 (3 figs.).

apparatus gears down 1 : 4, but by varying the relative diameters of the plunger and the ram the ratio could be reduced almost to any extent—e. g. a plunger of 1/12 in. and a ram 1/2 in. would gear down

Fig. 131.

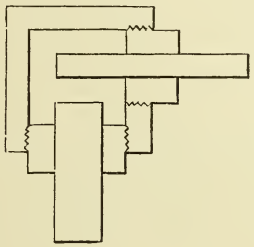
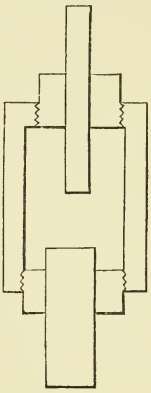


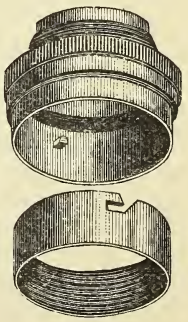
Fig. 132.



in the ratio of 1 : 36, so that one revolution of a 50-thread screw would only make a movement of 1/1800 of an inch in the objective."

Griffith's Nose-piece.—Mr. E. H. Griffith suggests yet another form of nose-piece as shown in fig. 133. The adapter has a short pin fitted on the inner surface of the cylinder, while the ring for the objective has a bayonet slot. The ring is as deep as the Society-screw to the objective, allowing it to be put into the box with the latter. This device was employed by Chevalier many years ago.

Fig. 133.



Kellner Eye-piece with additional Lens as a Condenser.—At the closing meeting of the last Session, after Dr. Wallich had pointed out the advantages of his new form of condenser, Dr. R. L. Maddox explained the plan he had used for some time, especially when photographing minute objects, such as bacteria. Instead of the usual pin-hole in the cap of a Kellner eye-piece, he substituted a movable diaphragm, with a small deep lens of 1/12 in. radius and of some thickness. The diaphragm, with lens duly centered, slides by friction in the cap of the eye-piece, and is pushed up close to the ordinary opening; the cap is then closed down upon the eye-lens to the best position for the purpose required. Single lenses of other radii can also be tried. The whole is used as a substage condenser, and with or without the usual diaphragm wheel.

The advantage claimed for this form is its inexpensive addition to what is ordinarily part of the apparatus of the microscopist. It can be used as an ordinary or immersion condenser, and when employed for photo-micrography, on looking along the path of the illumination from behind, a ring of light is observed round the edge of the field lens, equally divided by a narrow vertical image of the flame, if all the parts be correctly centered.

Osborne's Diatomescope.*—Lord S. G. Osborne calls attention to a little instrument he has invented, which he thinks "may, when once known, be of great service to those observers who, like myself, take great interest in the study of the beautiful forms found in the diatom class of objects.

I have now, for a very long time, worked patiently in an endeavour to procure the means of viewing these objects by oblique light. I possess many of the modern inventions for the purpose; with all I could get much good result; but I yet failed with them to arrive at my chief aim—to possess means of a simple character, easy to use, capable of being put into the market at small cost, which should give with all powers, from 1 in. to 1/4 in., a perfectly black background, the objects under observation brilliantly illuminated.

I have now done this, and the rough models made by my own hands have been seen in use by some well-skilled observers, who have all admitted that my purpose has been fully achieved.

It was my first intention to have simply published in your columns the formula for the construction of the instrument; but having had to make a great many with my own hands, experience taught me that it would be far better to employ skilled labour to act in the first instance under my own supervision to secure accuracy, than to risk the disappointment in the case of those who, wanting my practical experience, might well fail to get all the nicety of adjustment necessary for success.

I therefore have gladly availed myself of the offer of Mr. Ernest Hinton, who has had much experience in connection with the mounting of diatoms, to aid me in getting the little apparatus accurately made. . . .

The instrument is applicable to the stage of any stand which has the usual lateral and vertical movements, and if there is a clamp to keep the slides *in situ*, nothing more is wanted; failing the existence of a clamp, two small pegs fixed to the instrument to drop into two holes in the sides of the stage will answer equally well. If, as in some of the small stands, the aperture in the stage is circular, no clamp is necessary, as the instrument can be set in a piece of tubing to drop into this, with a narrow thin flange to prevent its falling through.

In whatever way it is applied to the stage, the method of use is very simple. The stage being set central, the diatomescope is either laid on it, or, as above, dropped into it. It is well to have a pilot slide. I always use the '*Orthosiren*.' Place this in the springs,

* Engl. Mech., xxxix. (1884) p. 561.

focus the mirror so as to throw light through the slide; with very little manipulation of stage and mirror you will find there is a position of the field in which, with 1-in. power, the centre of the slide has the objects illuminated on dark ground. A very little practice will effect this. You can now change for any object of the class you wish, not moving either mirror or stage; but you will find that if you now put on, say, a 1/4-in. objective, you may have to move the stage a very little to get the full effect; you will also find that by using lateral movement only you will get with the high powers at the edge of the dark field a pearl-coloured light, giving most beautiful definition.

From some that I have constructed with very small lenses I have been astonished to find the comparatively large field I obtain. I get by the above means a result such as I had never conceived possible—effects most beautiful; good slides of *P. angulatum* (Möller's) with 1/4 in. are lit up as with electrical light, on what I may well call perfect black background, and this with wonderful definition. The way all the beautiful markings of all the coarser diatoms are brought out is most satisfactory. The *Podura* and other scales I certainly never had really seen before as I can now see them. With a Zeiss 1/14 I get beautiful definition of everything short of *A. pellucida*.

What I chiefly claim for the invention is, however, not simply the results thus obtained, but that they can be so obtained with scarce any trouble by a simple apparatus of small cost, thus giving to those who cannot afford the more or less costly affairs now in use equal means of enjoying the study of this class of objects.

I have fitted some to the substage of my large stand with advantage; but these would be more costly, as they require a different position of the parts of the instrument, and are not so readily applied.

I have arrived at one fact in experimenting, which I have not the scientific knowledge to explain. Say that I have some *P. angulatum* well shown with high power, and that the background is very black; strange (to me) to say, by shutting in the binocular prism it makes this ground even darker still. . . . I use no condenser to throw light on the mirror, only a common reading-lamp with small flame; either this, or the white cloud of daylight, answers every purpose. The apparatus is constructed to work with the source of light on the left hand."

S. C. S. says * that the above "leaves microscopists no wiser than they were before," and "hopes, if his lordship really wishes to benefit his fellow-workers with the Microscope, he will publish his formula for the construction of the Diatomescope," but this his lordship objects to do.†

Hardy's Collecting Bottle.‡—Mr. J. D. Hardy devised this apparatus for collecting and examining aquatic specimens whilst out on excursions. It consists of two plates of glass with a narrow strip

* Engl. Mech., xl. (1884) p. 18. † Ibid., p. 38.
‡ Journ. Quek. Micr. Club, ii. (1884) pp. 55-6.

of thick indiarubber cemented between them on three sides, the fourth side being left open, and thus forming a very convenient flat bottle for the side coat-pocket. The space between the glasses is sufficient to allow of *Anacharis* 5 in. long being inserted without pressure, at the same time enabling the collector to bring all parts of the weed into good focus. By the insertion of an indiarubber flat cork the bottle is rendered water-tight, and can be used as a slide on the stage, so as to obviate the necessity of disturbing the weed should any object of interest be observed when collecting.

Mr. Hardy also proposes a simple and effective method of straining the water poured into or out of an ordinary wide-mouthed collecting bottle, viz. by means of a small cylinder of copper wire gauze, which extends above the neck of the bottle.

Eye-piece Amplification.—Prof. Abbe points out that his view as to the comparatively low eye-pieces which the best Microscope objectives of the present day will usefully bear * is supported by the recognized rules for telescopes.

"The essential principle for a valid comparison of the telescope and the Microscope is that every Microscope involves in its action that of a given telescope. The effect of the Microscope cannot in any case extend farther than the effectiveness of such telescope. Now the most trustworthy power of eye-piece for a telescope is approximately 40 per inch of the diameter of the objective, i. e. 1/4 in. focal length for every telescope in which the proportion of focal length to aperture is 1 : 10. This relation of eye-piece to objective in the telescope is exactly paralleled in the Microscope when to a 1/8 in. dry objective of maximum aperture is applied (with a 10-in. tube) a 1 in. eye-piece, or a 3/4 in. eye-piece with a homogeneous immersion 1/8 in. of 1·33 N.A.

If therefore it is contended that Microscope objectives can usefully bear the application of a 1/4 in. eye-piece, it must at the same time be contended that a telescope will bear a useful power of 120 per in. aperture!"

Illumination and Focusing in Photo-Micrography.†—Dr. R. A. Hayes, after considerable experience with electric (arc) magnesium, lime, gas, and oil-lamp lights, finds that only the lime-light and the oil-lamp fulfil the necessary conditions required in the case of a source of artificial light for photo-micrography which shall at the same time have light-illuminating power, be perfectly steady, possess very active actinic properties, and be easily produced and maintained. The use of the oil-lamp being confined to cases where the magnifying power does not exceed 50–100 diameters; or in other words, to the 1 in. or 1/2 in. objective. The difficulty as to the intensity of the light is not so much in reference to the exposure of the plate, as to

* "Usefully" that is in the sense defined in Prof. Abbe's paper, Vol. III. (1883) p. 790, and not merely "useful" for an amusing exhibition of the diffraction phenomena.

† Proc. R. Irish Acad. (Sci.) iv. (1884) pp. 59–61.

the impossibility of getting the image focused in a satisfactory manner, the great rapidity of the dry gelatine plates now in use making the time of exposure quite a secondary matter.

The arrangement for making the photographs is as follows:—In front of the condenser of the lime-light lantern is fixed a tube 10 in. in length, at the further end of which is placed a plano-convex lens, of about 2 in. focal length, mounted in a sliding tube movable by rack and pinion, the beam of light passing through which comes to a focus, and then while only slightly divergent falls on the achromatic condenser fixed in the substage of the Microscope. This arrangement gets rid of most of the heat-rays; the beam passing through the condenser traverses the object to be photographed, the image of which is projected directly on the screen by the object-glass, no eye-piece being used. For focusing, a sheet of glazed white paper is used pasted on a glass plate placed in the dark slide. By focusing in this manner as one sits in front of the screen the various adjustments of the Microscope and condensers are easily made, while keeping a distinct view of the image.

As regards the details of focusing the image, he adopts the following method:—

The object having been brought into the desired position and roughly focused, it is then by means of the mechanical stage removed from the field, and the diaphragm aperture which is intended to be used in the particular case having been placed in position, the achromatic condenser and light are manipulated until the field is evenly illuminated; the diaphragm plate is then revolved until the full opening is reached; the object is then brought back into position, and the best possible image obtained by means of the fine adjustment; the diaphragm plate is then again returned to its former position; the image, of course, gains much in sharpness, and although quite sufficiently bright to produce an impression on a rapid plate, is not at all in as satisfactory a condition for accurate focusing as when presenting a brighter appearance.

When all the adjustments have been made, the sleeve suspended from the frame is placed in position, one end of it being attached to the sliding front of the camera, and the other end to a pasteboard cylinder, which fits on to the back of a narrow box, containing a sliding shutter by which the exposure is made. To the front of this box the body of the Microscope is attached by a small black velvet sleeve which completes the camera. The large sleeve is made of mackintosh cloth, with three hoops fastened inside to prevent its collapsing.

Mitchell's Focusing Glass for Photo-Micrography.*—G. O. Mitchell, finding that no matter how finely the focusing screen was ground, it would not allow the finer details of objects to be seen, made use of a Huyghenian eye-piece in the following manner. A narrow strip of thin board, 15 × 2 × 3/8 in., had a circular hole cut in its centre through which the eye-piece could be just forced with con-

* Amer. Mon. Micr. Journ., v. (1884) p. 81 (1 fig.).

siderable pressure and a screwing motion. Throwing back the ground-glass screen and allowing the projecting ends of the strip to rest upon the edges of the camera, as clear and distinct an image was obtained as in looking through a Microscope.

To adjust the glass to the position occupied by the plate during exposure, focus with the ground-glass screen upon a printed text placed at some distance from the camera, using an ordinary view lens and getting the edges of the letters as sharp as possible. Then throwing back the screen and being careful not to change the position of the bellows, apply the eye-piece with its carrier resting against the edges of the box, and screw it in or out till the sharpest and clearest focus is obtained, making a mark upon the eye-piece to serve in case of accident.

When an objective is used which is not well adapted to photographic work, owing to the difference between the focus for vision and that for actinic rays, the eye-piece can be so adjusted, by experiment, that when the image is sharp as seen in the eye-piece the actinic rays will be focused on the plate.

Photo-Micrography in Legal Cases.*—Dr. W. T. Belfield points out that among the numerous applications of photography, none is more satisfactory to the operator than photography with the Microscope in legal cases, it being indeed the only way for conveying to judge or jury absolutely accurate and faithful conceptions of the microscopic appearances upon which the expert microscopist bases his evidence.

It is naturally and notoriously difficult to present technical evidence clearly to a jury; and this difficulty arises not necessarily from any lack of intelligence on the part of the jury, but simply from their lack of technical knowledge of the subject in question. The difficulty is especially great in presenting facts obtained through the Microscope. The actual exhibition of such objects as blood-corpuscles in court cannot be satisfactorily accomplished, and while drawings made with the Microscope are admissible as means of general *illustration*, they are totally inadmissible as *representations* of absolute accuracy and fidelity to nature.

The photograph is the only method which we at present possess whereby accurate and faithful representations of microscopic objects can be presented to individuals who are not familiar with the instrument.

The author then relates a case coming within his own experience of the application of photo-micrography to the determination of a legal question.

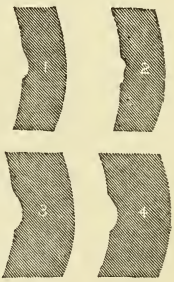
"I was induced to submit hairpins to microscopic examination some months ago under the following circumstances:—In the pocket of Zura Burns, found murdered at Lincoln last October, was found a single hairpin; in the buggy of O. A. Carpenter, suspected of having perpetrated the murder, were found two pins, one of which appeared to be the exact counterpart of the pin found in the girl's pocket.

* 'Photography' (Chicago), i. (1884) pp. 54–9 (7 figs.).

The prosecuting attorney inquired of me whether or not the Microscope would reveal additional proofs of the similarity of the two pins. I had at that time never made a critical examination of hairpins with the Microscope, and was not aware that such examination had been made by others; I so informed him. I was commissioned to investigate the subject.

The two pins were of the pattern known as the 'crimped' or curvilinear hairpin; I therefore directed my investigation to the structure of these pins and the mode of their manufacture. I found that these 'crimps' are made by a punch which bends the wire; and it became evident that the pins made in the same machine would probably exhibit the same punch marks or indentations at the curves. An examination of numerous packages of crimped hairpins showed that such was actually the case; all the pins from a given package as bought in the store, showed precisely the same marks at the same points on the pin. Pins of different manufacture, even though similar to the naked eye, showed different punch marks, corresponding to their production in different machines. Nos. 1 and 2, Fig. 134, are specimen punch marks, the two pins photographed having been obtained from different packages. Of course merely a small fragment of the pin is represented.

Fig. 134.



All the hairpins contained in the package from which No. 1 was taken, exhibit the same indentation at the same point on the pin; all of those in the package from which the second hairpin was taken, exhibit the same mark as is pictured in No. 2. However close the resemblance to the naked eye, therefore, such pins can be readily identified or distinguished with the aid of the Microscope by means of these marks.

The two hairpins already mentioned in connection with the Carpenter case were sent by express to my address; one of them—that found in the girl's pocket—was unfortunately lost *en route*. Upon examining the other with the Microscope, I found that it presented four distinct machine marks, the most prominent of which is represented in No. 3. The loss of the other hairpin seemed at first to vitiate the value of the information which might probably be derived from a comparison of the two. However, it was ascertained that on the morning of her departure from home (in St. Elmo) for Lincoln, the girl's father had purchased for her at a country store a package of pins, some of which she had used in making her toilet, the remainder being placed in her pocket. The prosecuting attorney forthwith bought all the hairpins in stock at the store where this purchase had been made. The stock was found to consist of the one variety of pin from which a small packet had been sold to the girl's father. Microscopic examination of these pins showed precisely the same machine markings as were exhibited by the pin found in Carpenter's buggy. A photograph of the indentation on one of these

pins from the St. Elmo store is copied in No. 4. I was thus enabled to assert that the pin found in Carpenter's buggy must have been made in the same machine as those used by the girl just before the murder.

These pins were, moreover, of a peculiar pattern; among eighty packages purchased in Chicago and in Lincoln, and some twenty odd hairpins obtained at random, I did not discover a single pin exhibiting the same markings. The scarcity of pins of this pattern was afterwards explained by the fact that the factory in which they had been made was closed eleven years ago. The rarity of hairpins made in this particular machine combined with the presence of one of them found in Carpenter's buggy, rendered it highly probable at least that the girl had ridden in this buggy."

American Society of Microscopists.—The deputation (Dr. Dallinger and Mr. A. W. Bennett *) appointed to represent our Society at the Rochester, N.Y., meeting of the American Society have not yet returned from America, so that we are not in a position to give any authentic report of the proceedings of the meeting, but we understand from private sources that nothing could exceed the courtesy and warmth with which the deputation were received by our American brother microscopists, everything being done to testify to the friendly feeling entertained for our Society on the other side of the Atlantic. We are sure that Dr. Dallinger and Mr. Bennett did not leave unacknowledged at the time the courtesies extended to them, but the appreciation of the Society at large will remain to be expressed at the ensuing meeting, by which time it is anticipated that the deputation will have returned.

The toast of "The Royal Microscopical Society" was proposed at a supper given to the American Society, and Dr. Dallinger was elected an Honorary Fellow.

Health Exhibition. — The connection of this exhibition with health is, as is generally recognized, one of a very slender kind, and it is to be regretted that such a department as the Biological Laboratory, which in a true "health" exhibition would have occupied a prominent place, is relegated to the comparative obscurity of the topmost rooms of the lofty City and Guilds Institute.

The laboratory is under the charge of Mr. W. Watson Cheyne, M.B., who exhibits a large series of microbes of various kinds, isolated and growing in the media suited to them. The laboratory contains examples of fungi injurious to animals or plants, or altogether innocuous; and it is well equipped with apparatus and appliances, including incubators, sterilizers by steam and dry air, aspirometers, and Microscopes; there are also 36 photo-micrographs and some diagrams, among the latter of which are those that illustrate the excellent influences of vaccination and re-vaccination, and show that in later years no German soldier has died of small-pox, and that in some years only 2·12 in 100,000 have been ill of it. Many of the

* Mr. Glaisher was unfortunately prevented from attending.

specimens and most of the diagrams have their origin in Dr. Koch's laboratory. On Thursday afternoons microscopical preparations are exhibited, and at 4 P.M. on that day Mr. Cheyne gives a demonstration.

Microscopes and apparatus are exhibited by Messrs. Beck, Powell, Swift, Watson, and other makers.

American Society of Microscopists.
[Further Notes as to the Rochester Meeting by G. E. Davis, R. Hitchcock, C. H. Stowell, D. S. Kellicott, E. H. Griffith, and E. Bausch.]
Micr. News, IV. (1884) pp. 195-6.
Amer. Mon. Micr. Journ., V. (1884) pp. 136-7, 139.
The Microscope, IV. (1884) pp. 160-1, 162-3, 163-4, and 164-5.

Baumann, T.—Ueber einen Scalen-Taster mit festem Mikrometer im Mikroskop. (On Callipers with fixed Micrometer in the Microscope.) [*Supra*, p. 794.]
Zeitschr. f. Instrumentenk., IV. (1884) pp. 149-52 (2 figs.).

Bausch and Lomb Optical Co.'s New Illuminator. [*Ante*, p. 623.]
Amer. Mon. Micr. Journ., V. (1884) p. 126 (1 fig.).

Behrens, W.—Eine neue Construction des Abbe'schen Beleuchtungsapparates. (A new Construction of Abbe's Illuminating Apparatus.) [*Post.*]
Zeitschr. f Wiss. Mikr., I. (1884) pp. 409-12 (1 fig.).

Blandy, H.—Culpepper's Microscope.
[Description of one.] *Engl. Mech.*, XL. (1884) p. 97.

Bottone, S.—See Wright, L.

Bulloch, W. H.—"Falsus in uno, falsus in omnibus."
[Further reply to Prof. McCalla in regard to the Congress Nose-piece.]
The Microscope, IV. (1884) p. 163.

Cooke, M. C.—The President's Address (1884).
[To "serve as a caution to some of our younger members, and at least convince them that an old microscopist of 40 years' experience believes it to be his duty to warn them of one of the vices of the age, and to put them on their guard against exaggeration."]
19th Report Quekett Micr. Club, 1884, pp. 9-18.

D., E. T.—Graphic Microscopy. VIII. Spiracle of Breeze Fly (*Œstrus equi*). IX. Polypidom of *Lepralia nitida*.
Sci.-Gossip, 1884, pp. 169-70 (1 pl.), 193-4 (1 pl.).

Dallinger, W. H.—The Lowest and Smallest Forms of Life as revealed by the Modern Microscope.
[Some of the principal passages of lecture at the Montreal Meeting of the British Association. *Supra*, p. 721.]
Times, 2nd September, 1884.
Engl. Mech., XL. (1884) pp. 10-1.

Davis, G. E.—Objective Changers.
["We have never found the so-called instantaneous changers to enable more work to be done, and we have even discarded the double nose-piece in ordinary work."]
Micr. News, IV. (1884) p. 218.

„ „ Proceedings of Provincial Societies.
Micr. News, IV. (1884) p. 218 and p. 215.

Dudley, P. H.—[Exhibition of Photo-micrographs of sections of American timber-trees taken with ordinary lamp-light and enlarged 100 diameters.]
Bull. Torrey Bot. Club, XI. (1884). p. 84.

Ermengem, E. Van.—Microphotographies obtenues à l'aide des plaques isochromatiques préparées par Clayton et Attout-Tailfer. (Micro-photographs made with the isochromatic plates of Clayton and Attout-Tailfer.) [*Post.*]
Bull. Soc. Belg. Micr., X. (1884) pp. 170-2.

GIACOMINI.—Nuovo Microscopio per l'esame delle sezioni dell'intero encefalo umano adulto. (New Microscope for the examination of sections of the entire human adult brain.) [*Post.*] *Giorn. R. Accad. Med. Torino*, 1883 (1 fig.). *Gazz. delle Clin.*, 1883, p. 528. Cf. *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 427–9 (2 figs.).

GRAVIS, A.—Microscope à grand champ de A. Nachet. (Microscope with large field of view, by A. Nachet.) [*Supra*, p. 797.] *Bull. Soc. Belg. Mikr.*, X. (1884) pp. 194–7.

GROVE, W. B.—A Synopsis of the Bacteria and Yeast Fungi and Allied Species. (Schizomycetes and Saccharomycetes.) [Contains Appendix A, pp. 101–2, "On the Unit of Micrographical Measurement" [*post*], and Appendix B, pp. 103–4, "On the staining of '*Bacillus tuberculosis*,'" describing Koch's, Ehrlich's, Gibbes', and Prideaux's methods (*supra*, p. 787).] vi. and 112 pp. (87 figs.), 8vo, London, 1884.

GUÉBHARD, A.—Puissance et grossissement des appareils dioptriques. (Magnifying power of dioptric instruments.) [*Post.*] *Rev. Scientifique*, XXXI. (1883) pp. 804–11 (5 figs.). Transl. *Centralztg. f. Optik. u. Mech.*, V. (1884) pp. 183–8 (6 figs.), 194–7.

HANAUSEK, E.—Eine zweckmässige Mikroskopierlampe. (An effective microscopical lamp.)

[A petroleum lamp made by Rob. Rühe, at Landsberg a. W. Over the glass chimney is placed a metal structure of white composition, consisting of a conical tube inclosing the glass chimney, to which is attached a fixed metal cylinder placed obliquely. This latter is closed at the lower end by a convex lens of small curvature, and permits the application of a blue glass plate.]

Fachztg. f. Warenkunde, 1883, No. 6, p. 32. Cf. *Bot. Centralbl.*, XVIII. (1884) p. 53.

HAYES, R. A.—Notes on Microphotographic methods. [*Supra*, p. 804.] *Proc. R. Irish. Acad.* (*Sci.*), IV. (1884) pp. 59–51.

HEURCK, H. VAN.—Entgegnung auf den Artikel des Herrn Stein: Die Verwendung des elektrischen Glühlichtes zu mikroskopischen Untersuchungen, &c. (Reply to Stein's paper, "The application of the electric incandescence light to microscopical investigations, &c.)

[Same as the French protest, *ante*, p. 632.] *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 419–22.

HITCHCOCK, R.—The Electric Light in Microscopy. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) pp. 138–9.

„ „ Growing Slides, or Microscopical Vivaria.

[Charters White's, and J. D. Hardy's, I. (1881) p. 671.] *Amer. Mon. Micr. Journ.*, V. (1884) p. 141 (1 fig.).

HOLLEY, G. W.—Suggestions for improvement in the manufacture of glass. . . .

[Proposal "to improve the quality of glass by introducing silver into its composition."] *Journ. Frankl. Institute*, CXVIII. (1884) pp. 132–8.

JANNEY, R.—Simple Solar Microscope. [*Post.*] *Scientific American*, L. (1884) p. 276 (1 fig.).

KORITSKA, F.—Norme pratiche per l'uso del Microscopio. (Practical rules for the use of the Microscope.) 14 pp. 32mo, Milano, 1883.

LIMONT, W.—Notes on Modern Forms of the Microscope.

["When it can possibly be afforded, an English skeleton Microscope on the American (Jackson-Zentmayer) model should be got by students and others. . . . In no case is it a good investment to buy a foreign first-class instrument, and in most cases a first-class English 'skeleton' Microscope should be got in preference to a third-class Microscope, either English or foreign."] *Proc. Phil. Soc. Glasgow*, XV. (1883–4) p. 118.

MERCER, F. W.—Incandescent Lamps and Accumulators in Photo-micrography.

[Describes Swan and Edison lamps, and a "small and very portable accumulator made on the Faure principle," with practical directions.] *Photography*, I. (1884) pp. 147–9 (4 figs.).

M'Intosh, L. D.—Lanterns for Projection.
[Includes microscopic projections.]
Photography, I. (1884) pp. 131–4 (6 figs.).

Moeller, J.—Ein neues Präparirmikroskop. (A new dissecting Microscope.) [*Ante*, p. 613.]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 412–3.

Moore, A. Y.—Beck's Vertical Illuminator and Immersion Objectives.
[Description and directions for use. Also as to coating diatoms with silver, *infra*, p. 829.]
The Microscope, IV. (1884) pp. 157–9, 165.

" " The Fakir's Secret.
[*A propos* of F. L. James's account of the exhibition of paste eels as animalcules in water, *ante*, p. 146. The secret is probably the use of a few drops of cider vinegar, which promotes the growth of the eels.]
The Microscope, IV. (1884) pp. 170–1.

Nelson, E. M.—A hydrostatic fine adjustment. [*Supra*, p. 800.]
Engl. Mech., XXXIX. (1884) p. 576 (3 figs.).

" " Microscope Tube-length.
[Reply to query. "Place an object on the stage accurately centered and focused to the objective whose back focus is to be measured. Centre the substage condenser, and focus by it the edge of a flame on the object. Remove the object out of the field, leaving slip and cover-glass between objective and condenser. Take out the eye-piece. Insert down the tube of the Microscope a smaller tube having its lower end closed by a diaphragm of paraffined tissue paper. Slide this up and down until the image of the flame is focused on it, which will give the solution to the first part of "B. C.'s" question. By pushing the tube further down until the smallest spot of light is found, the place where the rays cross can be determined."]
Engl. Mech., XXXIX. (1884) p. 589.

" " Plane Mirror for Microscope.
[Reply to query. "I find it difficult to write a complete answer to 'Mirror's' question within reasonable limits, there being so many combinations and varieties of methods of illumination, each of which demands a separate consideration before the reply could be termed exhaustive. 1. When using artificial transmitted light with substage condenser, I, if possible, dispense with the mirror altogether and work direct; but when this is not possible, I use the plane mirror. 2. With lamplight, but without a substage condenser, concave mirror. 3. Diffused daylight without substage condenser, concave mirror with high and medium powers, plane with low. 4. Diffused daylight with substage condenser, always plane mirror. 5. Dark ground with lamp-light and bull's-eye, always plane mirror."]
Engl. Mech., XXXIX. (1884) p. 593.

" " Illumination for the Microscope (*in part*). [*Post.*]
Engl. Mech., XL. (1884) p. 68 (2 figs.).

Osborne, S. G.—The Diatomescope. [*Supra*, p. 802.]
Engl. Mech., XXXIX. (1884) p. 561 and XL. (1884) p. 38.
Also letter by S. C. S., XL. (1884) p. 18, *supra*, p. 803.

Pease, J. L.—The Facility Nose-piece.
[Description of it. *Ante*, p. 425.] *The Microscope*, IV. (1884) p. 171.

Plehn, J.—Apparat zur Prüfung der Brennweite des Auges oder anderer optischer Systeme. (Apparatus for testing the focal length of the eye or other optical systems.)
German Patent, Kl. 42, No. 27,860, 27th January, 1884.

Purser, J. M.—See p. 839.

[Redding, T. B.]—The Microscope. Its uses and revelations.
Indianapolis Journal, 16th August, 1884, p. 10.

S., S. C.—See Osborne, S. G.

Schöffler und Smolarz.—Das elektrische Gewehr, elektrische Minenzündung, elektrische Distanzmesser und das Gastroskop. 8vo, Wien, 1884, pp. 93–109. (17 figs.). Extr. from 'Die Elektricität und der Magnetismus.'
[Describes the Gastroscope, III. (1883) p. 420.]

Sexton's (L. R.) retirement from business.
Amer. Mon. Micr. Journ., V. (1884) pp. 158–9.

St. Clair, G.—Note on a possible source of error in photographing Blood-corpuscles. [*Post.*]
Nature, XXX. (1884) p. 495.

Stein, T.—Die Verwendung des elektrischen Glühlichtes zum mikroskopischen Untersuchungen und mikrophotographischen Darstellungen. (The application of the electric incandescence light to microscopical investigations and photo-micrography.)
[Additions to his original paper, *ante* p. 466, describing the battery of five elements which he uses.]
Centralztg. f. Optik u. Mech., V. (1884) pp. 170-1 (1 fig.).

Stewart, C.—Polarized Light.
[Report of Demonstration.] *Journ. Quek. Micr. Club*, II. (1884) pp. 37–41.

St. Joseph (Mo.) Microscopical Society formed.
The Microscope, IV. (1884) p. 165.

St. Louis Society of Microscopists.
[Adoption of a rule requiring each member to furnish six slides annually to the Society's cabinet.]
Science Record, II. (1884) p. 233.

Stowell, C. H.—High angles or low angles?
[As to the superiority for a physician of a 1/4 in. objective of 75° over one of 100°.]
The Microscope, IV. (1884) p. 180.

„ „ Mr. Griffith's new box.
[Facetious anecdote of a person to whom Mr. Griffith exhibited his Microscope and who thought the box the "handsomest he ever saw."]
The Microscope, IV. (1884) pp. 180-1.

Tolman, H. T.—Photo-micrography with an Eye-piece.
[Directions for photo-micrography generally.]
Photography, I. (1884) pp. 124–6.

Viguier, C.—Note sur un nouveau Compresseur à verres mobiles. (Note on a new compressor with movable glasses.) [*Post.*]
Arch. Zool. Expér. et Gén., II. (1884) pp. xii.–xvi. (5 figs.).

Wales' (W.) High-power lens for use with the Binocular.
[Apparently the same as that described III. (1880) p. 1050.]
Amer. Mon. Micr. Journ., V. (1884) p. 139.

Wheeler's (E.) retirement from business. *Sci.-Gossip*, 1884, p. 184.

Woodward, J. J., death of. *Times*, 17th September, 1884.

Wormley, T. G.—Microscopic Science.
[Abstr. of an address to the Section of Histology and Microscopy of the Amer. Assoc. Adv. Sci.
[Describes the advantages and possibilities of two special applications of the Microscope: first, to the detection of very minute quantities of certain poisons, notably arsenic, by the examination of the sublimate; second, to the examination of blood stains. Also the limits within which identification of different animals, and the recognition of human blood, is feasible; he denied that human blood can be absolutely identified; he also stated that the result of prolonged experiments indicated that pure water is the best reagent for restoring the blood-corpuscles in a stain to their natural condition.]
Science, IV. (1884) p. 244.

WRIGHT, L.—Micro-photography.

[Reply to inquiry as to photographing diatoms and diffraction-gratings. Also reply by S. Bottone.]

Engl. Mech., XXXIX. (1884) pp. 519–20.

ZENGER, C. V.—Détermination des Indices de Réfraction par des Mesures linéaires. (Determination of indices of refraction by linear measures.)

[Simple method of strict determination to the 5th decimal by means of a divided rule with a small telescope sliding on the alidade which carries the vernier.]

Comptes Rendus, XCIX. (1884) pp. 377–80.

β. Collecting, Mounting and Examining Objects, &c.

Killing Infusoria.*—J. P. McMurrich finds that for killing infusoria, provided only a temporary preparation is required, a saturated solution of corrosive sublimate in water is the most useful he has tried. A drop or two run under the cover-glass produces almost instant death without any of the shrinkage so annoying even with osmic acid. After this treatment staining with anilin blue, black, or Brunswick brown takes place very rapidly and very satisfactorily.

Perchloride of Iron.†—H. Fol has overcome some of the inconveniences of this reagent and has made it "really practical." The iron salt may be completely extracted from a preparation fixed by being for 1/2–1 hour in the perchloride, diluted with alcohol, by washing with an aqueous solution of oxalate of potash, or an alcoholic solution of oxalic acid. The tissues can then be preserved in weak alcohol and stained with success by the ordinary process, using carmine, hæmatoxylin, and anilin dyes.

The author adds "These preparations are only distinguishable from those obtained by the usual fixing agents by the extraordinarily faithful preservation of the vibratile cilia, the pseudopodia, and the nuclear filaments."

Mounting of Foraminifera—New Slide for Opaque Objects.‡—Dr. F. M. Hamlin considers that for the finest forms, and for calcareous sands, such as the famed Bermuda sand, there is no plan so satisfactory as to search through the material with the Microscope, to save time and labour separating the sand into grades by passing it through sieves of three different degrees of fineness. The shells from the last will exercise the skill nearly as much as diatoms. Having sifted the sand, it should be examined on a specially devised slide, made as follows:—A piece of pasteboard the size of an ordinary slide has a long slit cut in it, and is then fastened to a glass slide. The width of this slip is of importance, and is determined thus: Take a low power objective, say a three or four inch, which affords just sufficient power to see the shells well, and measure the width of its field. Make the slit or opening in the pasteboard just twice this distance. The slide being ready, a little pinch of sand is put on the glass, and a slight shake spreads it out in a single layer confined by

* Amer. Natural., xviii. (1884) p. 832.

† Arch. Zool. Expér. et Gén., ii. (1884) p. ix.

‡ Proc. Amer. Soc. Micr., 6th Ann. Meet., 1883, pp. 65–8.

the pasteboard. It is then placed under the Microscope, and moving it so that the edge of the pasteboard is just visible, pass up one side and down the other, and every particle of the sand is brought into view without loss of time in searching over the same portions many times, and perhaps entirely omitting other. It is surprising what a quantity of sand can thus be looked over in a short time by this systematised labour.

The shells may be picked up by a very fine needle dipped in turpentine, or a very small camel's hair brush.

Not being satisfied with the ordinary slides and cells for this class of objects, the author has devised a slide which he thinks serves the purpose admirably; it is made as follows:—The slide itself is of wood, of the ordinary size, and about 1/10 in. thick. Through its centre is bored a hole 1/2 in. in diameter. Over the back of this is pasted a strip of stout paper. The hole in the slide with the paper back constitutes the cell. In the bottom of the cell is pasted a disk of coloured paper, cut with a gun-wad punch, to serve as a background for the "mount." To give a neat finish, a brass curtain-ring which just fits in the hole is fastened in with a bit of cement. The edges of the slide are now bound or covered with coloured tissue paper. The shell may now be arranged in the cell, and the cover-glass dropped in upon the brass ring, the top of which has been covered with cement. A suitable label the whole size of the slide is now pasted on the front, and a plain one may be put on the back.

Should a shell be very rare, and it is desirable to show both sides, a piece of thin glass may be let into the back of the slide, and the curtain-ring placed upon this instead of the paper background. Such a slide would need a hole in the back as well as in the front label.

When these slides are finished with pretty and suitable labels they make a fine appearance, pack and carry as easily as so many slips of wood, and if made of white bass wood do not warp. The porosity of the wood prevents any accumulation of moisture upon the cover-glass.

Hæmatoxylin as a Reagent for Non-lignified and Non-suberized Cellulose Membranes.*—The reagent described by E. Giltay in this paper and which he finds to be very sensitive and preferable in most cases to those hitherto employed for the purpose, is prepared as follows:—

To 5 cc. of a solution of hæmatoxylin (7 grams of hæmatoxylin to 50 cc. of water) add 100 cc. of a solution of alum (3/4 per cent.). The mixture should be prepared two days before it is required, and as it speedily becomes turbid, a small amount is filtered each time before use. The sections to be stained are left in from 5 to 15 minutes, according to circumstances, and subsequently mounted in glycerine, oil of cloves, or Canada balsam. In the last, or in oil of cloves, the colours keep for a long time.

In general this reagent and that of Schultze have the same action

* Arch. Néerland. Sci. Exact. et Nat., xviii. (1883) pp. 437–52.

on vegetable tissues, and they both stain blue. The value of the hæmatoxylin consists, however, in the fact that it does not stain the membranes which are completely transformed into cork or wood. It is therefore well adapted to reveal the unaltered cellulose elements in cell-walls which are imperfectly lignified or suberized. With Schultze's solution, which colours the lignified and suberized parts yellow, the blue colour simultaneously developed in the cell-wall is not brought out sufficiently clearly to enable the extent of the lignification to be determined with certainty.

Canarine for Staining.*—L. Errera finds that canarine, a new colouring matter derived from sulphocyanide of potassium, is specially adapted for sections of stems, and the author adds that it "exercises its staining action in the presence of caustic potash, which will make it without doubt valuable for various researches in vegetable anatomy."

Cultivation of Bacteria upon the Slide. — Dr. Pierre Miquel writes us as follows:—

"The first efforts towards cultivation upon the slide whilst on the stage of the Microscope date far back, and have always attracted the attention of micro-botanists, anxious to follow the germination of microscopic spores, their growth, and fructification. De Bary, Woronin, Brefeld, and many others have carefully studied the arrangements necessary for these delicate cultivations. In France, Van Tieghem and Lemonnier have popularized a very convenient method from their memoir on which the following is derived.†

In the centre of an ordinary slide is fastened, by Canada balsam, a glass ring from 4–5 mm. thick, cut from a tube used for organic analysis, and the cut sides properly ground level. A thin cover-glass, round, and of a sufficient diameter to just cover the ring without overlapping the edge, is fixed on the upper side, by three very small drops of a greasy oil, to complete the cell. In order that the interior air may be always saturated by moisture a few drops of water are placed on the bottom of the cell. A small drop of nutritive liquid is suspended at the centre of the under surface of the thin cover. In this drop are sown the spores for cultivation. This plan allows us to follow, with great facility and without interruption, from hour to hour if required, all the details of the germination, characters of the mycelium, and all the phases of the different fructifications, in a word, the life-history of the plant, however long the time may occupy. It offers all the advantages of cultivation upon the slide as habitually practised without being liable to such errors as may otherwise happen from contamination by foreign germs falling into the nutritive fluid during the period of cultivation.

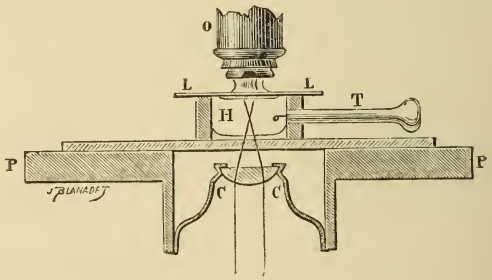
The cultivating liquids employed by these investigators, who were at that time specially occupied in the study of the Mucorini, were of different kinds, as orange-juice, boiled and filtered, or a decoction of

* Bull. Soc. Belg. Micr., x. (1884) p. 183.
† Ann. Sci. Nat., xviii. (1872).

horse-dung, both of which are abundantly provided with azotized principles, or of the so-called mineral liquids proposed by Pasteur and Cohn.

The moist chambers used by Van Tieghem and Lemonnier have during the last ten years undergone many modifications, more or less satisfactory; some investigators have pierced the sides of the little chamber with one or more square holes for the facility of introducing into the interior various reagents, as iodine or ammonia. It is nevertheless singular that these observers have overlooked the chance of these holes permitting the access of dust charged with germs. It is not, however, my purpose to give the history of these moist cells, but simply to describe a method of cultivating the bacteria upon the slide, free from these errors, and which I have employed for the study of the atmospheric Schizophytes. The same cell is made use of, pierced laterally by an opening which can be closed by a small glass rod stopper. Fig. 135 represents the same in section, where O is the immersion objective, L the thin cover with the droplet attached to the

Fig. 135.

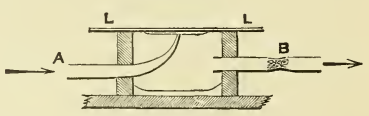


under side, H the moist chamber, T the small glass rod stopper, P the stage of the Microscope, and C the condensing lens. The cells and cover should be attached to the slide by a cement that will not be loosened by the heat used to sterilize the chamber. Afterwards, by the lateral opening, one or several drops of sterilized water for the purpose of keeping the air in the cell saturated with moisture, are placed in the little chamber. Then, by means of a pipette with a curved capillary point, the sterilized nutritive liquid—as blood serum, broth, urine, vegetable juices, &c.—is placed upon the under surface of the thin glass cover, whilst the sowing of the organisms, whose development is to be watched, is accomplished by the aid of a fine platinum wire slightly bent at the point. The small rod stopper is replaced, and the whole with the Microscope is placed in a warm chamber kept at 30° C. If immersion objectives be used, a little glycerine can be added to the water, or cedar oil used on the cover. Good dry objectives and the light from a paraffin lamp generally suffice for the observations, but I give the preference to the excellent No. 7 immersion objective of Nachet. It is not necessary that I

should further describe the precautions required to prevent contamination and the neglect of which may entirely nullify the value of the cultivation."

Another form used by M. Miquel is shown in fig. 136. By the tube A air is projected on the drop of nutritive liquid at the under side of the plate L L, and this having been done, the tube is withdrawn, and the hole closed with a piece of cork; the tube B, which contains some wadding, serves as the aspirator.

Fig. 136.



Dr. Koch describes the method adopted by Hesse for defining the exact quantity of air from which the spores originate. A glass tube 12 in. by $2\frac{3}{8}$ in. is closed at each end with indiarubber coverings, in one of which a glass pipe is inserted, while in the middle of the other is an opening about 3/8 in. in diameter. Gelatine is placed along the bottom of the tube, which is in a horizontal position. The smaller pipe is then placed in connection with an exhausting apparatus and a given quantity of air is forced through, the bacteria and spores falling on the gelatine.

Staining of Schizomycetes in Sections and Dry Preparations.* —C. Gram proposes the following method for producing an isolated staining of pneumonia-cocci, leaving the nuclei and other elements of the tissue uncoloured, the deep staining of the cocci usually found in the sweat-cells causing them to be much more readily found than in ordinary preparations. The method he considers applicable also to almost all examinations of Schizomycetes in sections and dry preparations.

He takes the ordinary Ehrlich's anilin-gentian-violet solution. The sections to be examined for Schizomycetes must be preserved in absolute alcohol and brought direct from it to the staining fluid; here they remain from 1–3 minutes (in the case of preparations of tubercular bacilli from 12–24 hours); then placed in an aqueous solution of potassium biniodide (1 part I, 2 parts KI, 300 parts water), without or after a slight washing with alcohol, where they remain again from 1–3 minutes. A precipitate takes place in the iodine solution, and the sections, previously a dark blue-violet, become a blackish purple-red. They are now laid in absolute alcohol until the colour is again entirely removed, the alcohol being renewed once or twice. They are then clarified in the ordinary way by clove-oil, the remainder of the pigment being given off to the oil. The nuclei and the fundamental tissue are now coloured light yellow by iodine, while the Schizomycetes, if present in the section, are of a conspicuous intense blue colour, often nearly black, the colour being much deeper than in any other mode of staining. After the application of alcohol, the sections may be placed for a moment in a weak

* Fortschr. d. Medicin, ii. (1884) No. 6. See Bot. Centralbl., xviii. (1884) p. 383.

solution of Bismarck brown or vesuvin in order to produce a double staining.

Permanent preparations have been kept for four months without change in Canada balsam, xylol, or gelatin-glycerin. The whole process takes a quarter of an hour, and the preparations may remain for some days in clove-oil without losing their colour. The method can also be applied to dry preparations, the cover-glass being treated as a section. The following diseases were tested for Schizomycetes by this method:—pneumonia cruposa, pyæmia, nephritis suppurativa, arthritis suppurativa after scarlatina, multiple brain diseases, osteomyelitis, typhus, liver abscesses, erysipelas, tuberculosis, cattle distemper, as well as the bacteria of putrefaction. After treatment with iodine the following Schizomycetes remained coloured in alcohol:—The cocci of crupose pneumonia, the Schizomycetes of pneumonia, the cocci of the liver abscesses after perityphlitis, the cocci and small bacilli in circumscribed infiltration of the lungs, the cocci of osteomyelitis, of arthritis suppurativa after scarlatina, of nephritis suppurativa after cystis, those of multiple brain abscesses, of erysipelas, the bacilli of tubercular cattle distemper, and the Schizomycetes of putrefaction. On the other hand, no staining was exhibited of the capsular cocci in a case of crupose pneumonia, or of the capsules without cocci in another case, or of the bacilli of typhus.

Staining Fluid for Sections of Tubercle-Bacilli.* — Dr. Klein recommends a staining fluid devised by Weigert as yielding the finest specimens of tubercle-bacilli in sections through tuberculous growths that he has seen. The sections may be either fresh or hardened.

The fluid is prepared as follows:—Take a 2 per cent. aqueous solution of gentian-violet 12 ccm., and of a saturated aqueous solution of anilin oil 100 ccm. Mix. This is used like an ordinary staining fluid for the first stain. For the second or contrast stain the following solution is used:—Bismarck brown, 1 gr.; spiritus vini rectificati (sp. gr. ·830), 10 ccm.; distilled water, 100 ccm. The sections remain in a few drops of this solution for fifteen minutes. Dr. Klein states that the results obtained by this method are very beautiful, the only drawback being the liability of the colour of the bacilli to fade.

Methods of Imbedding.†—Dr. J. Blochmann reviews the various methods of imbedding, describing in detail those that have come into general use, and pointing out the advantages and disadvantages of each.

In every method of imbedding the principle is the same, namely, to saturate objects with substances which not only fill out the larger internal cavities, but which also penetrate the tissues themselves,

* 'Practitioner,' xxxiii. (1884) p. 35. Sci. Monthly, ii. (1884) p. 92.

† Zeitschr. f. Wiss. Mikr., i. (1884) pp. 218–33 (2 figs.). The above taken from one of Dr. C. O. Whitman's excellent abstracts, Amer. Natural., xviii. (1884) pp. 842-4 (2 figs.).

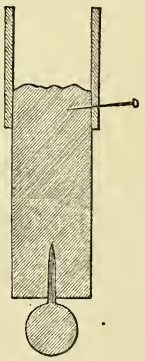
rendering them (after cooling) sufficiently hard for the process of sectioning.

Glycerin and Gelatin.—Gelatin 1 part; distilled water 6 parts; glycerin 7 parts. For preservation a little carbolic acid (1 gram for 100 grams of the mixture) should be added. Objects are transferred directly from water to the melted mixture, and after complete saturation imbedded in paper boxes. After cooling the objects thus imbedded are hardened in alcohol, then sectioned and mounted in glycerin.*

Schiefferdecker's Method of Imbedding in Celloidin.—Schiefferdecker † uses two solutions, one of syrupy consistency, the other somewhat thinner. The celloidin plate is cut into small pieces and dissolved in absolute alcohol and ether (in equal parts). Objects are transferred from absolute alcohol,‡ first to the thinner solution, then to the thicker. After remaining a few hours (or days, according to the character of the object) in the latter, they are imbedded in paper boxes. As soon as a hardened film forms on the solution in the box, the whole is placed in 82 per cent. alcohol for 24–28 hours, and thus rendered sufficiently hard for cutting.

Blochmann recommends imbedding on a cork rather than in a paper box, as less celloidin is required, and as the cork is held more firmly in the holder. One end of the cork is made rough and surrounded by a strip of paper, which is made fast by a pin as shown in fig. 137. The roughened surface of the cork is wet with absolute alcohol, and then the object is imbedded in the usual manner. In order that this small box may sink in alcohol, in which it is placed for hardening the celloidin, it may be weighted with a small lead ball fastened to the cork by a needle.

Fig. 137.



In cutting, the knife is kept wet with alcohol (70 per cent.). The sections may be placed in water or in alcohol and afterwards stained with carmine or hæmatoxylin, in which the celloidin is only a little or not at all stained. Anilin dyes colour the celloidin, and therefore should not be used.

The sections can be mounted in glycerin or in balsam, but in the latter case they must be anhydrated with 95 per cent. alcohol, as absolute alcohol dissolves the celloidin. They should be clarified in bergamot-oil or origanum-oil (clove-oil dissolves the celloidin).

Objects imbedded in celloidin can be preserved ready for cutting for a long time in 70–80 per cent. alcohol.

Imbedding in Paraffin.—The object is transferred from absolute alcohol to chloroform, and left till the alcohol has been entirely replaced; it is next placed in a shallow vessel with a small quantity of chloroform and enough paraffin added in fine pieces to cover it

* This method was recommended by Kaiser, Bot. Centralbl., i. (1880) p. 25.

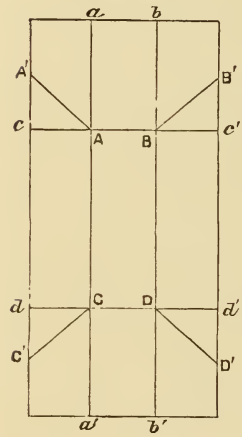
† Arch. f. Anat. u. Physiol. 1882, p. 199.

‡ If the objects are penetrated with difficulty they may be transferred from absolute alcohol to ether, then to the celloidin solution.

after the chloroform has evaporated. The vessel is then exposed to a temperature which corresponds to the melting point of the paraffin employed. The paraffin melts and the chloroform evaporates, so that the object is brought very gradually into pure melted paraffin. In this way the object becomes *completely* saturated with the paraffin.

It is essential that the mixture be kept at the proper temperature until *all* the chloroform has evaporated. A simple test is to place a hot wire in the paraffin, if no bubbles arise it is safe to conclude that the chloroform has entirely escaped.

Fig. 138.



After evaporation of the chloroform the object may be placed in any desired position, and the paraffin allowed to cool. After cooling the object can be cut out and fixed to a larger block of paraffin fitted for the holder of the microtome.

Boxes for imbedding may be made of rectangular pieces of paper, of the thickness of postal cards, in the following manner. The paper is first broken in the lines *a a'* and *b b'* (fig. 138), then *c c'* and *d d'* (by bending always towards the same side). Then in every corner a break (A A' B B' C C' D D') is made by bringing A *c* and A *a* together. The four sides of the box are next bent up, and the corners at the same time turned outwards and back behind the ends A B, *a b*, and C D *a' b'*. Finally the upper edge of these ends is bent down over the corners.

Bubbles around the object may be removed by means of a heated wire.

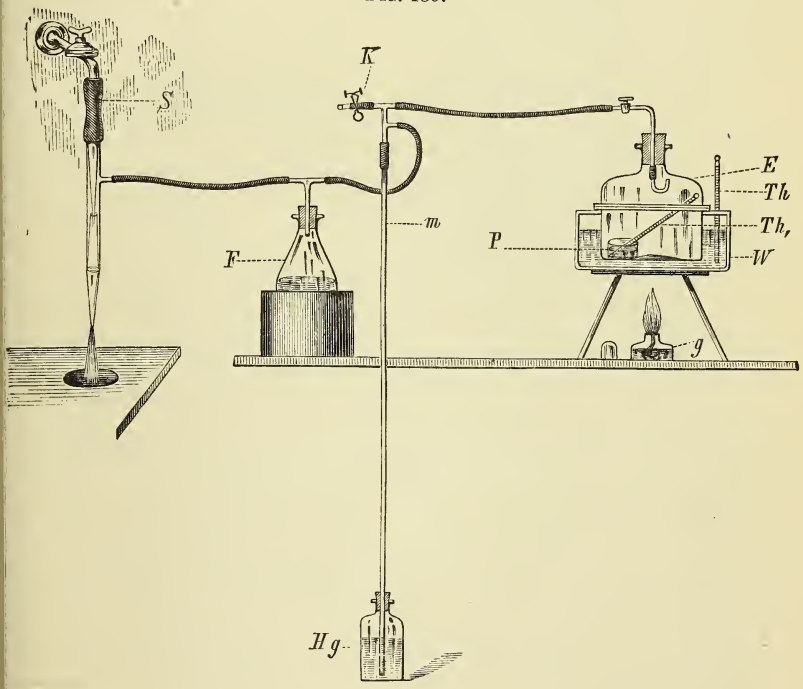
Hoffmann's Imbedding Apparatus.*—Dr. F. W. Hoffmann describes the apparatus he has devised for the more accurate imbedding of anatomical preparations, in which an air-pump is replaced by a suction-pump in connection with a water supply of sufficient pressure.

The suction pump S, which ought to have as free a discharge as possible, is connected with the exsiccator E by means of a strong non-compressible indiarubber tube (or one with a glass tube inside it). The exsiccator contains a few small bowls P, filled with paraffin. The whole is placed in a zinc vessel W, filled with water, and so arranged that the temperature remains constant. Between S and E is the flask F (with strong sides), which is connected with the indiarubber tube by a T piece. A glass tube *m* passes into a bottle of mercury *Hg*, and serves as a manometer. The object of the flask is to prevent the entrance of the water into E in case of any difference of pressure in the pipes. The manometer enables the pressure to be read directly, and enables one to judge whether the preparations are sufficiently penetrated with paraffin.

* Zool. Anzeig., vii. (1884) pp. 230–2 (1 fig.).

In using the apparatus, first heat the water-bath in which E is placed to a temperature of 60° C., then put the bowls containing the melted paraffin and the preparations to be imbedded into E and turn on the water. The two thermometers *Th* and *Th,* record the temperature in W and in the bowl P. The spirit- or gas-lamp *g* should be regulated so that the paraffin does not harden. When the mercury is at the highest point and no more air-bubbles form on the preparation, then the process is finished, and the air may be allowed to enter through K. Before this is done, however, the cock on the vessel E can be closed, so as to leave the preparation still longer in

Fig. 139.



the vacuum. The cock can then be carefully opened and the air allowed to enter. The small bent tube is for the purpose of preventing the scattering of the paraffin by the entrance of the air. Finally the object is taken out and put in a little box filled with liquid paraffin. With sufficient pressure (700–720 mm. *Hg*) every preparation, be it ever so difficult, provided that it is not too large, will be penetrated by the paraffin in about twenty minutes, so that a longer stay in the vacuum is only exceptionally necessary.

Preparations may be left imbedded in this way for weeks in the open air with unprotected cut surfaces without their undergoing any

change. As in other methods, the water must be previously entirely removed from the preparation, and then it is quite unimportant whether before putting it into paraffin it is placed in turpentine oil or oil of cloves, or, as the author does, into resinous turpentine saturated with paraffin, which must not be too thick.

Celloidin for Imbedding.*—The following is the manner of preparing and using this material practised in the laboratory of the Alumni Association of the College of Physicians and Surgeons at New York (as given by Dr. G. C. Freeborn).

A saturated solution of celloidin is made in a mixture of equal parts of ether and 97 per cent. alcohol. This requires about 24 hours with occasional agitation. The object to be imbedded is soaked in a mixture of ether and alcohol for some time, then transferred to the imbedding fluid and allowed to remain overnight.

One of two ways of imbedding may be adopted :—

1. Cover the smooth surface of a cork with a thick layer of celloidin solution and allow it to dry; place the specimen, which has previously been soaked in the imbedding fluid, on this, and cover it, layer by layer, with a solution of celloidin, allowing each layer to partially dry before applying another. When the specimen is completely covered immerse in alcohol of 80 per cent. for twenty-four hours when it will be ready to cut.

2. The specimens are imbedded in paper boxes in the usual way, or a cork is wrapped with one or two layers of thick writing paper, allowing it to project an inch or an inch and a half above the surface of the cork. By this procedure a round box with the cork for a bottom is obtained. Into this box pour a small quantity of the imbedding fluid, and allow it to dry. The specimen having been previously soaked in the celloidin solution, is now placed in the box, adjusted as to position and allowed to dry for five or ten minutes, so as to fix it; the box is now filled with the imbedding fluid. The boxes are exposed to the air until the imbedding mass has become semi-solid, and are then immersed in weak alcohol (alcohol 95 per cent. two parts, water one part) for twenty-four hours, when the specimen will be ready for cutting. If the specimen has been imbedded in a paper box and sections are to be cut with a sliding microtome, it is necessary to mount it on a cork. This is accomplished in the following manner :—Cover the surface of a smooth cork with a thick layer of celloidin solution, allow it to dry, and again cover with the same. Trim off the superfluous imbedding mass from around the specimen, cut the lower surface even, wet it with a drop or two of ether, and adapt it to the layer of celloidin on the cork. Dry for a few moments and place in dilute alcohol for a few hours, when the specimen will be ready for cutting. If the plan of imbedding in the boxes with a cork for the bottom is adopted, the specimen is imbedded and mounted on the cork at the same time.

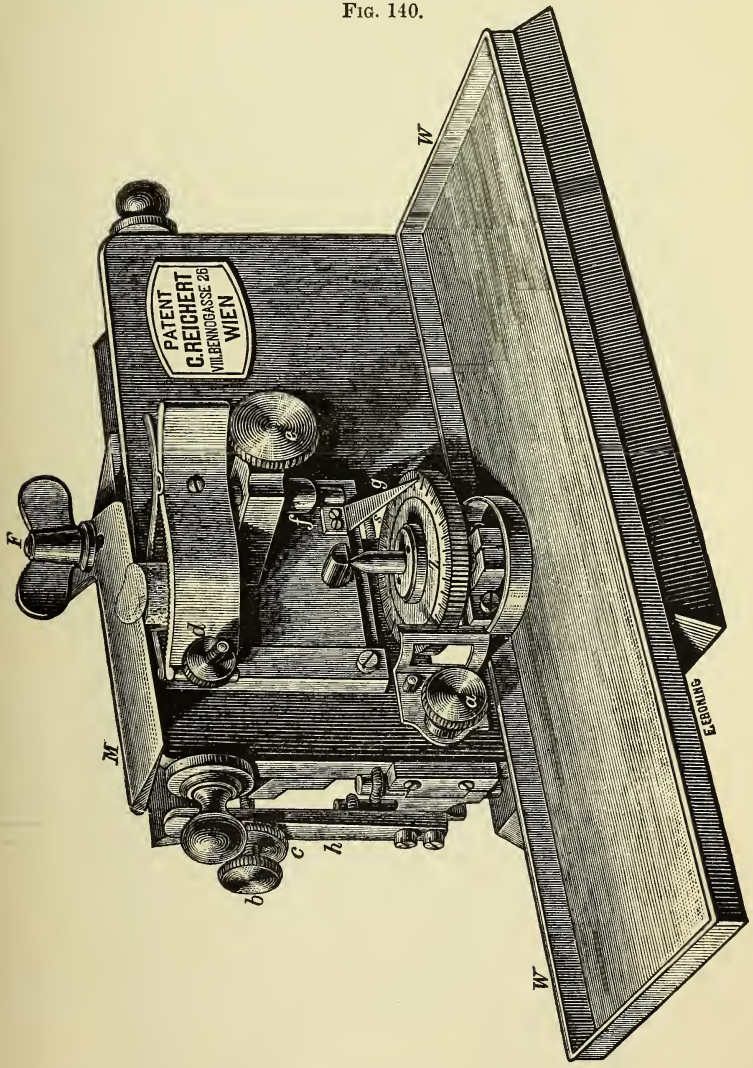
Sections may be stained with the different staining fluids and mounted in glycerine or other media. If mounted in Canada balsam

* Amer. Mon. Micr. Journ., v. (1884) pp. 127-8, from New York Med. Journ.

and the specimen is to be retained in the imbedding mass, absolute alcohol for dehydrating and oil of cloves for clearing are to be discarded, for they both dissolve the celloidin, and alcohol of 96 per cent. and oil of bergamot, oil of sanders, or oil of origanum used.

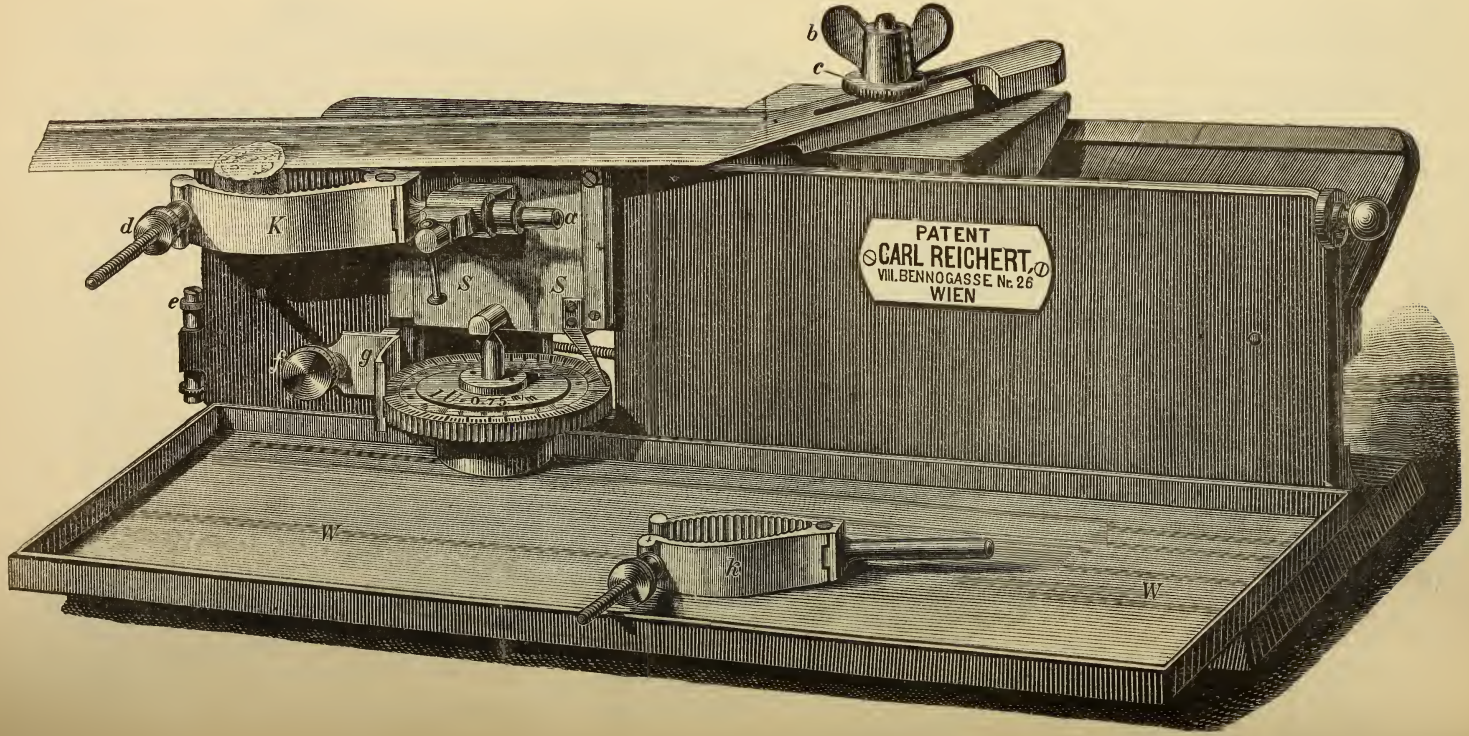
Reichert's Microtomes.—The essential feature of these Microtomes is that the object is automatically raised.

FIG. 140.



The carrier, to which the knife M is attached by the screw F, rests on six points, for greater exactness and for reducing friction.

Fig. 141.

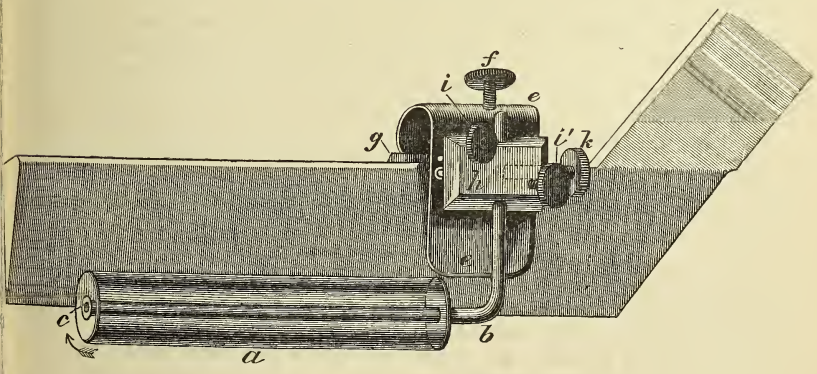

b
c
d
K
a
S
S
e
f
g
PATENT
CARL REICHERT
VIII. BENNOGASSE Nr. 26
WIEN
W
W

The vertical axis of the toothed wheel *z* on the top of which the object-carrier rests, ends below in a screw with a pitch of 0·75 mm. The knife-carrier at each cut pushes against the lever *h*, the horizontal arm of which catches in the wheel *z*, which has 100 teeth. At the commencement of each cut a spring *s* draws the lever back ready for the cut. The lever is regulated by *b c*, so that it will move the wheel *z* only one tooth forward or several teeth up to ten. The wheel is prevented from moving backwards by a catch attached to *a*. Sections of 0·0075–0·075 mm. can thus be cut. If sections thicker than 0·075 mm. are required the automatic apparatus is detached, the catch at *a* being removed and the spring *s* detached. The thickness of the section is now indicated by the pointer *g* and the graduations on the periphery of the wheel. So that the knife may not inadvertently cut against the object-carrier a contrivance is added which prevents the lever working in the wheel after a given height has been reached. The axis *f* of the object-clamp is fixed by the screw *e*, so that it can be raised or lowered. The jaws can be brought closer together by *d*. The tray W serves for catching spirit, &c.*

The instrument fig. 141 is a larger form of the previous instrument, 38 cm. long instead of 20 cm.

Decker's Section-smoother.†—Dr. F. Decker describes the apparatus shown in fig. 142. The essential principle consists in the application to the knife-blade of a glass cylinder *a*, which can rotate on an axis *b c*.

Fig. 142.

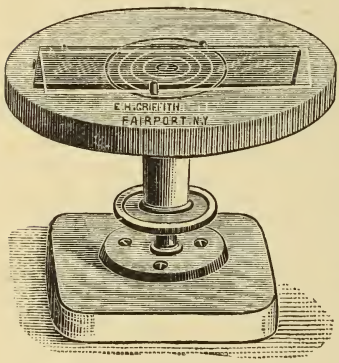


The knife has attached to it a steel bow *e e*. By turning the screw *f*, which acts on a long steel plate *g*, the bow is made to grip the knife tighter. The block *h* is attached by a hinge to *e* (its axis

* Cf. Zeitschr. f. Wiss. Mikr., i. (1884) pp. 241–4 (1 fig.).
† Arch. f. Mikr. Anat., xxiii. (1884) pp. 537–43.

being parallel to the knife-blade), and the bent arm of the axis of the glass cylinder passes into it and is clamped by the screw *k*. By the screws *i* and *i'* the block *h* can be raised at one end and depressed at the other, thereby raising or lowering the cylinder *a* above the knife-blade. The maximum length suggested for the cylinders is 5 cm. and the diameter 4, 6, and 9 mm.

Fig. 143.



Griffith's Turntable. — Mr. E. H. Griffith has devised the ingeniously simple turntable shown in fig. 143.

The centre of the table, marked with the circles, has a spiral spring attached to it beneath. The slide being placed between the two pins in this centre, is partially rotated against the spring and pushed forward, when the spring keys it between the two pins and a third fixed pin at the upper side of the slide (towards the left). The fourth pin, at the left end, is for length. The table rotates on a pointed spindle, and can be lifted off it as required.

Reversible Mounts.*—Of late years much attention has been given to the preparation of whole insects, without subjecting them to pressure, by using cells of vulcanite or other suitable substance affixed to the ordinary slides. T. J. Briant has in the same way put up *thick sections* of various parts of insects with very good results. Such preparations allow of the examination of the various parts as they are arranged in the body of the insect, and are comparatively easy to make, either by the ordinary section-cutter or by hand. It is, however, frequently found, both in the case of whole insects as well as that of the thick sections, that one wants to know the appearance from the opposite side. Of course the slide may be turned over, but the critical examination of an object through glass of the thickness of an ordinary slip is very difficult—practically impossible.

In order to overcome this difficulty take a vulcanite ring and fasten a thin cover as a bottom to it with any good cement; fill it with balsam, immerse the preparation, and cover with another thin cover. Then put this aside to dry, placing it on the top of a small cork fixed in a bottle, and thus preventing the superfluous balsam fastening the ring to the shelf or table. The ring with its cover and contents is then placed in a wooden slide, with a hole corresponding in size to that of the ring. Usually there is enough balsam around the edge to hold the ring in place, but if not the slip may be covered on both sides with paper. In the case of small objects, two glass covers may be used, kept apart by small pieces of thin glass cover;

* Thirteenth Ann. Rep. South London Micr. and Nat. Hist. Club, 1884, p. 13.

these can be fastened in the wooden slips by covering one side with paper, with of course, the necessary hole cut a smaller size than the hole in the wood slip, and while the gum is wet dropping the glass in place; then when dry covering the other side.

Mr. Briant has found immense advantage in being able to reverse the preparation in this way, many difficult points being easily solved upon examining both sides.

Hinman's Device for Mounting.*—G. C. Hinman's device consists of a perforated plate with the edges turned up so as to receive a glass slip, and hold it with the centre over the centre of the perforation, thus enabling the object to be placed centrally without difficulty. When the object is mounted this plate is placed upon another under a spring having three points in a plane parallel with the surface of the slip, which can be pressed down upon the cover-glass with any desired force, and thus bring the cover-glass into a plane parallel with the slip.

Mr. J. H. Pillsbury considers this by far the most convenient instrument for holding the cover-glass in place which he has ever seen.

Preparing Schultze's Solution.†—Prof. W. Hillhouse describes the following method of preparing Schultze's solution, a modification of that of Radlkofer. Pure granulated zinc is dissolved in hydrochloric acid at an ordinary temperature; the solution is evaporated at a temperature of about 70° or 80° C. and under contact with metallic zinc, to a syrup which does not get muddy on addition of much water, and has the specific gravity 2·0 This syrup is poured off and diluted with water to specific gravity 1·8—that is, twelve parts of water are added to every hundred of the syrup. In 100 parts of the resulting fluid dissolve at a gentle heat six parts of potassium iodide, and then dissolve in the whole as much iodine as it will take up. The solution will now have the consistence of concentrated sulphuric acid, is perfectly clear, of a bright golden-brown colour, slowly becoming somewhat darker on exposure to light. It can be brought to various degrees of dilution, as its action varies according to the strength. It is best kept in the dark.

Styrax and Liquidambar.‡—Dr. H. van Heurck has a further note on these substances, in which, after referring to the commendations of Cole, Dippel, Grunow, and Kitton, he quotes that of Strasburger in his 'Das Botanische Practicum,' who recommends it for making visible the details of the nucleus of plant-cells previously stained with hæmatoxylin. The cytoplasm is invisible, while the details of the nucleus are seen with the greatest clearness.

A "new quality" of styrax Dr. van Heurck finds to be, as mentioned *ante* p. 655, that instead of becoming coloured by time and

* Amer. Mon. Micr. Journ., v. (1884) p. 140.
† Proc. Camb. Phil. Soc., iv. (1883) p. 399.
‡ Bull. Soc. Belg. Micr., x. (1884) pp. 178–82.

light like Canada balsam, the preparation becomes absolutely colourless.

The solution should be used as follows:—Place the cover-glasses on a large glass plate, and put on each by a pipette a large drop of distilled water, and on this let fall gently a drop of the liquid containing the diatoms. Then cover them with a watch-glass and allow to evaporate spontaneously. When this is done the cover-glasses are separately heated to redness on platinum and transferred to the glass plate, and a drop of a very fluid solution of styrax or liquidambar put on them and the watch-glass replaced. In twenty-four hours the benzine is completely evaporated. The cover-glass is then put on the slide and slightly heated, preferably in a water-bath. A light pressure will drive out air-bubbles.

Preparing Shellac Cement.*—R. Hitchcock gives an easy method of preparing an excellent clear solution of shellac.

Obtain from a paint-shop a quantity of shellac spirit-varnish, or prepare it by dissolving common shellac in alcohol. It is well to use five or six ounces of the varnish, as there will be considerable shrinkage in volume during the process. Place the varnish in a bottle, which it should not more than two-thirds fill, and add to it about one-quarter of its volume of naphtha or "petroleum spirit." Put in the cork and shake well, to thoroughly mix the two liquids. Let the mixture stand a few minutes and shake it again, repeating the operation two or three times. Then let the bottle stand undisturbed for twelve hours, or as much longer as convenient. The naphtha will be found in a layer above the shellac containing the flocculent matter, which, being insoluble in cold alcohol, renders the ordinary solutions of shellac turbid, while the alcoholic solution beneath will be perfectly clear. By means of a siphon, extemporized by a rubber or glass tube, the clear shellac may be drawn off from beneath the naphtha.

The solution thus obtained will be too thin for microscopical use. It should therefore be placed in an evaporating dish and heated very gently—preferably over a water-bath in which the water is not allowed to boil—until it reaches a syrupy consistence. When cold it will be thicker than while warm, and it should be tested by placing a few drops on a cold slide and watching its behaviour. When it seems to be right the solution may be poured into a bottle and about three drops of castor-oil added for every ounce of solution. This causes it to flow smoothly from the brush.

In practice we have found it advisable to evaporate the solution, as above described, until it is too thick to flow from the brush, and then to thin it with strong alcohol. The reason is that during evaporation the alcohol of the original solution is driven off more rapidly than the water that is associated with it. Therefore, by the time the solution is reduced to one-fourth its original volume the alcohol has become much weaker than it should be, and the cement

* Amer. Mon. Micr. Journ., v. (1884) pp. 131-2.

dries slowly. By thinning the solution with strong alcohol the resulting cement becomes all that can be desired.

It is well to have two kinds of shellac cement always at hand—one so thick that it will just flow from the brush on the turntable, the other thinner. The first is useful for making cells, the second as a general cement to attach covers, &c.

Coating Diatoms with Silver.*—A. Y. Moore burns one side of a diatom to the cover-glass and then coats the other side with pure silver. The refractive index of silver according to Brewster is 3·27, and the visibility of a diatom so prepared is four times as great as when mounted dry, or more correctly, in the proportion of 1·84 to ·43. "The results obtained by giving such a visibility to the diatom and at the same time utilizing the full aperture of the objective, can hardly be imagined by one who has never seen it. The dots upon *Amphipleura pellucida* are shown in a way which would readily convince those who still deny their existence. Even *Rhizosolenia alata* yields transverse lines which, so far as I know, have never been seen by any other method."

Lyon's Mailing Case.†—H. N. Lyon takes two slips of wood 3 by 1 in. and 1/16 in. thick, and in the centre of one makes a hole a little larger than the cell. Paste a piece of stiff paper on one side of this slip, covering the hole. Lay the slide between the slips and along one side paste a piece of paper, not touching the glass slide however. A rubber band holds the package tight, and it may be sent as it is or first wrapped in paper. If two or more slides are to be sent the modus operandi is the same, except that the openings are alternately on opposite sides. In this case the middle slips need not be covered.

Action of Reagents in the discrimination of Vegetable Fibres.‡—V. Berthold classifies the more important vegetable fibres according to the action upon them of iodine and sulphuric acid, as follows:—

A. Coloured blue, violet, or green by iodine and sulphuric acid:—
Flax, Chinese grass and ramie (*Boehmeria nivea*), roa (*Pipturus argenteus*), cotton, hemp, and sunn-hemp (*Crotalaria juncea*).

I. Transverse sections coloured blue or violet, but showing no yellow middle lamella; cell-cavity usually filled with a yellow mass.

a. Flax. Transverse sections occur either isolated or a small number in a group; the separate transverse sections are not contiguous; they are polygonal, bounded by straight lines, and have sharp edges. Lamination evident, blue or yellow; cell-cavity a yellow dot. Longitudinal distortions of the striæ indicated by darker lines which usually cross.

* The Microscope, iv. (1884) pp. 157–9 and 165.

† Ibid., p. 179.

‡ Zeitschr. f. Warenkunde, 1883, pp. 14–5, 17–8 (16 figs.). See Bot. Centralbl., xvi. (1883) p. 308.

b. Chinese grass and Ramie. Transverse sections isolated or a small number in a group; their connection very loose; they are polygonal or irregular, and very large. Lamination very evident; cell-cavity large and irregular, often filled with dark yellow masses; sometimes striated radially. In the longitudinal aspect some fibres appear very broad, but their breadth is very variable; distortions evident; the ends thickly rounded.

c. Roa-fibre. Transverse sections not many in a group, polyhedral, usually with straight or slightly curved sides and rounded edges; cell-cavity narrowly oblong, regular; contents sometimes yellow. Some transverse sections are surrounded by a thin greenish lamella, and show well-marked radial striæ or fissures and connective lamination; the separate lamellæ vary in depth of colour.

d. Cotton. Transverse sections always isolated, rounded, of various forms, usually reniform; cell-cavity narrow, linear, contents usually yellow. No lamination.

II. Transverse sections blue or violet, polyhedral, rounded or irregular, always surrounded by a yellow middle lamella.

a. Hemp. Transverse sections always in groups, contiguous, with rounded edges, surrounded by a thin yellow middle lamella, beautifully laminated concentrically; cell-cavity linear, simple or branched, irregular, sometimes broad, without contents.

b. Sunn-hemp. Transverse sections numerous in a group, closely contiguous, resembling hemp, often sickle-shaped, either polygonal or oval, with a small round cell-cavity, often with yellow contents. Surrounded by a broad yellow middle lamella, from which the inner laminæ are often detached.

B. Coloured yellow by iodine and sulphuric acid.

I. Dicotyledons. No vessels besides the bast-fibres; cell-cavity with constrictions.

1. Transverse sections in groups, polygonal, bounded by straight lines, with sharp edges; cell-cavity round or oval, smooth, empty, surrounded by a narrow middle lamella of the same colour.

a. Jute. Cell-cavity large, roundish, oval; middle lamella very narrow; no lamination; the ends always rounded, and almost always strongly thickened.

b. Abelmoschus. Transverse sections larger than *a*, bounded by straight lines, sharp-edged; cell-cavity a dot or line, oval, rarely angular, smaller than *a*. Fibres of uniform thickness; ends broad, rounded, often thickened; cell-cavity variable, often reduced to a line.

2. Transverse sections always in groups, polygonal, bounded by straight lines, with sharp or slightly rounded edges; cell-cavity empty. Middle lamella broad and decidedly

darker than the transverse sections; cell-cavity with constrictions, locally entirely absent.

a. Hibiscus. Edges sharp or rounded; in the first case the cell-cavity small, in the latter case broader and oval; middle lamella sometimes wanting; transverse sections only slightly and inconspicuously laminated. Fibres of very various thickness, not usually striated longitudinally; ends rounded, blunt and almost always thickened

b. Urena sinuata. Edges sharp; cell-cavity very small, a dot or narrow short line; middle lamella broad and very distinct; transverse sections not laminated. Fibres of uniform thickness; rarely striated longitudinally; ends rounded, rarely somewhat thickened.

II. Monocotyledons. Vessels in addition to bast-fibres; cell-cavity without constrictions.

1. Transverse sections usually rounded, rarely polygonal; cell-cavity always round; no middle lamellæ.

a. New Zealand Flax (*Phormium tenax*). Transverse sections small, usually round, closely contiguous, polygonal with rounded edges; cell-cavity empty. Fibres thin, uniform, smooth, rigid; cell-cavity small, of uniform breadth, without striation or distortion; ends sharp.

b. Manila Hemp (*Musa textilis*). Transverse sections polygonal with rounded edges, or roundish; cell-cavity large, roundish, sometimes with yellow contents. Fibres of uniform thickness, smooth, not striated; walls thin; ends sharp, or slightly rounded. After combustion siliceous skeletons remain behind in the form of strings.

2. Transverse sections evidently polygonal; cell-cavity polygonal, with one or more sharp edges, moderately large; no middle lamella.

a. African Hemp (*Sanseviera*). Transverse sections closely contiguous, not laminated. Fibres thin, smooth, with sharp ends.

b. Aloe. Transverse sections not very numerous in a group; edges slightly rounded; cell-cavity not very large, polygonal, often with rounded ends; large spiral vessels; fibres of uniform thickness, without structure; ends sharp or rounded.

c. Agave. Transverse sections polygonal, bounded by straight lines, closely contiguous; cell-cavity large, polygonal; its edges less sharp. Fibres rigid, considerably broader towards the middle; ends broad, thickened, sometimes split.

3. Transverse sections polygonal, closely contiguous, small, bounded by straight lines; edges very sharp; cell-cavity small, round or linear; middle lamella very evident. Fibres narrow, striated, with sharp ends:—*Yucca.*

Reagents for Tannins in Vegetable Cells.*—W. Gardiner specifies objections to all the micro-chemical reagents for tannins hitherto used. Iron sulphate he finds convenient when the products are blue and not green. He prefers to use a solution of ammonium molybdate in concentrated ammonium chloride; this gives with tannins a copious yellow precipitate. It can also be used for determining the presence of gallic acid, with which it produces only a red colour; the compound with gallic acid is soluble in ammonium chloride, while that with tannin is not.

The determination of tannins in tissues preserved in alcohol is facilitated by the fact that dead protoplasm gives a permanent precipitate with tannins.

The author regards the tannins as secondary products of metastasis, especially when this process is very active, and thinks that they have no further use. In the old leaves of a cutting of the cherry-laurel which had already put out roots and shoots, the quantity of tannin had considerably increased.

Microscopical Examination of Chestnut-meal.†—T. F. Hanausek gives the following microscopical characteristics of the various parts of the sweet chestnut. The testa of the chestnut consists of three layers. The cells of the outermost layer are polyhedral thick-walled plates with yellow or dark-brown angular flakes (tannin?). Many bear stiff cylindrical unicellular hairs, varying in thickness from 0·018 to 0·029 mm., and of variable length. Some have thin and others very thick walls; the former contain tannin. The middle layer is composed of tangentially elongated, thin-walled, bright-red parenchymatous cells, which swell up in potash to a broad elliptic form, and are coloured of a beautiful violet-blue by chloride of iron. It has also strong vascular bundles and large cavities. The innermost fibrous layer forms a narrow light-brown streak composed of thin-walled fibrous elements.

The two cotyledons consist of an amylaceous parenchyma. The outermost layer of cells are narrow five- or six-sided radially arranged prisms, with a diameter of 0·007–0·01 mm.; in the radial direction they are three or four times as long. The very small colourless protein-grains are only coloured pale yellow by iodine, on account of the envelope of oil which surrounds them. The amylaceous cells have a diameter from 0·055–0·075 mm., and contain, besides starch, a parietal layer of albuminoids and oil. The starch-grains are sometimes simple, sometimes double. The simple grains are extremely variable in form; the most characteristic forms are triangular, and one has an acute projecting appendage. Some resemble the cap-shaped partial grains of tapioca. The nucleus is central and difficult to detect; stratification is indicated in the largest by two or three inconspicuous lines. The polarization-cross is very conspicuous. The smaller spherical or ellipsoidal grains have a diameter of from 0·005–0·009 mm.; the

* Proc. Camb. Phil. Soc., iv. (1883) pp. 387–94.

† Zeitschr. f. Landwirtschaft. Gewerbe, 1883, pp. 3–5 (3 pls.). See Bot. Centralbl., xiv. (1883) p. 180.

largest observed measured 0·025 mm. in length and 0·016 mm. in breadth; the most common length was about 0·02 mm.

Microscopical Investigation of Dyed Cotton Fabrics.*—R. Meyer finds that cotton goods which have been dyed by means of the albumin process can easily be distinguished from articles which have been printed with soluble dyes, by means of the Microscope. For example, if a piece of cotton is first treated with a solution of lead acetate, and afterwards with a chromate, the fibres are uniformly coloured. But if the goods have been printed with a mixture of precipitated lead chromate and albumin, and the colour fixed by steaming, the fibres themselves appear colourless under the Microscope, but patches of coloured albumen are attached to the fibre.

Microscopical Examination of Water for Organic Impurities.†—J. Brautlecht produces a precipitate in the water by adding to 100 cc. 5 drops of a solution consisting of 1 part aluminium sulphate, 1 part hydrochloric acid, and 8 parts water, followed up by one to three drops of liquid ammonia. The precipitate settles readily, and after decanting off the clear solution, is collected upon a smooth filter, stroked off with a glass rod, and thus transferred to a test-tube, in which it is dissolved in ten to fifteen drops of dilute acetic acid. The clear solution is examined with the Microscope, at first alone, and then after the addition of a solution of saffranine. By adding one-half per cent. of gelatine permanent preparations may be obtained on Koch's principle.

A. Certes‡ summarizes in a very convenient form the procedure necessary for an effective microscopical examination of water. The more general observations of the first sixteen pages are followed by eleven of practical instructions, in which are dealt with the collection of the water, the employment of reagents and their formulæ, preservative liquids, colouring matters, &c.

For the ordinary examination of microbia the power ought not to be less than 250 or 300. For more extended study, powers of 700 to 800 are necessary.

"The use of staining reagents ought never to be neglected after direct examination, as they define much more distinctly the colours and certain details of structure, such as the vibratile cilia, flagella, nuclei, and nucleoli of the ciliate or flagellate infusoria. Especially important is the part which staining reagents will certainly play in the future in regard to the different elements of the protoplasm.§

* Journ. Chem. Soc.—Abstr., xliv. (1883) p. 751. Ber. Deutsch. Chem. Gesell., xvi. pp. 455–7.

† Rep. Anal. Chemie und Chem. Zeitung. Cf. Chemical News, xlviii. (1883) p. 180.

‡ Certes, A., 'Analyse micrographique des Eaux,' 8vo, Paris, 1883, 28 pp. and 2 pls.

§ The various colouring substances give very different reactions, according to the organisms with which they are brought in contact. Manufactured for the most part for commercial purposes, they are far from being homogeneous. Still more rarely are they chemically pure. Hence arise mistakes and uncertainty in their use.

Some organisms, morphologically alike so far as appears with our present means of investigation, behave very differently with the same staining agents. The chemical affinities are not always the same during life and after death, and there seems to be some relation between the diversity of constitution of the protoplasm, revealed to us by the diversity of the reactions, and the physiological or pathogenic *rôle* of certain microbia. In other terms, where there are no morphological species, reagents like inoculations show us distinct physiological species.

Is it not remarkable, for instance, that dahlia violet, methyl blue, and iodine green, which, managed carefully, only colour the nucleus of living infusoria, also colour, but always entirely, a great number of rods and bacterian filaments? We are thus led to consider the chromatic elements of the protoplasm as diffused in the microbia, whilst they are differentiated and condensed under the form of nucleus or nucleolus in the infusoria properly so called.

If, on the other hand, we consider that in the cells and infusoria the transformations of the nucleus and nucleolus always precede the phenomena of reproduction, however much they differ, and that generally these transformations largely modify the form of the nucleus and nucleolus, we are less surprised to see the same bacterian rod in process of development pass, as Cienkowski has shown, through phases corresponding with the very distinct forms from which morphological species have been made."

Dr. J. D. Macdonald has also issued a second edition of his 'Guide to the Microscopical Examination of Drinking Water,' in which he gives the following directions for collecting and examining sediments:—

When water is very turbid, from an obviously impure source, it is easy enough to obtain a sufficient amount of sedimentary matter for microscopical examination, and a just estimate of the unfitness of such water for drinking purposes may be thus readily formed. But it more frequently happens that the deposit, even after long standing, is but slight, and when this is the case, we must have recourse to special means, by which the whole or a large amount of the matters in suspension may be concentrated or collected together within a small compass. In the first place one of the tall glass vessels above described, should be filled with the water to be examined, and a circular disk of glass, resting on a horizontal loop at the end of a long aluminium wire lowered to the bottom, when the whole arrangement, lightly covered, must be set aside for 24 or 48 hours, as the case may be.

At the end of the specified time, the water should be siphoned off with a piece of indiarubber tubing, so as to leave only a thin stratum of the liquid over the glass disk. This should now be carefully raised and laid upon blotting-paper to dry its under surface and remove the surplus moisture, when it may be at once transferred to the Microscope, with a large piece of cover-glass so placed upon it as to exclude all air-bubbles. An ordinary watch-glass may in some cases be substituted for the disk alluded to, with advantage, as being less likely to permit the loss of sediment by overflow, which is certain to happen

with a plane surface. The operator must be cautioned not to use iron wire, which rusts so rapidly that it will soon throw down a flocculent precipitate. Another good plan, which is perhaps the better of the two, is to siphon off the water until only a sufficient quantity remains to permit the sediment to be shaken up with it, and poured into a tall conical glass, from which, after standing again for a short time, portions may be taken up by means of a pipette, and placed on slides for examination. If the subsidence is observed to be complete, it is rather an advantage to have a good body of water in the glass, or, at least, so much as will permit the pipette to be used with ease and facility. It may be observed here, that it is very inconvenient to have too much fluid at a time on a slide. The cover-glass will be unstable and liable to have its upper surface wetted, while the objects themselves will be tremulous, if they do not quite run out of the field. To obviate this, the pipette, when taken out of the water, should be held in a vertical position for some little time, until the suspended matters gravitate to the bottom of the tube, when a well-charged droplet might be placed on a number of separate slides and examined seriatim. This is, in fact, the only way in which a large sediment can be thoroughly inspected.

M. Balland also gives * a neat and easy method for examining water contaminated by the drainage of cesspools. Into a long tube he pours a few cubic centimetres of a solution of sodium hypobromide, and then fills it completely with the water to be examined. Placing the thumb on the tube, it is inverted and placed in a glass containing mercury. If urea is present, bubbles of nitrogen gradually rise in the tube and collect at the closed end.

J. W. Mallet describes † apparatus whereby the water to be examined may be evaporated under greatly reduced pressure and at a correspondingly low temperature, out of contact with the air. Under such conditions, the organic matter is altered much less than in the apparatus generally made use of. As test-materials, leucine and tyrosine were selected, as representing the more stable products of putrefaction liable to occur in natural water, and for which the combustion process in its natural form had been found to give results far from satisfactory.

Mr. G. E. Davis has also published ‡ two articles on 'Water, Water Analysis and the Microscope.'

Changing the Water in Aquaria containing Microscopical Organisms.§—F. Könike describes the following as the more convenient way for emptying aquaria without drawing away the minute organisms :—

Tie over a small flask or glass, with the widest possible mouth, a piece of fine muslin in such a manner as not to stretch it tight. Then put the end of an indiarubber tube through the middle of the muslin to the bottom of the glass. At the place through

* Journ. de Pharm. et de Chimie, 1883. Cf. 'Athenæum,' 24th Nov., 1883.
† Chem. News, xlvii. (1883) pp. 218–20, 232–3.
‡ Micr. News, iii. (1883) pp. 309–13 (7 figs.).
§ Zool. Anzeig., vi. (1883) pp. 638–9.

which the tube passes, fasten the muslin tightly with thread to the tube, and sink the glass to the bottom of the aquarium. On exhausting the tube the glass will fill with water, and the aquarium will in this way be emptied, the water passing through the muslin. If a stoppage should occur the cause will in most cases be some dirt having settled on the muslin. It is for this reason that a glass with a wide mouth is recommended.

Micro-chemical Test for Sodium.*—A. Streng proposes to employ uranium acetate as a test for sodium; by its action on any sodium solution, crystals of uranium sodium acetate are formed, which are but sparingly soluble in water. They appear in the form of tetrahedra and the minute yellow crystals cannot be mistaken for the rhombic crystals of uranium acetate, which separate out as the solution dries, on account of their action on polarized light. The reaction is very sharp, as the double salt contains a very low percentage of soda (6·6 per cent.).

Micro-chemical Reaction of Solanine.†—J. Schaarschmidt gives the following test for determining the presence of this alkaloid. The section is laid in a drop of nitric acid or of not too concentrated sulphuric acid, covered, and immediately placed under the Microscope. A rose-red colour supervenes after a few seconds, especially if nitric acid be employed. By this method the author found solanine in *Solanum tuberosum*, especially in the sub-peridermal cells of the tuber, and in the sub-epidermal cells of the stem and leaf-stalk; also in the collenchyma of *S. nigrum* and *Dulcamara*, *Capsicum annuum*, *Lycopersicum esculentum*, and *Mandragora officinalis*. The epidermis of the sepals of *Solanum nigrum* is especially rich in solanine.

Size of Atoms.‡—Sir W. Thomson gives an estimate of the size of atoms or molecules, founded on four lines of reasoning—(1) the undulatory theory of light, (2) the phenomena of contact electricity, (3) capillary attraction, and (4) the kinetic theory of gases—which all lead to substantially the same estimate of the dimensions of molecular structure. "Jointly they establish, with what we cannot but regard as a very high degree of probability, the conclusion that, in any ordinary liquid, transparent solid, or seemingly opaque solid, the mean distance between the centres of contiguous molecules is less than the 1-5,000,000th, and greater than the 1-1,000,000,000th of a centimetre.

"To form some conception of the degree of coarse-grainedness indicated by this conclusion, imagine a globe of water or glass, as large as a football, or say a globe of 16 centimetres diameter, to be magnified up to the size of the earth, each constituent molecule being magnified in the same proportion. The magnified structure would be more coarse-grained than a heap of small shot, but probably less coarse-grained than a heap of footballs."

* Jahrb. f. Mineral., ii. (1883) p. 365. See Journ. Chem. Soc.—Abstr., xlv. (1884) pp. 366-7.

† Zeitschr. f. Wiss. Mikroskopie, i. (1884) pp. 61-2.

‡ Proc. Roy. Inst., x. (1883) pp. 185-213 (11 figs.).

In an article on "Liquid Films and Molecular Magnitudes" * A. W. Reinold and A. W. Rücker give the results of their measurements of soap films in the last stage of tenuity, and in which, refering to Sir W. Thomson's lecture, they say: "If the size of the molecules of which the liquid is composed is between 2×10^{-6} and 1×10^{-8} mm. (the limits given by him) it follows that the thinnest film measured by us, which was $7 \cdot 2 \times 10^{-6}$ mm., must contain not less than 3 and not more than 720 molecules in its thickness. The smallness of the smaller of these numbers tends to show that the real size of the molecule is considerably below Sir W. Thomson's superior limit."

B. Sc.—Difficulties in Mounting.
[To avoid air-bubbles in glycerine cell-mounting. — Varnish twice at intervals of a couple of hours with a solution of shellac in alcohol and then finish off with ordinary bitumen.]
Sci.-Gossip, 1884, p. 212.

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„ „ Ueber eine gute Färbungsmethode zur Untersuchung von Kerntheilungsfiguren. (On a good staining method for investigating the figures in the division of nuclei.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 415–7.

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[I. Tea, Coffee, Cocoa, Sugar, &c. II. Milk, Butter, Cheese, Cereal foods, &c.] 8vo, London, 1884.

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On Photo-micrography. Plate of T. S. Spine of *Echinus* under (4) various conditions of illumination—1 fig.
„ „ Popular Microscopical Studies. No. XII. pp. 53–6. The Dodder-plant. Pl. 12. T. S. of Dodder (*Cuscuta*) in its host, double stained × 75.
„ „ Studies in Microscopical Science.
Cf. *Micr. News*, IV. (1884) p. 242.
Vol. II. No. 23. Sec. I. No. 12. pp. 45–8. Human Cerebrum. Plate 12.
No. 24. Sec. II. No. 12. pp. 47–50. Secondary Tissue. Pl. 12. T. S. Stem of Maple showing annual rings × 50.

Cox, C. F.—Cement for Mounting.
[Correction as to the material he employs for his finishing cement.]
Amer. Mon. Micr. Journ., V. (1884) p. 140 (cf. also p. 132).

Davis, G. E.—The President's Address.
[Deals with "the use of the various processes in connection with microscopical manipulation which have been so universally employed during the past few years" and "the past history of the Microscope."]
Ann. Rep. Manchester Micr. Soc., 1883-4, pp. 60–72.

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* Nature, xxviii. (1883) pp. 389–93 (2 figs.). See also Proc. Roy. Soc., xxxv (1883) pp. 149–51.

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Zeitschr. f. Wiss. Mikr., I. (1884) pp. 413–4.

E., H. L.—Mounting Infusoria.
[Reply to H. M. J. Underhill. Chromic Oxydichloride acid = Chlorochromic acid.]
Sci.-Gossip, 1884, p. 185.

Ehrenbaum, E.—Ueber eine Methode zur Anfertigung von Dünnschlitten zoologischer Objecte. (On a method of preparing thin sections of zoological objects.) [*Post.*] *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 414–5.

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„ „ Sur l'emploi de l'encre de Chine en Microscopie. (On the employment of Chinese Ink in Microscopy.) [*Post.*]
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„ „ Remarques supplémentaires sur la technique du perchlorure de Fer. (Supplementary remarks on the technic of perchloride of Iron.) [*Supra*, p. 813.]
Arch. Zool. Expér. et Gén., II. (1884) p. xi.

„ „ Contribution à la technique des Injections. (Contribution to the technic of Injections.) [*Ante*, p. 312.]
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Bot. Centralbl., XVIII. (1884) p. 383.

Grant, F.—Bacteria and the Microscope.
[Reply to "Amateur," *ante*, p. 630.]
Engl. Mech., XXXIX. (1884) pp. 490–1.

Gray, E.—Glycerin in Mounting.
[Recommendation not to use an acid glycerin.]
Amer. Mon. Micr. Journ., V. (1884) p. 140.

Griffith's (E. H.) Turntable. [*Supra*, p. 826.]
Amer. Mon. Micr. Journ., V. (1884) p. 126 (1 fig.).

Grove, W. B.—See p. 810.

Hardy, J. D.—Contrivance for collecting and examining aquatic specimens whilst out on excursions. [*Supra*, p. 803.]
Journ. Quek. Micr. Club, II. (1884) pp. 55–6.

Heurck, H. Van.—De l'emploi du Styrax et du liquidambar en remplacement du baume du Canada. (On the employment of Styrax and liquidambar in place of Canada Balsam.) [*Supra*, p. 827.]
Bull. Soc. Belg. Micr., X. (1884) pp. 178-82.

Hitchcock, R.—The preparation of Shellac Cement. [*Supra*, p. 828.]
Amer. Mon. Micr. Journ., V. (1884) pp. 131-2.

„ „ Microscopical Technic.
Amer. Mon. Micr. Journ., V. (1884) pp. 132-4, 147-9.

Ingpen, J. E.—Smith's Mounting Medium.
["He did not think he had ever seen a slide of *Amphipleura* so well shown as the one which Mr. Nelson exhibited, which was mounted by Prof. Smith. No doubt the objective and the manner of showing it had something to do with the matter, but there was also no doubt that something was due to the medium. He could only say that probably the exhibition had never been surpassed or equalled, and the fact was to be recorded as an era in the history of resolution."]
Journ. Quek. Micr. Club, II. (1884) p. 43.

Karop, G.—Section-cutting. *Abstr. Proc. Western Micr. Club*, 1883-4, p. 12.

Kesteven, W. B.—On Staining Fluids for Sections of Brain and Spinal Cord.
Sci. Monthly, II. (1884) p. 138.

Klein.—[Weigert's] Staining Fluid for Sections of Tubercle-Bacilli.
[*Supra*, p. 818.] *Practitioner*, XXXIII. (1884) p. 35.

Lyon, H. N.—A New Mailing Case. [*Supra*, p. 829.]
The Microscope, IV. (1884) p. 179.

Murray, F. W.—Celloidin for Imbedding.
[Similar to G. C. Freeborn's directions, *supra*, p. 822.]
Amer. Mon. Micr. Journ., V. (1884) p. 128.

Nealey, E. T.—A rapid method for making Bone and Teeth Sections. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) pp. 142-4.

Nelson, E. M.—Bacteria and the Microscope.
[Reply to "Amateur," *ante*, p. 630.]
Engl. Mech., XXXIX. (1884) p. 517.

Peirce's (J.) Slides.
["Intended to prevent the drying of specimens during several hours' continuous observation. A rather deep circular cut is ground in the middle of each slide about 1/2 in. in diameter, which is intended to hold a sufficient quantity of the water to prevent evaporation from under the cover within the cut. It is expected that physicians will find these slides useful."]
Amer. Mon. Micr. Journ., V. (1884) p. 139.

Pillsbury, J. H.—[Hinman's] Device for Mounting. [*Supra*, p. 827.]
Amer. Mon. Micr. Journ., V. (1884) p. 140.

Purser, J. M.—A Manual of Histology and of Histological Methods. viii. and 396 pp. 8vo, Dublin, 1884.
[Contains an Introduction (pp. 1-11) on the Microscope and its use, and an Appendix (pp. 339-86) on measuring, drawing, determining magnifying power, injecting, hardening, embedding, cutting, mounting, summary of reagents, &c. In the Introduction it is stated that "the image must always be formed for each eye-piece at a certain distance below the latter."]

Pataboul, J.—Les Diatomées. Récolte et preparation. (The Diatomaceæ. Collection and preparation.) *Concld.*
Journ. de Microgr., VIII. (1884) pp. 451-4.

Slack, H. J.—Pleasant Hours with the Microscope.
[Thrips—Fungi—Heaths.]
Knowledge, VI. (1884) pp. 125-6 (5 figs.), 179-80 (1 fig.), 230-1 (4 figs.).

Smith, W. D.—On Staining Vegetable Tissues.
[Report of Demonstration.]
Journ. Quek. Micr. Club, II. (1884) pp. 46-52.

Sorby, H. C.—On the detection of Sewage Contamination by the use of the Microscope, and on the purifying action of minute Animals and Plants. [*Post.*]
Journ. Soc. Arts, XXXII. (1884) pp. 929–30.

Stowell, C. H.—Studies in Histology. IV. Staining.
The Microscope, IV. (1884) pp. 149–53.

„ „ How to harden Balsam Mounts.
[Reply to inquiry how to harden balsam mounts quickly and safely. "We have never tried to hasten the drying or hardening of the balsam. Should we desire to have a mount become hard quickly we would use balsam of such a consistence that it was fluid only when warm and quite solid and firm when cold, or we could expose the mounted preparation to a low temperature; this could be accomplished by placing the mount in a drying oven or in a sand bath. Nearly all specimens, however, can be mounted in warm balsam without fear of injury, and then as soon as the balsam becomes cold it is firm and hard."]
The Microscope, IV. (1884) p. 159.

„ „ Studies in Histology. V.
[Metallic stains.—Mounting.]
The Microscope, IV. (1884) pp. 171–6.

„ „ A new solid Watch-glass. [*Post.*]
The Microscope, IV. (1884) pp. 176–7.

Sudduth, W. X.—Dento-embryonal Histology and Technology. 19 pp. and 12 figs. 8vo, Chicago, 1884.

W., A. W.—Mounting Fresh-water Algæ.
["After trying all sorts of media . . . . I came to the conclusion that none was so good as plain water with the least addition of camphor water to prevent fungoid growths." Also suggests to preserve the green colour (1) the use of water recently boiled and then closed up in a flask to minimise the amount of air dissolved in it; (2) to put the slide in the dark immediately after mounting.]
Micr. News, IV. (1884) p. 216.

Wagstaff, E. H.—Pond Life in Winter.
[List of objects found in one haul.]
Amer. Mon. Micr. Journ., V. (1884) pp. 144–5.

Whitman, C. O.—A simple Section-smoother.
[Kingsley's, *ante*, p. 659. "For use with the Sterling (well) Microtome it is evidently ill adapted, for the ends which come underneath the blade would interfere with the work."]
Amer. Natural., XVIII. (1884) p. 844 (1 fig.).

Wichmann, A.—Ueber eine Methode zur Isolirung von Mineralien behuf ihrer mikrochemischen Untersuchung. (On a method for isolating minerals for their investigation micro-chemically.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 417–9.

Wilder and Gage.—On the use of Vaseline to prevent the loss of Alcohol from specimen Jars.
[Used *inter alia* to prevent the sticking of the covers or stoppers of cement vials.]
Proc. Amer. Assoc. Adv. Sci., XXXII. p. 318.
Cf. *Amer. Natural.*, XVIII. (1884) p. 845.

Wolle, F.—Fresh-water Algæ.
[Directions for collecting.]
Amer. Mon. Micr. Journ., V. (1884) pp. 129–30, from 'Desmids of the United States.'

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

DECEMBER 1884.

TRANSACTIONS OF THE SOCIETY.

XVIII.—*Description and Life-history of a new Fungus, Milowia nivea.*

By G. Massee, F.R.M.S.

(*Read 12th November*, 1884.)

Plate XII.

Milowia n. gen.—Pulvinate. Monœcious. Mycelium sparsely septate, branched, flexuous, giving origin to numerous lateral fertile three-celled branches. Pollinodium clavate, springing from the basal cell of the fertile branch. Carpogonium formed from the terminal cell of the fertile branch, broadly obovate, producing from near its apex from two to five cylindrical octosporous asci.

M. nivea n. sp.—Tufts globose, minute, white; sporidia colourless, cylindrical truncate; conidia globose, moniliform, occupying the same position as the carpogonium when the latter is not developed. Forming minute snow-white spots on decaying leaves of *Blysmus compressus*. When seen under a low power the plants look like minute tassels standing erect; the asci are numerous and radiate from a subglobose sterile portion. This plant, one of the simplest of the *Ascomycetes*, approaches in structure the genera *Podosphæra* and *Gymnoascus*, but differs from both in the total

EXPLANATION OF PLATE XII.

Fig. 1.—*Milowia nivea*, nat. size.
Figs. 2, 3.—Portions showing asci in different stages of development, × 750.
Fig. 4.—Sporidia, × 750.
Fig. 5.—Sporidia germinating, × 750.
Figs. 6, 7, 8.—Organs of reproduction in various stages. *a*, carpogonium, *b*, pollinodium, × 750.
Fig. 9.—Branch bearing conidia, × 750.

absence of an envelope to the fructification, and in the carpogonium remaining undivided.

I have much pleasure in naming the genus after my friend Mr. J. T. Milow, to whom I am indebted for many rare and interesting fungi.

The sporidia of this fungus were sown on a glass slip, moistened with a mixture of glycerin and the liquid from decaying rushes, placed under a bell-jar, and kept in the dark. After a few days some of the sporidia showed a slight projection at one end, the exospore split at this point, and the endospore protruded as a hypha. Out of some hundreds of sporidia that germinated only four were observed to give origin to more than one thread, these produced two, one springing from each end. Immediately preceding germination the protoplasm becomes granular and opaque, and contains several large refractive globules of an oily-looking substance; after germination the whole of the contents pass into the mycelium, which is cut off from the cavity of the sporidium by a transverse septum formed close to the latter. The hyphæ after elongating for some distance as simple threads with but few septa, branch repeatedly in a monopodial manner, these in turn give off numerous lateral branches in acropetal succession; some resemble the branch from which they spring, in having cells about four times as long as broad, and are probably organs of nutrition, penetrating the tissues of the host, and undergoing no further modification of form; others, which eventually give origin to the organs of reproduction, may be recognized during the earliest stages of development, by the much shorter cells, not longer than broad, and invariably three in number; of these the terminal one becomes the carpogonium, the basal one gives origin to the pollinodium as a lateral branch, while the central one remains unchanged, and forms the basal cell of the fruit. In some instances the pollinodium is not developed; then the terminal cell of the fertile branch, instead of forming a carpogonium, elongates and gives origin to a chain of conidia; this asexual form of reproduction occurs mixed with the sexual form.

The three cells forming the fertile branch are at first of equal size, but the terminal one, owing to continued growth, soon becomes very much larger than the remaining two, assumes a broadly obovate form, and contains coarsely granular opaque protoplasm, crowded with vacuoles of varying size; this cell is the carpogonium, now ready for fertilization. During the development of the carpogonium, the pollinodium originates as a lateral outgrowth from the basal cell of the reproductive branch; this outgrowth, during elongation, assumes a clavate form, at the same time curving upwards towards the carpogonium; a well-defined nucleus con-

taining one or more nucleoli is present in the semi-transparent fine grained protoplasm, which is cut off from the basal cell by a septum; when fully developed the nucleus disappears, and the pollinodium contains numerous minute granules, floating in a transparent fluid and undergoing active molecular movements; eventually the cell-wall at the apex of the pollinodium is absorbed, when the contents escape and adhere to the surface of the carpogonium. Contact with the substance contained in the pollinodium stimulates the carpogonium to further growth; the vacuoles disappear from its protoplasm, from two to five papillæ appear on its surface near the apex, which grow for some time as slender tubes, then widen and develop into cylindrical asci, into which the protoplasm from the carpogonium passes and becomes resolved into eight sporidia by free cell formation. Not unfrequently the slender tubes branch and give origin to two asci.

The value of the plant above described does not consist so much in the fact of its being a new species added to the already voluminous list of fungi, as to the suggestions it offers relating to the functions of analogous organs met with in the higher fungi, where owing to the difficulty with which the spores germinate under artificial conditions, and complications of structure, the life-history cannot be satisfactorily traced. The carpogonium differs from that of other Ascomycetes in remaining unicellular, and in giving origin to slender spicules which are terminated by the asci, calling to mind the basidium with its sterigmata in the Basidiomycetes. The points of agreement between the pollinodium and certain structures met with in the hymenium of Hymenomycetal fungi, known as *cystidia*, are yet more evident; both are terminal cells of large size, which during development contain a well-marked nucleus; the contents, at first homogeneous, become resolved into minute granules floating in a mucilaginous fluid, which finally escapes through an opening at the apex, and comes in contact with the spore-producing organ. The difficulties attending the practical demonstration of the functions of cystidia will not probably be overcome, but their close morphological agreement with organs, respecting the functions of which no doubt can be entertained, offers strong presumptive evidence of the same physiological function being common to both; this view respecting the nature of cystidia has already been entertained by Hoffmann,* who called them *pollinaria*, without, however, giving any evidence in support of his conclusion; the same may be said of Corda, who termed them *pollinaires*.

* "Die Pollinarien und Spermatien von *Agaricus*." Bot. Ztg., Feb. and March 1856.

The plant under consideration also demonstrates some points necessary for the completion of a theory of sexuality, which may be stated as follows.

Protoplasm contains two substances, the combined action of which enables the plant to perform its vegetative functions, and continue its existence as an individual; the proof of this is the fact that when the two components are differentiated into sexual organs, neither of these alone can perform vegetative functions, which can only be resumed after fertilization has effected a reunion of the requisites. That a separation of vegetative protoplasm has taken place is shown by reagents; glycogen is absent from the basidia (before fertilization) and cystidia of fungi, but is present in the hyphæ and spores; nuclein on the other hand is present in the pollinodium of *Milowia nivea* and in the cystidia of all fungi examined, but absent from every other part of the plant. In *Fucus vesiculosus* and *F. serratus* the oospore behaves similarly to the protoplasm of young parts of the thallus with reagents, but the oosphere and antheridia differ from both and from each other. In other experiments on plants belonging to widely separated families the difference between the sexual and vegetative organs is equally well marked, which, even when the significance from a chemical point of view is not understood, clearly shows a difference of composition, the point of most importance to the present inquiry. Tetragonidia, conidia, and the parthenogenetic reproductive bodies of the *Phæosporeæ* so far as examined give the same reactions as the vegetative parts of the plants to which they belong. This method when more fully developed and verified by extended experiments, may prove of value in determining the sexual or asexual nature of certain reproductive bodies belonging to the lower plants respecting which, at present, opinions are divided. As an example, no difference has been found in the protoplasm of conjugating plants of *Spirogyra*; and the mingling of vegetative protoplasm to form a zygospore, in place of being considered a sexual act, may be looked upon as the precursor of cross fertilization. The advantage of this method over reproduction by conidia consists in the zygospore being an admixture of two individuals, which presumably confers the same benefit as that effected by cross fertilization in the higher plants; the disadvantage, compared with the sexual method, which it shares with reproduction by fission, consisting in the destruction of the parent plant, which survives when parts only are specialized as reproductive organs.

It has been already stated that in *Milowia*, when the pollinodium is not developed, the terminal cell, instead of developing into a carpogonium, produces conidia; had this cell in such instances developed into an organ resembling the carpogonium with its asci,

it would according to present ideas have been considered as an example of parthenogenesis, which can in all cases be explained by assuming the non-differentiation of the vegetative protoplasm, as was proved in this instance, an idea supported by the fact, that in the most satisfactory examples* the male organ is absent or functionally imperfect; this being so, parthenogenesis means a retrogression to the vegetative stage of reproduction, which is not invalidated by the organ retaining the sexual female form.

* Sachs, 'Text-book of Botany,' 2nd English edition, pp. 902-3.

XIX.—*Notes on the Structural Characters of the Spines of Echinoidea. (Cidaridæ.)*

By Professor F. Jeffrey Bell, M.A., Sec. R.M.S.

(*Read 12th November*, 1884.)

Plate XIII.

Notwithstanding the labours of Dr. Carpenter, Mr. Stewart, and Prof. Mackintosh, there still remain points in the structure of the spines of Echinoidea that require much further investigation.

The first problem to which my attention was directed in a research into the characters of the spines of Cidarids may be stated thus. How do these spines grow, and what is the effect of the enveloping crust, or, as it may conveniently be called, the *ostracum*, of the spine? This is, of course, but a branch of the interesting question to which Dr. Carpenter some years ago directed the attention of this Society * when he stated his conviction that the growth of the spine was due to the presence of an "organic basis-substance," and gave up the idea of the possession by the spine of that investing membrane to which, in earlier works, he had ascribed the formative capacity of these organs. This view of the constitution of the Echinid spine is that taken also by Giesbrecht,† whose careful investigation into the minute structure of the teeth of Echinids gives especial value and weight to his opinion; he says, "Das Material, aus welchem der Seeigelzahn, wie auch das ganze Skelett der Echinodermen aufgebaut ist, ist Calciumcarbonat oder vielmehr eine eigenthümliche Mischung desselben mit organischer Substanz."

If this organic substance penetrates the inner parts of the spine, we may regard the cavities, spaces, and canals which are revealed

EXPLANATION OF PLATE XIII.

Fig. 1.—Primary spine of *Goniocidaris florigera* (natural size), to show the form of the spine, and the prickle-like processes on its surface.

Fig. 2.—Transverse sections of the same, showing that the prickles are formed not by the crust only, but also by the cancellated tissue.

Fig. 3.—Transverse section of *Phyllacanthus imperialis*, especially to show the mode of arrangement of the cancellated tissue.

Fig. 4.—Transverse section of *Stephanocidaris bispinosa*, in which, as in figs. 2 and 3, the continuation of the canals into the ostracum is distinctly seen.

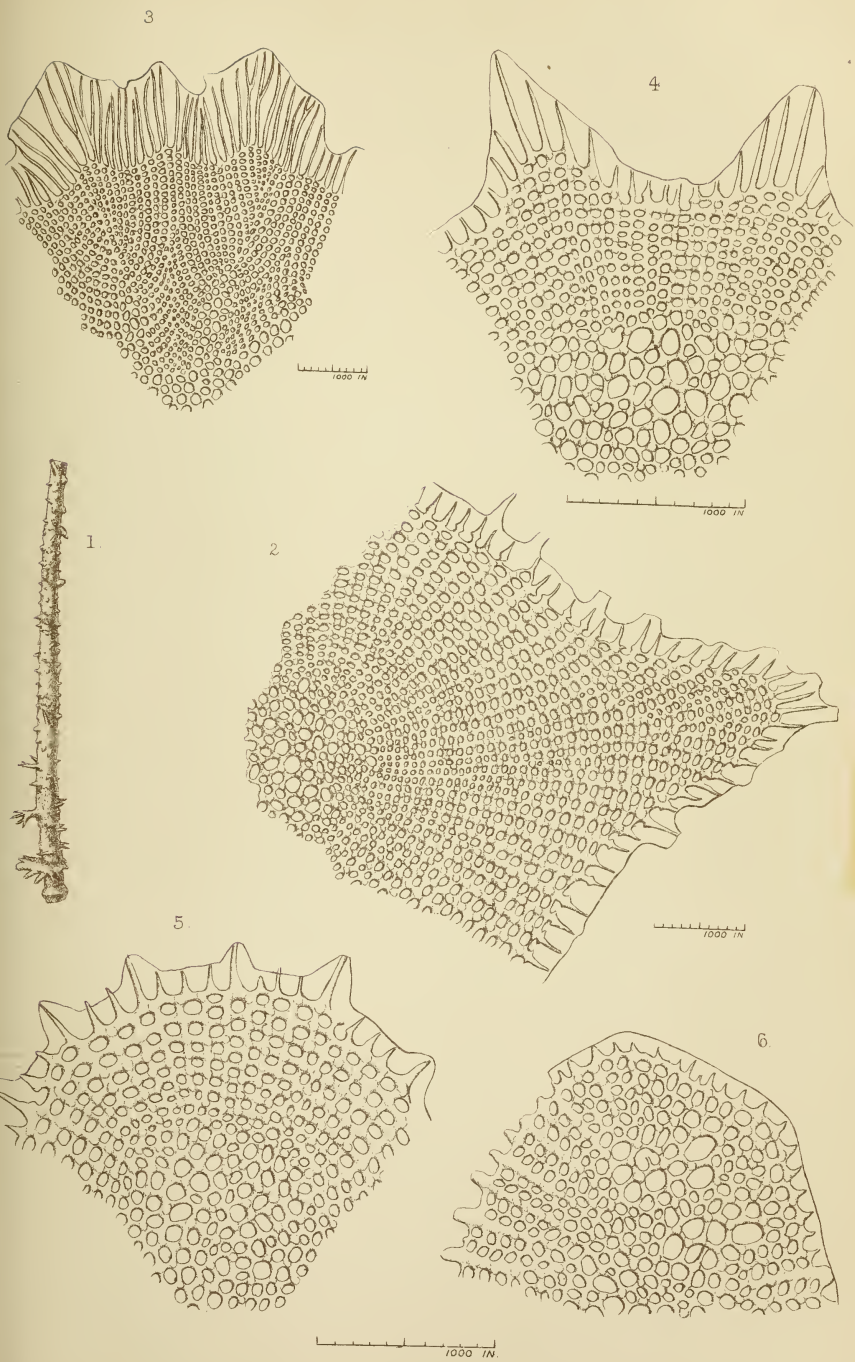
Fig. 5.—Transverse section of *Salenia profundi*, showing its "acanthostracous" characters.

Fig. 6.—Section of tip of spine of *Echinocidaris spatuligera*, to show the mode of distribution of the cap of ostracum.

The scale to which the figures are drawn is shown on the plate.

* Monthly Microscopical Journal, iii. (1870) p. 225.

† Morphol. Jahrbuch, vi. (1880) p. 79.



Berjeau & Highley del et lith.

Mintern Bros. imp.

Transverse Sections of Spines of Cidarida; Salenia & Echinocidaris.

in transverse sections of dried spines as expressions of its distribution during life.*

With these considerations in our minds let us apply ourselves to the spines of Cidarids. They are by no means so constantly regular and cylindrical in this, as in other groups of Echinoids, and are to be at once distinguished histologically by the presence of the ostracum (the Cidaridæ are the *Acanthostraca* of Mackintosh), which is rarely found on the spines of other or non-Cidarid forms.† Thanks, it is said, to the possession of this outer crust, the spines become swollen out into irregular enlargements, or provided with more or less elegant and prominent ridges, or with a broadened free end. The remarkable differences in the forms of the spines have been ascribed to various causes by various writers. By A. Agassiz ('Revision of the Echini,' p. 653) they are said to be due to "the independent growth of the outer sheath; while in other regular Echini the growth of the outer layer takes place uniformly with the increase in size of the spine." This view, I take it, is a modification of that held by Mr. Stewart (Q. J. M. S., xi. p. 52), who is of opinion that the perisome which invests the spine dies down when the outer crust of the spine has been deposited, consequent on the acceptation of Dr. Carpenter's view as to the existence of a permeating protoplasmic substance. As expressed, however, it fails to convey the ideas of the author definitely to the mind, and, if put into other words, such as—the outer portion of a Cidarid spine grows independently of the inner—it gives an idea of the minute structure of these spines, which can hardly be said to agree with the facts.

If evidence be wanting of the close relation of the inner and outer regions of a spine, reference need only be made to the exact figures given by Stewart or Mackintosh; the former (op. cit.) has published a sketch of a transverse section of *Cidaris annulata* (*C. tribuloides*) in which the dense crust is seen to be traversed by delicate tubules continuous with the spaces that lie between the radiating plates that form the greater part of the spine; and the latter ‡ has given us a figure of *Goniocidaris geranoides* which shows, as sections of its spines always do, that some of the radiating spaces between the plates § extend to quite the extreme edge of the periphery of the spine.

* A student at a marine biological laboratory might well repeat and extend Dr. Carpenter's observations (op. cit.). He would, doubtless, derive considerable aid from the copal method of Koch (cf. Zool. Anzeig., i. (1878) p. 36).

† *Salenia* has a true crust (see fig. 5), and *Echinocidaris* has a crust on the tip of some of its spines.

‡ Trans. R. Irish Acad., xxvi. (1878) pl. ix. fig. 9.

§ It is greatly to be regretted that Prof. Mackintosh has followed Prof. Agassiz in applying a term of such definite significance in histology as "cell" to what are "really interspaces or foramina." Neither convenience nor the advan-

It seems then to be quite certain that there is not the distinction between the outer and inner portion of Cidarid spines which Prof. Agassiz appears to have drawn.

Another view taken with regard to the ostracum is that its presence has the effect of terminating the growth of the spine; the evidence that I have to adduce will, I think, lead us to see that this supposition is not well-founded. I do not know whether Dr. Carpenter would express himself now exactly as he did in 1847, but there is no doubt that what he said then has had a very considerable influence in determining the ideas and statements of succeeding writers. In his well-known Report to the British Association on the microscopic structure of shells he says (p. 125), "This much, however, seems certain, that whatever additions these spines may receive in length they cannot be augmented in diameter, this being fixed in the first instance by the production of the solid calcareous cylinder which forms the exterior of the spine."

The observations which I now proceed to describe seem hardly to support the views so clearly expressed by Dr. Carpenter, and suggest rather the idea that the ostracum grows with the rest of the spine, and retains the protoplasmic ground-substance which is found in the rest of the tissue.

1. As it is clearly impossible to make a transverse section of a spine, and afterwards allow it to continue to grow, one has had to be content with comparing a spine of fair size with one that was a good deal larger, and was taken from a *larger specimen;* this last point is one of some importance, as the different spines of one interambulacral area may vary considerably in length in one and the same individual. The larger spine that I took was one to the size and form of which the smaller might have been fairly expected to grow had not its possessor fallen a victim to a collector.

The tips of two such spines of *Cidaris metularia* measured, in transverse section, 1 mm. and 2·6 mm., while the crust, at its thickest, was ·227 mm. in the smaller, and ·4 mm. in the larger specimen. The basal parts of two spines of the same species were 1·3 and 3 mm. in thickness; the crusts respectively ·17 and ·3 mm. Three spines of *Phyllacanthus imperialis*, in which the transverse section was taken at the middle of their length, measured respectively 3, 4, and 4·75 mm., and had a crust of ·3, ·35, and ·5 mm. thick.

It is clear that, on the theory of determinate growth, as Mr. Stewart has called it, the increase in the size of the spine ought to

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tage of similarity of nomenclature can be pleaded in defence of a course which is, really, extremely inconvenient, and, so far as nomenclature is concerned, disturbing, if not revolutionary.

be due to the increase in the thickness of the crust, but our observations show that for *Cidaris metularia* (α) while one-fourth of the diameter of the base is crust in the smaller, only one-fifth is crust in the larger specimen, and (β) that of the tip two-fifths is crust in the smaller, but only one-third in the larger specimen. The growth, therefore, is due more to the internal portion than to the external crust, and, as we obtain the same kind of result with the base as with the tip of the spine, we cannot say that the crust is as thin as it is because it has been worn away, or, at any rate, make that more than a very subsidiary reason for the difference. The varying proportions presented by *Phyllacanthus* offer some difficulties on other scores, but it is abundantly clear that the crust does not become proportionately thicker than the interior.

2. The evidence now collected as to the power of growth of the spine as a whole, is supported by the structural characters of the tips of certain spines which are remarkable for their form. One of these, which is perhaps the most striking, is that of *Goniocidaris florigera*, which are widened out at their free ends and provided along their sides with spinose projections in the way that is shown in pl. XIII. fig. 1. A transverse section of such a spine (fig. 2) shows that the outgrowths have a comparatively thin crust, and that the greater part is formed by exactly the same kind of reticular tissue as that which occupies the greater part of the interior of the spine. Here, at any rate, there is a relation between the characters of the surface of the spine, and the disposition of the tissue covered by the ostracum.

Goniocidaris geranoides, a figure of which has been given by Prof. Mackintosh,* is an example of a spine in which the projections are again distinctly formed by the reticular tissue, and not by a crust that is in any sense amorphous. *Phyllacanthus imperialis* (fig. 3) and to a less extent *P. verticillatus*, afford us examples of spines in which the external contour of the crust is distinctly seen to be dependent on the arrangement of the layer within.

3. Finally, to conclude this line of argument, we observe that in all cases the ostracum is penetrated by spaces which we cannot, from what we now know, look upon as being otherwise than occupied during life by a protoplasmic ground-substance. The continuation of the interspaces into the crust is, of course, better seen in some than in other species; fig. 4 shows the arrangement which obtains in *Stephanocidaris bispinosa*, the structure of the spine of which is now illustrated for the first time.

When we combine the information afforded by the facts and figures now offered, with that which has been acquired by pre-

* Loc. cit.

ceding observers, we are, I think, led to the conclusion that, even in the systematic arrangement of the families of Echinoids, some hints of value are to be obtained from a consideration of the facts of spine-structure; there is, in fact, a kind of continuity in histological structure which is not always apparent in the grosser details.

The Cidaridæ, with the simplest, that is fenestrated,* type of spine structure, have in some cases, though not in all (e. g. *Goniocidaris geranoides*, where it is only scattered) a surrounding ring of thicker crust which, as Mackintosh suggests, prevents the softer internal part from being too rapidly worn away; such a crust is found in the Salenidæ, and at the tip of the spines which in *Echinocidaris* are found in the neighbourhood of the mouth.

The fact that it is found in the Salenidæ is really in favour of the value of spine structure as an aid to the phylogenetic systematist, for *Salenia* does by certain, just as much as it does not by other, characters proclaim its relations to *Cidaris*. Similarly *Echinocidaris* stands nearer to the Cidaridæ than does *Echinus*, and, in that portion of the spine which is most liable to be worn down by friction, the interior layer, which is acanthosphenote rather than as in *Cidaris* fenestrate, tissue, is protected by a crust. (fig. 6.)

The figures of *Salenia profundi* (now for the first time given, fig. 5) will show how, even in *Salenia*, there is a tendency to a regular spoke-like arrangement of the inner layers, and a marked reduction in the fenestrate arrangement. Within the limits of the true Cidaridæ stages in the extent of the fenestration, and the regularity of the spoke-like intermediate layers are to be observed: when combined with the inquiry into the relations of other structural characters, to which I hope soon to be able to devote myself, they will perhaps be found to be of use in determining the minor questions of the limitations and relations of the genera of which that family is composed.

That the term Acanthostraca is not synonymous with the name, or the group denoted by it conterminous with that of the Cidaridæ, is, after all, only another way of saying that it takes note of only one structural character, and it does not really afford any ground for neglecting a study which is full of interest and instruction.

The figures of spines, now given for the first time, will be found to explain themselves to those who are acquainted with what has been already done, especially by Prof. Mackintosh.

* I quite agree with Prof. Mackintosh, who says, "Nor can I agree with Prof. Agassiz that the Cidaridæ present us with the most complicated type of spine structure."

XX.—*Researches on the Structure of the Cell-walls of Diatoms—Eupodiscus.** By Dr. J. H. L. Flögel.

(*Read 12th December*, 1883.)

Amongst the specimens of *Triceratium* received from Herr Möller, *Eupodiscus argus* Ehrenb. is well represented, the structure and sculpturing of which I have endeavoured to determine by sections. Researches were formerly made by Slack (25), who considered the membrane to consist of minute spherules. The different appearances this form presents in reflected light as compared with other diatoms, and which point to quite different sculpture details, have been discussed by J. Deby (2, p. 13). Indeed, the sections confirm this, presenting such a peculiar image that it is difficult to institute a comparison with others. The spine of an *Eupodiscus* valve has been described and figured by O. Müller (15, p. 633, pl. xv., fig. 8). Wells asserts that he has seen irregular depressions on the valve, which are closed by a membrane at the base and divided by lines which are coarse at the edge (29).

I send the photograph of a coarse section, being No. 9 of a series of nineteen sections through a valve, which at the same time contains one of the three spines (photograph 8). Only very indistinctly we see in some places that the mass must consist of nearly symmetrical chambers resembling closely in their general outlines the *Triceratium* chambers. If we compare with this the thinnest sections—I have given a drawing of a portion from such a section in fig. 144—it becomes very difficult to trace the chamber-

Fig. 144.

like spaces. Sometimes I see a delicate line like the vertical wall of a *Triceratium*, but in most instances this line is so darkened by what seems a small granular mass of high refracting power that one loses trace of it. I consider this granular mass to consist of numerous excrescences from the chamber-walls, without however being able to give proof for my assertion. Here then is a new field

* In consequence of omissions in the text this could not be printed in its proper place *ante*, p. 672.

for investigation; above all, it will be necessary to cut specimens that are in process of fission in order to ascertain the appearance presented by the chambers in early development, when probably the confused image of the fully developed state will become comprehensible. The condition of the spine is seen in the photograph; it has a distinct cavity with an air-bubble; but no opening exists as far as I can determine. The continuation looks something like the spines, stiff hairs, &c., of insects, which, as is well known, have no opening at the end.

XXI.—*On some Photographs of Broken Diatom Valves, taken by Lamplight.* By Jacob D. Cox, LL.D., F.R.M.S.

(*Read 12th November*, 1884.)

In a series of articles recently published * I gave the typical examples of numerous observations which I considered to warrant the following conclusions:—

(1) The diatom shell is usually formed of two laminæ, one or both of which may be areolated, and may be strengthened by ribs which have been described both as costæ and as canaliculi. (2) The normal form of the areolæ is a circle, and these when crowded together take an hexagonal and sub-hexagonal form. (3) The areolæ are properly pits or depressions in the inner surface of one of the laminæ, so that when two laminæ are applied together, the exterior surfaces of the shell thus formed are approximately smooth, and the cavities are within. (4) The apparent thickening on the exterior of the lines bounding the areolæ in some species, as *Eupodiscus argus*, &c., is not in contravention of, but is in addition to the formation above described. (5) However fine the dotted marking of diatom valves may be, the evidence from the colour of the spaces between the dots, and of the dots themselves, supports the conclusion that they follow the analogy of the coarser forms in which both fracture and colour are found to prove that the dots are areolæ, and the weaker places in the shell.

I have now sent to the Society, through the courtesy of Mr. Mayall, a parcel of photographs of broken diatom shells made by lamplight. They are intended as a contribution to the evidence as to the structure of the diatom valve, and were prepared under the strong belief that the study of broken specimens has not been followed up with the systematic care which their instructiveness would justify.

In my investigations, extending over a considerable number of years, it has been my habit to mark by the Maltwood finder and enter in my note-books the more suggestive examples of broken valves which I found, and especially such as seemed to throw useful light upon the question of structure. How to make this evidence available was a somewhat troublesome problem; but it is one which recent improvements in dry gelatine plates for photography seem to have solved very happily. Other duties prevented my using the daylight hours for work of this kind, and I was for some time deterred from attempting to photograph by lamplight by the fear

* Amer. Mon. Micr. Journ., v. (1884) pp. 45-9, 66-9, 85-9, 104-9; see this Journal *infra*, p. 943.

that it would not be found available for the high powers I desired to use. Amplifications of from one to two thousand diameters were what I wanted to have at command, and until quite lately it did not seem likely that this could be secured in photography by lamplight.

During the preparation of the articles on diatom structure above referred to, I determined, with some hesitation, to test the usefulness of this method of illustration. Beginning in April, I have made between fifty and sixty negatives of what I have called a "broken shell series," and from which the accompanying set is selected.

The apparatus I use is very simple. It consists of Walmsley's photo-micrographic camera with cone of *papier maché* attached, and a common coal-oil lamp with broad flat wick an inch and a half wide. In selecting a lamp I chose one having a strong draught and good combustion giving an intense white flame. In using it the edge of the flame is turned to the Microscope, as in the resolution of difficult tests. To obtain the desired amplification, even with a 1/15 in. objective, the full extension of the camera bellows is necessary, or the use of an amplifier in the body tube. Without pretending to be sure that my method is the best, I will still say that I have thus far got the best results by using the No. 1 eye-piece in the Microscope, and no other amplifier. It seems to me that after correcting the objective with care so as to present the best results to the eye directly, the satisfactoriness of image which is thus produced is best kept by using both objective and eye-piece in photographing, precisely as in ordinary observation, and with the same length of tube; changing nothing but the fine adjustment to correct the focus for the position of the camera screen. Such, at least, is the conclusion I have tentatively reached.

The thing I have specially aimed at has been to correct the objective by the collar with the utmost care to procure sharp definition of the broken edges of the valves, and to reduce the diffraction as much as possible, also, by this means and by the manipulation of the light. After patient experimenting to secure this, I place the tube in a horizontal position and attach it to the camera with as little change of conditions as may be. I use an achromatic condenser which is a slight modification of a Kellner eye-piece, with violet blue modifier and a variety of movable diaphragms and stops at the back. These were not specially provided for photography, but being such as I am in the habit of using in actual investigations, I have, on the principle before stated, continued their use with the camera.

With the exception of one or two negatives, my photographs

have been made with light strictly central; for I have sought to secure dioptric images and to avoid diffraction ones as far as possible. From the list of the photographs it will be seen that the objects have been mounted, some of them dry, some in balsam, and some in the very dense medium of Prof. H. L. Smith. Whilst both the denser medium and the dry mounts have their advantages for purposes such as the resolution of lined surfaces by oblique light, it should be remembered that by the exaggerated contrast in the refractive power of the object and the medium, the prismatic effect of a broken edge is increased. This exaggerated refraction and accompanying diffraction interferes more or less with the true presentation of such a marginal broken line. At first sight it seems much stronger and bolder, and what is coarsely presented is much more easily photographed; but my experience leads me to the opinion that the most truthful presentation of the details is given when the difference in the refractive indices of object and medium is as small as is consistent with the discrimination of the object. The image will, of course, be much fainter, but I find it also more delicately exact and of a better quality. Up to the limit of good definition in balsam, therefore, I prefer to use mounts in this medium, and the result seems to be worth the extra care and nicety required in all parts of the manipulation.

It will be seen from the description of the plates that the exposure of the sensitive film was not always in proportion to the amplification. The greater the difference in refractive index, the more quickly is a negative taken, for reasons already hinted at. The dry mounts and those in Prof. Smith's medium were therefore photographed more quickly than the balsam mounts. Within moderate limits, however, the amplification was varied whilst the time of exposure and the medium remained the same. The plates so taken were not of the same density, but the only important resulting difference was that the denser plates printed more slowly. Again, it is difficult, if not impossible, to manipulate the light so as to make it entirely uniform on different evenings. The lamp may be trimmed a little differently, the state of the atmosphere may affect it, or the plates themselves may not be exactly alike. There will therefore be, at last, room for the exercise of judgment based upon experience in determining the exposure to be given, and one must expect to spoil a plate occasionally.

I will only add that it has been a fixed rule with me to leave the photograph untouched. Any "stopping out," stippling, or retouching in any of the forms known to practical photographers, must, in my opinion, greatly diminish the value of a photograph for scientific purposes by introducing more or less of personal interpretation.

So much as to methods. The facts in structure of which the photographs are evidence, are these:—

1. The character of the costæ in *Navicula major* (*Pinnularia* W. Sm.).

2. The existence of films of silex above and below the large hexagonal cells in *Triceratium favus*, *Coscinodiscus oculus-iridis*, and *Heliopelta*.

3. That the "dots" of the diatoms are areolæ as shown by the fractured edges of a considerable series of examples, ranging from the coarsest to *Pleurosigma angulatum* inclusive.

I do not mean to repeat here the discussion of the subject, but only to present the photographs as illustrative of what I have said in the series of articles which has been mentioned.

The list of the prints which make up this shorter series of "broken shells" is as follows, viz.

No. 5. *Nitzschia scalaris*, and *Navicula sculpta* Ehr. × 650, exposure 6½ minutes. Fracture through rows of dots between the costæ in the *Nitzschia*, and through the irregular rows nearly parallel to the margin in the *Navicula*. From Möller's balsam mount of Södertelge mud (Sweden).

No. 6. *Epithemia turgida* Kütz. × 760, exposure 6½ minutes. Showing sub-rectangular reticulation at broken edge. From same slide as the last.

No. 7. *Navicula lyra* Ehr. × 700, exposure 6½ minutes. Showing fracture through radial row of dots between costæ, and through the dots on the broken edge. From Möller's balsam mount of Samoa sea-mud.

No. 10. *Navicula maculata* Edwards. × 1120, exposure 6½ minutes. Similar fracture to the last. From H. L. Smith's mount of Mobile Bay diatoms in dense medium; ref. index 2·4.

No. 11. *Odontodiscus subtilis* Ehr. × 1375, exposure 10 minutes. Showing wedge-shaped segment broken out, the fracture being through the rows of dots. From Möller's balsam mount of Wedel sea-mud.

No. 14. *Coscinodiscus obscurus* A. Schmidt, × 950, exposure 6½ minutes. Showing close hexagonal and loose circular areolation in same shell. From Möller's balsam mount of Nottingham earth.

No. 17. Same as No. 5. × 960, exposure 6½ minutes.

No. 20. *Odontodiscus subtilis* Ehr. × 1320, exposure 6½ minutes. Showing a radial crack through a row of dots. From same slide as No. 11.

No. 21. *Coscinodiscus oculus-iridis* Ehr. × 1600, exposure 9 minutes. Showing dotted film covering the large hexagonal areolæ and projecting beyond the walls of these. From Möller's balsam mount of Nottingham earth.

No. 22. Same as last, but taken with light a little oblique.

Exposure 12 minutes and plate afterwards intensified with merc. bi-chlor.

No. 23. Another specimen of same, showing group of large central cells with dotted film. × 1600, exposure 14 minutes.

No. 24. *Navicula granulata* Brebisson. × 950, exposure 9 minutes. Showing several fractures through the dots. From H. L. Smith's *species typica* in balsam.

No. 25. *Odontodiscus subtilis* Ehr. × 1100, exposure 14 minutes. Showing crack nearly parallel to the rim and running through the dots. From the same slide as No. 11.

No. 26. *Triceratium favus* Ehr. × 1333, exposure 10 minutes. A fragment showing film with radiating dots over the large hexagons. Dense medium (2·4). Same slide as No. 10.

No. 27. *Actinoptychus Heliopelta* Grunow. × 940, exposure 7 minutes. Showing finely dotted film extending far beyond the large hexagons, and the fracture through the fine dots. From Peticolas' balsam mount of Calvert Co. earth (Maryland).

No. 28. *Coscinodiscus oculus-iridis* Ehr. × 900, exposure 7 minutes. A fragment of the inner film, showing the "eye-spots." From same slide as the last.

No. 29. Same as 28 with slightly different focus.

No. 31. *Pinnularia major* W. Sm. × 870, exposure 6½ minutes. Showing costæ standing out like the teeth of a comb, the thin connecting film being mostly removed. From H. L. Smith's slide of *Nav. rhomboides* in dense medium (2·4).

No. 35. *Navicula granulata* Breb. × 1000, exposure 5½ minutes. Showing fractured margin, the break being through the dots. From H. L. Smith's *species typica*, dry.

No. 38. *Navicula serians* Kutz. × 1130, exposure 10 minutes. Showing fracture through the dots. From Moller's balsam mount of Monmouth earth (Maine).

No. 39. *Pleurosigma angulatum* W. Sm. × 1250, exposure 13 minutes. Showing marginal fracture through the dots. From Peticolas' balsam mount of Calvert Co. earth (Maryland).

No. 41. *Mastogloia angulata* Grunow. × 1015, exposure 10 minutes. Showing segment broken out with fracture through the dots and along the median line. From Peticolas' balsam mount of diatoms from Long Island Sound.

No. 44. Same species, × 1040, exposure 6 minutes. The septum separated from the valves. From Peticolas' dry mount of diatoms from Long Island Sound.

No. 46. *Pleurosigma angulatum* W. Sm. × 1250, exposure 7½ minutes. Showing marginal fracture through dots, and same on the surface where the shell has been crushed. From Peticolas' dry mount of Nottingham earth (Maryland).

No. 47. *Coscinodiscus subtilis* Ehr. var. *molaris* C. × 1130,

exposure 10 minutes. Showing crack through the dots. From Peticolas' balsam mount of Richmond earth (Virginia).

No. 50. Same as 46. × 1350, exposure 10 minutes and plate afterwards intensified with merc. bi-chlor.

No. 51. *Mastogloia angulata*, Grunow. × 1314, exposure 8 minutes and plate afterwards intensified. One side broken away, showing fracture through dots. From Peticolas' dry mount of diatoms from Long Island Sound.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Physiology of Protoplasmic Movement.†—A. G. Bourne has done considerable service to English biologists by translating Prof. Engelmann's important essay on the physiology of protoplasmic movement. Like muscular and ciliary movements, those of living protoplasm are to be regarded as phenomena of contractility. Their special character is "that the particles of the contractile mass move, as a rule, not in relation to any fixed position of equilibrium, but can change their arrangement and position (and this apparently voluntarily) as do the moving particles of a fluid substance. Further, the impulse to such movements does not normally come from without, but originates in the moving particles themselves." Protoplasm thus possesses, not only contractility and irritability, but also automatism.

Protoplasm may be doubly refractive, and different parts of a single mass may have different refractive powers. It varies in the degree of its fluidity, has great cohesive and great extensile powers, and has a tendency to form droplets; but these properties vary considerably. So again the contained granules vary in number, and, while most are albuminous, some are fatty and others inorganic. There is no chemical distinction between contractile and non-contractile protoplasm.

In the movements of naked protoplasm three chief types are to be distinguished—amœboid, streaming, and gliding. The first may be very well studied in the plasmodium of *Myxomycetes*, where the masses are large and the movements extremely rapid. When the

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Quart. Journ. Micr. Sci., xxiv. (1884) pp. 370-418.

protoplasm is bounded by finer integuments, as in ordinary vegetable cells, we have circulation or rotation.

Under the head of "General Conditions of Spontaneous Protoplasmic Movements" there are discussed the influences of (1) temperature. The optimum temperature—or that in which the movement attains its highest velocity—is generally several degrees lower than the maximum temperature compatible with movement. While great heat is certainly fatal, protoplasm even after freezing does, in certain cases, resume its spontaneous contractions; and it is not necessary that the thawing should take place very gradually. (2) The imbibition of water has effects similar to that of temperature. There is a maximum and minimum at which spontaneous movements stop, and there is always an optimum. There may be a dry rigor, due to the withdrawal of water by indifferent or diluted solutions. In many cases the slow increase of concentration is accompanied by an accommodation of the protoplasm to the solutions. (3) Without oxygen spontaneous movements can never go on for more than some hours at the most. It is clear that living protoplasm enters into chemical union with the surrounding media, and the oxygen thus taken up is probably used for the formation of carbonic acid. (4) Poisons are next dealt with, and diluted alkalies or acids proved to be injurious. Carbonic acid, ether, or chloroform cause temporary or permanent coagulations. Like the contractile substance of muscular fibres, many kinds of protoplasm are poisoned by veratrin.

Artificial stimuli are dealt with as (1) electrical, (2) thermal, (3) luminous, (4) mechanical, and (5) chemical.

"No theory of protoplasmic movements, leading back to their elementary physical and chemical processes, can be deduced from the hitherto collected facts." As we must start with the acknowledged fact that "each smallest microscopically distinguishable particle of every contractile protoplasmic mass is capable of independent movements," it follows that "the movement as a whole is the result of changes of form of these very small elements," the nature and cause of these being provisionally undetermined. There is no reason for supposing that what we can see with the Microscope are the contractile elements themselves; these are, doubtless, molecular in size, in form spherical when excited, and elongated when not so; these hypothetical contractile elements may be called "Inotagmata." Spheres of naked protoplasm appear after excitation, and this may be explained by the simultaneous assumption of a spherical form by the inotagmata; the protrusion of processes may be imagined as due to the relaxation (lengthening) of parts of a protoplasmic mass; rotation takes place when the inotagmata of the moving layers are distributed "with their long axes parallel to the direction of the movement and a forward movement of the spontaneous stimulus takes place in this direction. The moving protoplasm creeps in this manner over the motionless cortical layer just as a snail's foot over the surface upon which it is crawling."

The author throws out some hints for further investigations into the mechanism of the changes in form of the smallest component

particles; from what we know of muscles and cilia we may assume that the proximate cause of the change of form of inotagmata is a change of their water-contents; so that the cause of contraction is a peculiar process of swelling. The further analysis of the mechanism is a question for the physicist, and the chemist must consider the problem of how the change in the water-contents of inotagmata are occasioned. "It is, however, in the present state of our knowledge, idle to express any further opinions upon the subject."

Power of Reducing Silver possessed by Animal Protoplasm.*—Dr. O. Loew in conjunction with Dr. Th. Bokorny having already shown that living vegetable protoplasm has the property of reducing silver, now extends these observations to animal protoplasm.

The excised kidneys of frogs and toads were placed in 50–100 cm. of a particular silver solution described by the author, with the ventral side upwards; after being kept in the dark for fifteen minutes it was found that the ventral surface of the gland was traversed by black lines; after a sojourn of two hours in the solution the colour was intensified and more of the kidney affected; this most striking reaction can be only seen in the living condition. It is impossible, however, to extract from the kidneys any reducing substance, though it is clear from the following experiment that such a substance must exist; the urine of six frogs was extracted by means of a pipette and placed in the dark for twelve hours with some of the silver solution; at the end of this time a number of grey specks were observed at the bottom of the vessel; these were collected and treated with ammonia, and dissolved; they imparted to the solution a dark opalescent colour as if proceeding from a feeble reduction.

In *Spirogyra*, however, where the reaction is extraordinarily intense, it could be shown by direct experiment that the oxygen of the reduced silver oxide was taken up by the albumen.

Fœtus of Gorilla.†—J. Deniker describes a fœtus of the gorilla in the fifth month. In almost every respect it approaches closely to the form of the human fœtus at the same age. The hand differs from that of the adult gorilla by the greater proportionate length of the fingers. The leg is cylindrical, without the projection of the calf evident in the human fœtus. The cephalic index is 86·2.

Influence of Magnetism on the Development of the Embryo.‡—Prof. C. Maggiorani, during the process of artificial incubation, exposed a number of eggs to the influence of powerful magnets. A similar set of eggs, being hatched in the same manner, but kept away from all magnetic action, served as a check. Cases of arrested development were four times more numerous in the first group than in the second. Microscopical examination showed that the sterilization of the germs was probably due to an intense vascularization of the yolk-sac.

* Pflüger's Arch. f. d. gesammt. Physiol., xxxiv. (1884) pp. 596–601.

† Comptes Rendus, xcviii. (1884) pp. 753–6.

‡ Atti R. Accad. Lincei, Trans., viii. (1884) pp. 274–9. Cf. Journ. of Science, vi. (1884) pp. 600–1.

After the birth of the chickens, this increased mortality continued, deaths being three times more numerous in the magnetized group. All the counter-test chickens reached their full development, whilst of the 114 of the first group, 60 presented notable imperfections. Their movements were also abnormal. There were three cases of paralysis and two of contractions.

Six of the chickens arrived at maturity. Of these, two were cocks of a splendid stature, and endowed with an insatiable reproductive appetite. With the four pullets it was quite the contrary. One of them never laid at all, and the three others generally produced merely minute eggs (the heaviest weighing only 30 grms.), without yolks, without germinal spot, and in a word sterile.

The magnetic influence upon the embryo is therefore evident, and its action upon the structure and the functions of the germ is still manifest when the latter has arrived at maturity.

"May we not, to explain this effect of the magnets, suppose an interference between the magnetic vibrations and the heat vibrations which animate the molecules of the fecundated germ, and impel them towards a new condition of organic equilibrium. This influence generally prevents, and more rarely retards, the development of the embryos (hypertrophy in the two cocks, and atrophy in the four hens), and, as interference implies analogy, may we not infer that the vibrations which impel the germ towards its development are analogous to the magnetic vibrations."

Blastopore of the Newt.*—Miss A. Johnson has, at Mr. Sedgwick's suggestion, investigated and confirmed the correctness of his supposition that the blastopore of the newt (*Triton cristatus*) does not close, but persists as the anus. While the medullary folds are wide apart, the slightly elongated blastopore is found at the hinder end of the body; it then becomes carried round to the ventral surface, and when the folds have completely coalesced, it is placed at some little distance from the hind end of the body. This blastopore is found, on making transverse sections, to communicate with a cavity in the midst of the yolk-cells, which cavity is so narrow that it is difficult to see its connection with the middle part of the gut. Behind the blastopore there is a primitive streak, which is exactly comparable with that of the Amniota; there is no neurenteric canal; the blastopore marks the extreme front end of the primitive streak on the ventral surface. The hinder part of the medullary canal is solid near its point of fusion with the primitive streak, and its lumen is gradually continued back as the medullary canal is differentiated out of the primitive streak; the relation, in fact, is just the same as in birds.

Natural and Artificial Fertilization of Herring Ova.†—Prof. J. Cossar Ewart gives a detailed account of what was previously known of the spawning of the herring and of his examination of the spawning-beds in the Moray Firth, with the following observations of the

* Proc. Roy. Soc., xxxvii. (1884) pp. 65-6.
† Ibid., xxxvi. (1884) pp. 450-61.

process of spawning under natural conditions made at the tanks in the Rothsay Aquarium.

A perfectly ripe female set free in one of the tanks was in a few minutes noticed moving slowly quite close to the bottom of the tank, with four other fish making circles around her at some distance from the bottom. Appearing satisfied with some stones which she had been examining, she halted over them, and remained stationary a few minutes about 1/2 in. from their surface, the tail being in a straight line with the trunk and the pectoral fins near or resting on the bottom. While in this position, a thin beaded ribbon was seen to escape from the genital aperture and fall in graceful curves so as to form a slightly conical mass. As the little heap of eggs increased, the males continued circling round the spawning female at various distances, while the other females in the tank remained apart. The males kept from 8 to 10 in. above the bottom of the tank, and formed circles ranging from 18 to 30 in. in diameter, with a peculiar jerking motion of the tail as they performed their revolutions. Three or four times during each revolution each fish expelled a small white ribbon of milt, which fell slowly through the water, sometimes reaching the bottom almost undiminished in size, but in most instances they had almost completely dispersed before reaching the bottom. In this way the whole of the water about the female became of a faint milky colour, and practically every drop of it was charged with sperms. Thus there is no attempt on the part of the males to fertilize the eggs as they escape from the female, but only to fertilize the water in the neighbourhood. By forming circles round the female it does not matter how the currents are running.

Various experiments were tried to bring about an artificial fertilization of herring ova, but the best results were obtained when both male and female were held under water while the milt and roe escaped, i. e. when the natural process of spawning was followed.

Development of Pelagic Fish-Eggs.*—A. Agassiz and C. O. Whitman report that they are now able to distinguish twenty-two species of pelagic eggs, which it had before been difficult to know from one another on account of their great resemblances. It has, however, been found that the pigment spots on the surface of the yolk begin to make their appearance at very different times in different species, and there is a characteristic pigment-pattern. The eggs of six species of flounders, two species of *Cottus*, of *Ctenolabrus*, *Tautoga*, *Osmerus*, and *Lophius* have been recognized. The number of eggs is very great, but the spawning seasons are comparatively short.

As, in passing from 16-cells to the 32-cell stage, the central portion of the blastodisc becomes two cells deep, it is extremely difficult to follow out the genesis of the individual cells in the living egg.

With regard to their methods the authors state that the successive phases of cleavage were first followed many times in the living egg; profile views and optical sections were obtained by tilting the Micro-

* Proc. Amer. Acad. Arts and Sci., xx. (1884) pp. 23-75 (1 pl.).

scope; "two complete series of vertical optical sections were obtained by the camera lucida, one parallel with the longer, the other with the shorter axis of the blastodisc." None of the ordinary hardening fluids were found to be successful; Kleinenberg's picro-sulphuric acid causes the cleavage products to swell, and in many cases to become completely disorganized. The best preparations of cleavage-stages were obtained with osmic acid, followed by a modified form of Merkel's fluid, 1 per cent. instead of ·25 per cent. of chromic acid being used; the eggs must be first killed by a weak solution of osmic acid. When treated with alcohol, previous to cutting sections, the egg-membrane should be broken or perforated.

The teleostean ovum affords a beautiful illustration of what Lankester has called "precocious segregation"; the mature egg is characterized by a very marked polar differentiation. The generalization of Mark that the maturation spindle always lies in the axis of the ovum may be carried further, and we may say that "it is highly probable that the first cleavage-spindle invariably lies at right angles to the axis of the ovum throughout the Metazoa; and that therefore the first cleavage-plane is always a meridian plane." The authors discuss the apparent exceptions to this law that result from the observations of other embryologists.

With regard to the observations lately made by Pflüger on the influence of gravitation, it is stated that, if an ovum be turned upside down immediately after the appearance of the second cleavage, the position of the third was not affected, as it was if the inversion was effected an hour or more before the beginning of the first cleavage; the deduction made from this is that there is a corresponding internal transposition of the active protoplasmic matrix of the ovum.

Comparing the teleostean ovum with that of the frog, the authors say "the central portion of the blastodisc represents the active portion of the pigmented hemisphere of the frog's ovum; while the marginal portion of the disk, together with the periblast ["parablast" of His], represents the active portion of the unpigmented hemisphere." The first cleavage-amphiaster was found to have a horizontal position, at right angles to the ovum.

The authors enter into some details with regard to the velocity of cleavage, and state that the early cleavages are all introduced by grooves running from the inner towards the outer surface of the blastodisc. No discussion of the nature of the nuclei is entered into, and the authors refrain from selecting any one of these possible hypotheses as to the seat of the attractive power of that region of the egg; that is, namely, whether it resides in the nuclei, in a special portion of the protoplasm intimately associated with the nuclei in the process of division, or in both. Some of the accounts given by Hoffmann are closely criticized.

The origin of the endoderm has been variously described as being from the periblast, or from delamination or invagination of the margin of the blastodisc; the authors state that they have positive proof of a centripetal ingrowth of cells from the margin of the disk; they hope to show that, contrary to the opinion of Balfour, the development of

the amphibian and elasmobranch ova furnishes nothing incompatible with this fact.

Agreement is expressed with His and Rauber in the conclusions as to the nature of the process by which the embryonic ring becomes converted into the embryo; the median plane of the embryo appears almost certainly to coincide with the first plane of cleavage. The authors think with Balfour that the neural surface is identical throughout the Metazoa. A full memoir is promised.

Cell-Division, the Relation of its Direction to Gravity and other Forces.*—E. Pflüger has recently extended his observations on the influence of various forces on the direction in which cells divide, with especial reference to the ova of Batrachia. An ovum may be regarded as a bladder filled with a fluid not uniform in consistency. The granular portions tend, under the influence of gravity, to sink, whilst the specifically lighter nucleus floats in the lighter fluid towards the upper surface. The form of the ovum, acted upon by gravity alone, will be somewhat flattened vertically, the shortest (or vertical) diameter being the "symmetric axis" which does not coincide with the primary ("non-asymmetric") axis of the ovum. The karyokinetic figures of the nucleus consist of a rearrangement of the nuclear network in a direction at right angles to the symmetric axis. Pflüger concludes that this rearrangement is in the direction of least resistance, as being entirely in the lighter non-granular portion of the cell-contents. Vertical rearrangement would have to thrust aside the heavier granular portion lying inferiorly.

To verify this view, Pflüger compressed ova between two glass plates so as to assume the form of strongly flattened ellipsoids. In 80 to 90 per cent. such ova divided after showing vertical karyokinetic spindles parallel to the surface of the glass. This result follows because the thinner and lighter fluid at the top has a greater vertical extension and the influence of gravity is no longer exerted at a disadvantage. In fact, the direction of least resistance is now vertical.

The conclusion is that under the influence of gravity, pressure, or other forces, the dividing cell rearranges its elements preparatory to division in that direction in which it meets with least resistance. On the other hand, W. Roux † and G. Born ‡ have separately come to the conclusion that Pflüger's view is not justified by facts. Roux, working with frogs' eggs, used a centrifugal apparatus and found that, whether the centrifugal force were stronger or weaker than the force of gravity, cell-division took place uniformly in the same direction, invagination occurring always on the border of the (heavier) white hemisphere and of the (lighter) dark hemisphere. Consequently, "the force of gravity is not indispensably necessary to normal development, and it has no necessary directive influence on the

* Pflüger's Arch. f. d. gesammt. Physiol., xxxiv. (1884) pp. 607–16. Cf. Naturforscher, xvii. (1884) pp. 372–4.

† Breslauer Aerztl. Zeitschr., 1884, No. 6.

‡ Ibid., No. 8.

developing ovum, occasioning its differentiation. The formal development of the impregnated ovum is a process of complete self-differentiation." Born's inquiry had a different character, and dealt with the morphological side of the problem. Pflüger had found that ova of *Rana esculenta*, if placed with the white tract superior, did not divide. Born, on the other hand, found that in the ova (of *Rana fusca*) with the white tract superior, that tract did not retain its initial position, but either entirely or in great part dipped downwards to a sub-equatorial level when cleavage commenced. In such cases cleavage commenced on whatever happened to be the uppermost side of the ovum, though not without exception. Born concludes that the question is one of indirect influence of the force of gravity acting by virtue of the characteristic arrangement and disposition of constituent parts of the ovum with their varying specific weights.

Aspects of the Body in Vertebrates and Arthropods.*—The essay of A. S. Packard is a result of Sir Richard Owen's recent study on the "Aspects of the Body in Vertebrates and Invertebrates"; its special object is to present facts against the presumed homology between Arthropods and Vertebrates. It is pointed out that histological differences are to be detected in the presence of the dotted ("myeloid") substance in Arthropod brains, and its absence from those of the Vertebrata. As to "histological topography," the ganglion-cells are internal in the Vertebrate, cortical in the Arthropod; in the latter the ganglia are at first wholly formed of spherical cells, while the differentiation into round central cells and cortical white substance is much more early effected in the former. Indeed, in no way does embryology support the doctrine of the homology of the nervous system of these two groups; and the embryos themselves are in opposite positions. The characters of the investments are altogether different.

The author regards the original dispute between Cuvier and St. Hilaire as being in part metaphysical, and he looks upon questions of this kind as savouring more of scholasticism than of science.

B. INVERTEBRATA.

Function of Chlorophyll in Animals.†—L. von Graff, dissatisfied with the conclusions of Brandt as to the symbiotic relations of what the latter regards as green algæ to *Hydra viridis*, and with the methods of his experiments, arranged three specimens of *H. viridis* in eight different vessels; four of them, A, B, E, and F, he exposed to the light; A, B, C, and D were filled with water from an aquarium. In E–G the water was filtered. In A, C, E, and G the water was changed daily, in the others it was never changed at all. The first *Hydra* to die was one in glass G, on the 31st day of exposure, in which the filtered water was changed daily, and the light shut off. The glass A did not lose a specimen till the 109th day of observation,

* Amer. Natural., xviii. (1884) pp. 855–61, and Ann. and Mag. Nat. Hist., xiv. (1884) pp. 243–9.

† Zool. Anzeig., vii. (1884) pp. 520–7.

when one died. In C, in which the aquarium water was changed daily, and light shut off, the three specimens died on the 105th, 106th, and 109th days; B, in which the water was not changed, and which was exposed to the light, only lost one specimen, and that on the 100th day.

Dr. Graff concludes that the algæ or pseudo-chlorophyll bodies of *Hydra* have no significance as means of nutrition; the fact that all the specimens in filtered water died by the 87th day seems to show that the *Hydræ* died from the want of animal food, and that the green bodies do not serve as such, as Brandt supposes. The most unexpected and perhaps the most remarkable fact is that, whether the *Hydræ* were exposed to the light or placed in the dark, they in all cases retained their green colour throughout life.

Dr. Graff has lately been able to make some observations on the rare *Mesostoma viridatum*, three out of five examples of which were richly provided with chlorophyll-corpuscles; these varied very considerably in size, and no nucleus was to be detected in the smaller specimens; starch granules of proportionate size to that of the chlorophyll-bodies were found in them. The larger green bodies were arranged in closed groups, and the smaller examples lay between the groups; most of the bodies were rounded, but a few of the larger were oval.

Action of High Pressures on Putrefaction and on the Vitality of Micro-organisms.*—A. Certes has endeavoured to solve the problem which he has already touched upon,† as to the processes and conditions by which organic matter is restored to the inorganic condition at the bottom of the sea.

In his experiments he endeavoured, as far as possible, to keep to the conditions of nature, and by a special arrangement succeeded in avoiding sudden changes in pressure. The greater number of the experiments were made at 350 to 500 atmospheres, which corresponds to the pressure of the average depths registered in the 'Travailleur' and 'Talisman' expeditions. Owing to the warmth of the season the author was not able to repeat his experiments at the mean temperature, of great depths, + 4° C., but he is able to assert that the phenomena of putrefaction are invariably produced in infusions of very different kinds, which he cultivated under pressure. In all of them, after a certain time, the liquid becomes cloudy, the organic substances, animal or vegetable, disappear, and microscopical examination reveals an abundant development of microbes. This development is, however, slower than in the open air.

The author points out certain peculiarities arising from comparative experiments—for instance, on the 13th of June two tubes with a vegetable infusion in fresh sea water were put, the one under a pressure of 350 atmospheres, the other left in the air served for control. The apparatus was inspected every day, and the pressure

* Comptes Rendus, xcix. (1884) pp. 385–8.

† See this Journal, *ante*, p. 347 (2nd note). The footnote ‡ should have contained a reference to Comptes Rendus, xcviii. (1884) p. 690.

was at first 350 atmospheres, and at the end 500. From the 26th of June the infusion swarmed with bacteria ; a further examination on the 4th and 11th of July gave the same result. The experiment was stopped on the 24th of July, the day on which the putrefaction of the vegetable tissues was complete in the control tube. This tube contained nothing but liquid and a whitish pellicle.

The tube kept under a pressure of 350 to 500 atmospheres for forty-two days, presented the same appearance, but a closer examination showed striking differences :—

Infusion under pressure.	*Infusion left in air.*
No smell, acid reaction, numerous microbes, active, generally small; rods, short and fine, with forms resembling those already described.	Nauseous odour, alkaline reaction, numerous microbes, some active, others motionless; rods generally larger than in the other infusion ; long bacteridian filaments.
No special coloration by iodine.	No special coloration by iodine. Fusiform cells (yeast or mould?) Infusoria. *Pleuronema chrysalis.*

Of two tubes heated for ten minutes in a water-bath, at boiling point, one containing the liquid of the infusion under pressure, and another with the liquid of the infusion left in the air, the former was found sterile, while the latter gave abundant cultures on the following day. It therefore appears that in the greater number of cases both the chemical processes, and perhaps also the microscopic agents of putrefaction differ according as it is produced in the open air or under pressure. However this may be, the fact of the complete destruction of the organic matter by microbes which live under high pressures is, the author considers, formally established.

It is much more difficult to know what is the degree of resistance to high pressures presented by the higher microscopic organisms: infusoria, unicellular algæ, rotifers, &c. The privation of light and the progressive diminution of oxygen are so many causes of death added to the abnormal pressure. The author has, however, as already stated,* taken living Infusoria and even Rotifers and Tardigrades from the apparatus, after they have been subjected during 24, 48, and 72 hours to pressures of from 300 to 500 atmospheres. But, on the other hand, in tubes kept at a lower pressure for a much longer time there was nothing living except the microbes. Was not this result owing in great measure to the absence of oxygen ?

To satisfy himself on this head he prepared two tubes with the same infusion and put each under a pressure of 350 atmospheres, the one with a reservoir of abundant air, the other without any air. At the end of twenty-one days the aërated tube still contained a number of *Chlamydococcus pluvialis* alive and active. They were all dead in the other tube, and with the exception of the microbes, neither tube contained any other living organisms. To appreciate these facts at their full value it must not be forgotten that *Chlamydococcus* is renascent, and that it encysts itself for protection from atmospheric disturbances.

* See this Journal, *ante*, p. 547 (1st note).

Mollusca.

Operculum, and Foot-glands of Gastropoda.*—F. Houssay finds it necessary to distinguish the suprapedal from the other glands of the foot, on account of the position of their orifice, their own position, and the great complexity of structure to which they may attain. The rest, though less highly developed, are more interesting from the point of view of homology; they are typically formed of three portions, the transverse groove, the median canal, and the folded cavity, which opens on the middle of the ventral surface of the foot. By their structure, and sometimes also by their function, they are to be compared to the byssus-glands of the Lamellibranchiata; although in the latter the glands are better developed, yet they have no important additional parts. In the Lamellibranch, the glandular apparatus of the foot is essentially made up of a longitudinal ventral groove, into which there opens anteriorly a longitudinal canal which may be branched, and which stops before it reaches the byssal cavity. The interior of the foot contains a well-developed gland which uninterruptedly surrounds the small longitudinal canal, and the folded cavity. The byssus-gland appears to be formed by the union of the glands which surround the two organs, and this union may be regarded as due to the great development of these parts.

The author suggests as objections (1) that the longitudinal canal of the Gastropoda opens into the most anterior part of the foot, while in the Lamellibranchiata it opens much lower down: (2) that the canal is branched in Lamellibranchs, but simple in Gastropods: (3) that the secretions of the glands are too different to be comparable one with the other; and (4) that the transverse groove of the foot of Gastropods is suppressed and a longitudinal groove added on, in the Lamellibranch.

To these objections there seem to be the following answers:—(1) The long canal of Gastropods has an upper lip of a certain thickness; it is probable that, in Lamellibranchs, this lip has become considerably developed, or has formed the anterior portion of their foot. It is now known that this region is very generally formed of a mass of mucous glands, which are analogous, if not identical, with those which surround the transverse groove in Gastropods; these cells have not lost their muciparous function and they take no part in the formation of the byssus. (2) The reason why the canal is branched in one case and not in the other, is to be found in the fact that one has a gland much better developed than the other. (3) The difference in the secretions is no real objection; there is no greater difference between glands which secrete mucus or chitin, and those that produce chitinous or calcareous matter; and the latter obtains in the case of the byssus-apparatus. In some cases, indeed (*Venus decussata*) the byssus-gland does produce mucus. (4) There is a small transverse groove, or the representative of it, in the foot of Lamellibranchs, and the addition of a longitudinal groove is to be correlated with the greater development of the gland and its new function.

* Arch. Zool. Expér. et Gén., ii. (1884) pp. 171–288 (8 pls.).

Put shortly, the author's views are that the operculum of Gastropods is not the homologue, either of the second valve of the shell, as was thought by Gray, or the byssus of the Lamellibranchiata; it is a special production. The operculum is a calcified or horny production of the epithelium; the byssus that of a special gland. The pedal gland is, on the other hand, the homologue of the byssus-gland.

The author enters in great detail into the account of the structure of the operculum and the foot, in a number of selected types of Gastropods.

Latent Period in the Muscles of Helix.*—H. de Varigny here confines himself to an account of his observations on *Helix pomatia*, which he has studied by the aid of induced currents, applied to the two ends of the muscle of the foot. The period of latent excitation is remarkably long, and varies from 0·1 to 0·6 of a second; the period of contraction lasts much longer than in Vertebrates, and that of relaxation may extend over several minutes.

The extreme instability of equilibrium in the muscle is the next point to be noted; in other words, after removing a foot from the rest of the body of the snail one may have to wait two or three hours before it ceases to be excited by any external agent; a truly stable state is only reached when the muscle is quite or nearly dead. It is almost impossible to experiment twice successively on the same muscle in the same state; and it is quite impossible to experiment on one that has reached its maximum of extension; the experiments, therefore, that were made on the latent period of the muscle of *Helix* were made with one that was more or less contracted.

Affinities of Onchidia.†—R. Bergh, after discussing the views as to the affinities of the *Onchidia* which have been held by preceding writers, protests against the doctrine that they are nudibranchiate molluscs, and claims them as decidedly pulmonate; their nervous system does not differ essentially from that of the Pulmonata; it only differs in having the lowermost part more condensed and reduced; the ophthalmophores are like those of the stylommatophorous Pulmonata, and the pedal glands have very similar relations, as has too the digestive system. It is true that the *Onchidia* are "opisthobranchiate," but so are *Arion* and *Limax;* in this group, at any rate, the position of the heart has no systematic significance. The kidney is very like that of the Pulmonata, and the difference between the sizes of the lung-cavity is to be explained as due to the largely cutaneous mode of respiration in the *Onchidia.* The most striking proofs of relationship are to be found in the structure of the generative system; the seminal duct has a position in the lateral wall of the body, such as has never yet been demonstrated in any Nudibranch, but only in the Pulmonata. The *Onchidia* are Pulmonata which have adapted themselves to an amphibiotic or marine mode of life.

* Comptes Rendus, xcix. (1884) pp. 334–7.

† Morph. Jahrbuch, x. (1884) pp. 172–81. Cf. Ann. and Mag. Nat. Hist., xiv. (1884) pp. 259–66.

Dimorphism of the Spermatozoa in Paludina.*—It has been known for some time that the spermatozoa of this mollusc are of two kinds; the fact was originally discovered by von Siebold, and commented upon by subsequent writers. The subject has been recently studied by Max von Brunn, who contributes an elaborate paper upon the structure, function, and development of the two kinds of spermatozoa.

1. *Structure.*—The two forms are at once distinguishable by their size; the "hair-like" spermatozoa are 88 μ in length, while the "worm-like" forms are from 180–190 μ in length; the latter also are considerably thicker; the hair-like spermatozoa consist of a slender body narrowing at the "tail" into a delicate thread, and a head twisted in a corkscrew fashion for six turns; the "worm-like" spermatozoon is nearly uniformly cylindrical, and terminates in a bunch of fine cilia; the whole spermatozoon is traversed by an axial thread which commences at the base of the slightly thickened head, and terminates in the posterior bundle of cilia; a more minute examination shows that the central thread is in reality composed of a bundle of fine fibres, each one of which corresponds to a terminal cilium; the whole is enveloped by a protoplasmic sheath which forms the rest of the spermatozoon.

2. *Development.*—At first the testis cells which are to produce the two kinds of spermatozoa are indistinguishable, but later two kinds of cells are recognizable; one set divide again, and become the proper seminal cells which are to produce the "hair-like" spermatozoa; the latter are large cells which become directly modified into the "worm-like" spermatozoa. The nuclei of the cells that are to produce the latter break up into a number of small round bodies which eventually disappear, with the exception of a single one of conspicuous size which remains; at the same time a bundle of fine threads springs from the surface of the cell, close to which is the remnant of the nucleus; the bundles of threads indeed appear to take their origin from it, but this is not absolutely certain; this bunch of threads is undoubtedly the bunch of cilia already mentioned as attached to the "tail" of the spermatozoon; the nucleus to which they are attached becomes the head of this spermatozoon; the cell gradually elongates and forms the body of the spermatozoon. The formation of the "hair-like" spermatozoa is as follows:—In the ripe seminal cells the nucleus assumes the well-known spindle form and divides, division of the cell accompanying nuclear division; the first recognizable sign of the metamorphosis into spermatozoa is that the nucleus becomes homogeneous, and shows no nucleolus; in the next stage a fine thread is seen projecting from the cell, and close to the point where it is connected with the latter are several highly refracting bodies; the nucleus sends out a prolongation towards this thread, which includes the small round bodies, and which eventually becomes the middle portion of the developed spermatozoon, while the nucleus itself becomes its head.

* Arch. f. Mikr. Anat., xxiii. (1884) pp. 413–99 (2 pls.).

After describing the development of the spermatozoa, which is done in very great detail, and illustrated by numerous drawings, the author proceeds to sum up the known cases in which a similar dimorphism of the spermatozoa exists; these are *Notommata Sieboldii*, *Asellus aquaticus*, *Oniscus*, *Cypris*. The same phenomenon has been recently observed in a species of *Murex* by Schenk. The author himself records it in *Ampullaria*, and gives some description of the structure of the two kinds of spermatozoa, but was unable to find any but the "hair-like" form in other Prosobranchiata.

3. *Function*.—The question to be resolved is, What share does each kind of spermatozoon take in fertilization? Leydig previously stated that both kinds were concerned in the fertilization of the ovum, but a careful series of observations has resulted in the conclusion that only the hair-like spermatozoa penetrate the ovum; *the worm-like spermatozoa play no part in fertilization*, and their actual function is not easy to settle. It is, however, well known that in the testis of many animals, comprising examples from various groups, a great number of cells do not become spermatozoa, but increase in size and take on the appearance of ova, so that there is a kind of commencing hermaphroditism. It is possible that the "worm-like" spermatozoa of *Paludina* may be something analogous, produced by "a certain female tendency in the testis." Remembering also that the nearest allies of the Prosobranchiata are hermaphrodite, there seems nothing too improbable in imagining that they too may show an indication of hermaphroditism in their genital glands. Finally, a comparison of the structure of the testis of *Paludina* with the hermaphrodite gland of the Pulmonata shows a very considerable correspondence between the seminal cells which are to produce the worm-like spermatozoa in the one, and the ova in the other. In the hermaphrodite glands of the Pulmonata the spermatozoa and ova are developed in alternating masses; and the same is the case with the two kinds of spermatozoa in *Paludina*. All these considerations seem to show that the testis of *Paludina* and the hermaphrodite gland of the Pulmonata are very closely connected.

The author concludes this very important paper by a suggestion supported by many facts, that the Pulmonata are more nearly allied to the Prosobranchiata than to the Opisthobranchiata, as is more generally supposed.

Mode of Action of Shell- and Rock-boring Molluscs.*—Prof. F. H. Stoner considers the true explanation of the mode of action of many shell- and rock-boring molluscs to be that there is a power of osmotic dissociation, similar to that possessed by the rootlets of plants, and that it depends on the formation of chlorhydric acid through decomposition of sea-salt by certain tissues of the animals especially suited for the purpose, these tissues being kept meanwhile in direct contact with the shell or rock to be bored. In the case of shell-perforation the denticles of the odontophore would aid by

* Amer. Journ. Sci., xxviii. (1884) pp. 58–61.

removing mechanically the bits of loosened or softened shell; but the author is strongly of opinion that an acid solvent is made to act upon the shell during the process of boring.

Action of Sea Water on Molluscs.*—H. A. Coutance has experimented on the action of the salts contained in sea-water on the mussel, periwinkle, and whelk, and *Venus decussata*. As the result of these experiments, he finds that the saline elements of the sea water act very differently on molluscs, and that every modification in the composition of the water finally becomes fatal to the animals.

Their greater or less resistance depends on their organization. Bivalves resist better than spiral shells, and in these two groups the results vary according to the different species.

Salts of potash are less favourable to life than salts of magnesia, and salts of magnesia are less favourable than salts of soda. Outside of the salts dissolved in sea water sulphate of soda seems to possess a well-established preserving neutrality.

The death of bivalves is caused by a general weakening of the muscles. As the muscles can no longer draw together or open the valves, the animal is exposed to the unfavourable or poisonous action of the element.

Molluscoida.

Segmentation of Ascidians.†—E. van Beneden and C. Julin discuss the phenomena of segmentation in Ascidians and its relations to the organisation of the larva. The investigation was begun at Lervig in Norway, where the simple Ascidian *Corella parallelogramma* is very abundant and sexually mature in August and September. Since then the study has been continued at Naples—especially on *Clavelina rissoana*.

As soon as the first karyokinetic figure is formed it is possible to distinguish the sides, ends, and probably also the ventral and dorsal surfaces of the gastrula, and, consequently of the larva. The first plane of segmentation is along the median plane of the future Ascidian. At the 8-stage the materials from which the right and left, ventral and dorsal, anterior and posterior portions of the gastula are to be found, are already localized in distinct blastomeres. The ectoderm is gradually separated from the endoderm, beginning at the 8- and ending at the 44-stage. Throughout the whole period of segmentation the phenomena of cell-division proceed from behind forwards, in the sense that in all the cells the segmentation-grooves first appear on the face of the cell which looks backwards; whenever a blastomere is about to divide, two systems of concentric circles are to be seen on the surface of the cell; these may be called the antipodal systems. The inner—or polar—zone forms the most prominent, and, as a rule, very homogeneous portion of the surface. Around it there

* "Translated and published in the last report of the U. S. Commissioner of Fish and Fisheries." Original source unknown. Cf. Amer. Natural., xviii. (1884) pp. 945–8, and xvii. (1883) pp. 1079–80.

† Arch. Biol., v. (1884) pp. 111–26 (2 pls.).

is a circumpolar zone. The rays or fibrils which are inserted into the surface of the egg along the polar and circumpolar grooves form two lines, one polar and one circumpolar; the fibrils produce the cones, the apices of which correspond to the centre of attracting spheres. They form with the achromatic half-spindles a whole. When daughter-nuclei are formed and gain the surface of the blastomeres the principal cones—as the half-spindles may be called—and the antipodal systems disappear. The cause of cell-division seems to reside in the protoplasm, and the separation of the secondary chromatic disks from one another is an effect of the same kind as the appearance of the superficial antipodal systems. In a table the authors give a view of the filiation between the different cells at different stages of segmentation.

Relation of the Nervous System of the Adult Ascidian to that of the Tailed Larvæ.*—E. van Beneden and C. Julin contribute a detailed memoir upon this subject. For their investigations they made use of the larva of *Clavelina rissoana*, the earlier phase of which they had already studied.

The central nervous system is composed of (1) a cerebral vessel bearing the organs of sense, (2) a visceral portion reaching to the commencement of the tail, and (3) a caudal portion; all are traversed by a central canal dilated into a vesicle in the cerebral and further back in the visceral portion; these divisions of the nervous system are not peculiar to the larvæ of *Clavelina*, but have been shown by others to exist in *Salpa* and *Pyrosoma;* in the adult the caudal portion disappears entirely, while only a part of the cerebral and visceral portions remain; the parts that remain are those which in the fully mature larva have retained their embryonic character and are formed by a simple epithelium, i. e. the cerebral *cul de sac* and the visceral canal; the parts that are already differentiated in the larva, that is the sense-organs and the delicate epithelial wall of the vesicle together with the ganglionic mass adjacent to the floor of the visceral canal disappear.

Although nothing is known respecting the development of *Appendicularia*, there seems no doubt that the cerebral organ of that animal corresponds to the interoscular ganglion of the Ascidian and that the nervous cord traversing the tail corresponds to the caudal portion in the urodele larvæ. M. Fol, however, considers the central nervous cord of *Appendicularia* as a simple nerve.

The paper terminates with some remarks upon the formation of the branchial apparatus: it appears that the peribranchial cavities (in *Perophora*) are developed, as Kovalevsky showed, from the archenteron; in *Clavelina* these same cavities originate from the epiblast and become connected with similar outgrowths of hypoblast into which they open; this temporary condition is permanently retained in *Appendicularia;* in the adult Ascidian it is therefore clear that the peribranchial cavities are the homologues of the *endodermal* part of the branchial slits in *Appendicularia.* The development of the peribranchial cavities of Ascidians is precisely similar to that of the gill-

* Bull. Acad. R. Belg., viii. (1884) pp. 13–72 (4 pls.).

clefts in Vertebrata, and therefore the Ascidians are "Chordata with a single pair of branchial clefts while the Vertebrata are furnished with several and the Cephalochorda with a great number." The stigmata of the adult Ascidians clearly do not correspond to the branchial clefts of the Vertebrata and *Appendicularia*, but are secondary structures.

Segmentation of Simple Ascidians.*—L. Chabry's paper is supplementary to the recent important memoir of Van Beneden and Julin. His object is to show that the segmentation of Ascidians really differs but little from the regular mode, and that it is possible to approximate them to one another.

He describes the stages in which there are 2, 4, 8, 16, 22, and 30 cells; the planes parallel to the equator ("tropical planes") which, in a case of regular segmentation, lead to the succession of the 16- by the 32-stage are, in Ascidians, broken up into small parts, which do not regularly follow one another. In other words, the planes are more or less distant from the poles, and so give to the surface of the sphere an irregular appearance, which can only be brought into relation with that of regular segmentation by attentive study. The author enters into an account of his views on the subject, and expresses his belief that he has demonstrated the existence of a true comparative morphology of segmentation, the aim of which is to relate to one another the different modes of division of the yolk, and to find traits common to a number of animals in the midst of apparent irregularities.

Development of Social Ascidians.†—O. Seeliger commences with an account of the mode of cleavage in *Clavelina*, as he was not able to observe the process of fecundation, or the formation of the polar cells. The cleavage is not so regular as is ordinarily supposed, and it is interesting to note how the cleavage and the formation of the two primary germinal layers are combined in one process. Bilateral symmetry is at once observable, and a distinction into fore and hind ends appears with the 4-stage; the back and ventral aspect are seen in the 8-stage, when, too, the two primary layers begin to be differentiated.

Gastrulation commences with the appearance of 16 cells; the author does not feel able to speak definitely as to the mode of origin of the notochord; the blastopore appears to close up in much the same way as in *Amphioxus*, and the author suggests that the unaltered condition of the lower edge is due to the first appearance of the nerve-tube at this point. As the hinder portion of the body begins to increase in length, the embryo takes on a pyriform aspect, and it is in this region that the greatest activity in developmental processes is now apparent. The first organ to appear is the notochord, and its mode of formation is seen to be intimately connected with the mode of closure of the blastopore; just as in *Amphioxus* the cord extends from before backwards, and the fact that the hindermost cells are the first to become apparent, is due to the form of the blastopore. The

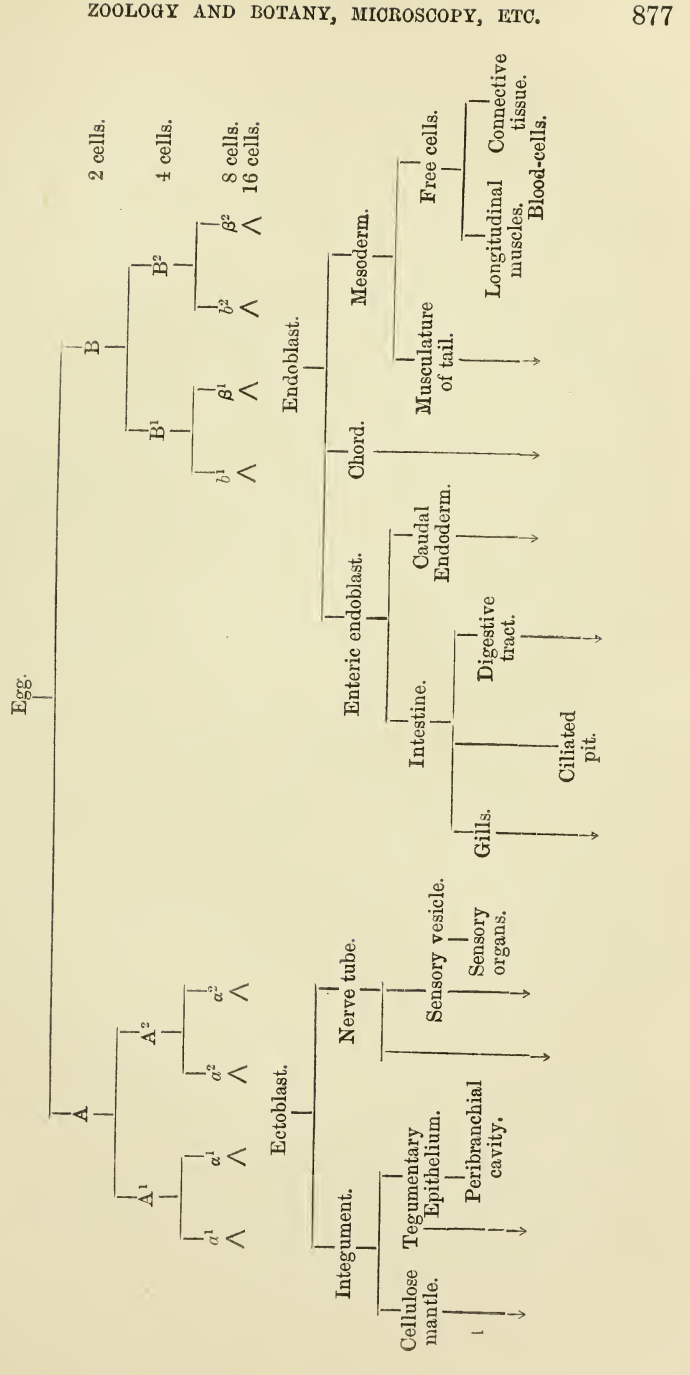
* Journ. Anat. et Physiol. (Robin), xx. (1884) pp. 387–92.
† Jenaisch. Zeitschr., xviii. (1884) pp. 45–120 (8 pls.).

mode of development of the nervous system is very closely similar to that of *Amphioxus;* the tube is for some time open at its anterior end, and in communication with the outer world. The mesoderm has a paired endodermal origin.

The fact that some of the organs begin to appear very early can, in Seeliger's opinion, only be explained by supposing that the Ascidian is derived from a more highly organized ancestral form, which was provided with a head and trunk.

The fourth period of development is distinguished as that of histological differentiation; in the fifth we have the free-swimming larva. That of *Clavelina* is more highly organized than the larva of simple Ascidians; the enteric tract is more complicated, and all the parts of the adult are to be recognized; the peribranchial cavity is, with rare exceptions, provided only with a single egestive orifice, and there are only two rows of clefts on either side; these, however, soon increase in number, and the dorsal exchange their rounded for an elongated, elliptical form. Part, at least, of the persistent musculature is formed of mesodermal cells, which had previously no function; and it is certain that the two kinds of muscles—the epithelial musculature of the tail, and the mesenchymatous muscles of the anterior portion of the body—which had been sharply separated by Hertwig, both arise from a common rudiment of mesoderm. At the end of this larval period all the organs consist of one layer, and their mode of origin may be summed up in the annexed table.

After a period of active life the larva begins to attach itself by the papillæ at the most anterior end of the stolon, so that the mouth of the animal is now turned downwards. Soon the primary axis begins to run parallel to the ground, and the mouth finally comes to lie superiorly; the communication between the cavities of the body and of the stolon becomes considerably narrower, and the stolon itself presents the greatest variations. The process of the absorption of the larval tail begins with the protrusion of the inner layers from the ectodermal tegumentary tube; the latter grows shorter, and its cells thicken. While the inner layers become spirally rolled up the few cells are set loose, as free mesodermal cells, into the circulation; the rolling up is effected gradually. What cells remain form an amorphous brown mass which, in consequence of the growth of the body, appear to pass forwards, and lie in the anterior part of the stomach. Finally, this also is dissolved, and no indication of the caudal segment is left. The whole of the nervous apparatus breaks up into its cellular elements. The growth of the young is principally effected in the direction of the long axis of the body, and in this way the plump fore-body of the larva becomes converted into the cylindrical body of the adult *Clavelina.* No indication remains, after the break up of the tissues of the tail, which would induce us to regard the Ascidian as one of the Cœlomata; the large primary cœlom is filled with free cells. The ciliated pit which early had the appearance of a canal, wide anteriorly and gradually growing narrower, has, later on, the anterior separated by a groove from the posterior part; the former widens considerably, and the canal disappears from


Egg.
A
B
2 cells.
A¹
A²
B¹
B²
4 cells.
a¹
a¹
a²
a²
b¹
β¹
b²
β²
8 cells.
16 cells.
Ectoblast.
Endoblast.
Integument.
Nerve tube.
Enteric endoblast.
Chord.
Mesoderm.
Cellulose mantle.
Tegumentary Epithelium.
Sensory vesicle.
Intestine.
Caudal Endoderm.
Muscullature of tail.
Free cells.
Peribranchial cavity.
Sensory organs.
Digestive tract.
Longitudinal muscles.
Connective tissue.
Blood-cells.
Gills.
Ciliated pit.

the latter; the inner surface is not seen to be ciliated until after the fixation of the larva. The enteric tract undergoes a number of considerable changes before it attains its definite form. At the hinder end there appears a new organ—the gland which surrounds the enteron; it is formed as a diverticulum of the mid-gut, and it is possible that it has the functions of some kind of "liver." The later stages of development are, as may be supposed, those in which the gill-clefts are to be seen increasing in number.

Tunicata of the 'Triton.'*—The most interesting point in Prof. W. A. Herdman's report on the Tunicata of the Faeroe Channel is that which deals with *Doliolum denticulatum*, of which between five and six thousand specimens were collected; they all belonged to the sexual generation. The best specimens for histological study were those which had been preserved in chromic acid, and which were thoroughly washed in alcohol, stained in picrocarmine, and mounted in Farrant's solution. The test is almost absent; the first and last of the eight muscular bands form sphincters for the apertures of the body. The nerve-ganglion, which is small, gives off four large nerve-trunks, and smaller nerves between them. As in all other Tunicata, where the matter has been investigated, the nerve-cells are all in the outer layer of the ganglion, and the centre is formed of a mass of delicate interlacing fibres and granular matter. The transverse muscle-bands of the heart appeared to be composed of a large number of very fine fibres, and not of one only, as supposed by Keferstein and Ehlers.

Two glandular systems, which appeared to be quite distinct, were found connected with the alimentary canal; the first, which does not seem to have been hitherto noted, lay along the ventral surface of the stomach and first part of the intestine; it consists of cæca, which branch and occasionally anastomose; no duct or opening into the alimentary canal was detected.

Prof. Herdman asks whence all the *Doliola* have come, and where are the asexual forms from which they have been produced; the nature of the area—whether warm or cold—has apparently no influence on them, but the questions put cannot yet be answered. Mr. Missing noted that on August 5, 1882, *Doliola* were abundant, and *Acanthometræ*, which in 1881 had been present in enormous multitudes, were absent from the surface gatherings. On August 7 the conditions were reversed. The *Doliolæ* were most abundant at 5 or 6 fathoms beneath the surface; at times they appeared in vast banks, between which there were always a few stragglers; the animals were observed to be phosphorescent, and the discharges appeared to follow the direction of the nerve-cords or filaments.

Organization of Anchinia.†—N. Wagner describes a phase of the development of *Anchinia rubra* characterized by a regularly globular form of body; moreover, the long caudal appendage of the form hitherto known is wanting. This phase is agamous. Individuals

* Trans. Roy. Soc. Edin., xxxii. (for 1882-3) pp. 93–117 (5 pls.).
† Comptes Rendus, xcix. (1884) pp. 615–6.

were twice met with having a small stolon covered with buds; but this stolon differed essentially from that of the sexual form.

In addition to two pairs of very strong nerves running towards the anterior and posterior apertures of the body, the ganglion gives rise to nerves that terminate in the cells of the exterior and interior epithelium, besides others to different portions of the body. The termination of these nerves is excessively varied, giving rise to the supposition that the specialization of the organs of sense here reaches a very high degree.

Among the corpuscles of the general cavity of the body two principal types predominate, which the author calls *nutritive* or *plastic corpuscles* and *formative corpuscles*. The blood-corpuscles present only a slight modification of the former. The plastic corpuscles are believed to originate from the cells of the alimentary canal, and by their aid restoration of injured parts takes place. The formative corpuscles may in some instances reconstruct or replace the nerve terminations. The corpuscles that give rise to buds differ by their very rapid movement and by the presence in their interior of small particles of crystalline form.

Closure of the Cyclostomatous Bryozoa.*—A. W. Waters, referring to the want of characters for classifying the Cyclostomata, points out that the ovicells ought to be very carefully examined, as there are more points of importance than have so far been used; the connecting pores are also, he considers, comparable with the rosette-plates of the Chilostomata, and give by their position useful characters. Stress must also be laid on the size of the zoœcial tube, which seems to be constant in each species, whilst the position of its closure constitutes a hitherto neglected character which may possibly be of great use. The most usual position for the calcareous plate which closes the tube would seem to be about the point where this tube rises free from the zoarium. Sometimes the plate has one opening, in other species there are a number of openings, or there may be only very minute perforations, and it is apparently sometimes quite closed. Two closures quite close together are sometimes present instead of one. Its function, the author considers, may be to keep the zoœcium from being choked up by sediment during its polypideless condition.

Arthropoda.

α. Insecta.

Movements of the Heart of Insects during Metamorphosis.†—J. Künckel, attracted to the question of cardiac movements in insects during their metamorphosis, has especially studied the Syrphidæ, where the length of the period of their development and the large size of the animals offer very favourable conditions for investigation. For four days after the larvæ have lost the power of movement the heart may be still seen to be beating very regularly; the phenomenon

* Journ. Linn. Soc. Lond. (Zool.), xvii. (1884) pp. 400–4 (1 pl.).
† Comptes Rendus, xcix. (1884) pp. 151–3.

ceases to be visible when the integument is hardened and the pupa begins to be formed. In the delicate and perfectly transparent nymphs the pulsations of the dorsal vessel in the abdomen are very apparent. Later on the beatings of the heart cease completely. Again they appear, and as many as 60 per minute may be seen; the movements are now regularly performed till the appearance of the imago. It is clear then that the heart continues to beat during histolysis, and even when the phenomena of histogenesis begin to be apparent. The short period of cardiac arrest corresponds to the moment when the organ undergoes the histological modifications which are specially manifested by the formation of an aortic region.

Tracheæ of Insects.*—G. Macloskie, as the result of his researches on the tracheal organs of insects, finds that their spiral filaments are not independent structures, but crenulations or inward foldings, with thickening of the chitinous wall; that the spirals are really tubular, fissured at the line of infolding, and continuous with the inclosing wall. The function of aeration is discharged by air passing, not through the wall into the blood, but directly to the tissues by lung-like terminal cells, described by Louis Agassiz, and shown by Max Schultze to be especially abundant near the luminous organs of the glow-worm.

Light of Pyrophorus.†—MM. Aubert and R. Dubois have examined the light of the Elaterid genus *Pyrophorus*, and find that the spectrum is very fine and continuous, having neither bright nor dark bands; it extends from between the lines A and B to a little beyond F in the solar spectrum. When the brightness of the light diminishes the red and orange disappear completely; the most persistent rays are the green. When the brightness increases the order of appearance is reversed, the least refractive rays being, in other words, the last to appear. The nearest approach to this phenomenon is to be seen in phosphorescent sulphate of strontium. When the light begins to appear the central and internal regions of the organ are alone luminous; it is only when the light is very bright that it appears from the peripheral portion, and it is then only that the red rays are seen. The light has an action on sensitized paper, when about 2 centimetres from it; the chemical action is, proportionately, very intense; sulphate of calcium exposed to the light for five minutes becomes feebly phosphorescent, but no results were obtained with sulphate of quinine or a solution of chlorophyll in ether.

Sting of Mellifera.‡—G. Carlet finds that the poison-vesicle of the Mellifera has not the muscular investment which is always found in the Diploptera, that it is not contractile, and it cannot in any way act on its contents. The stylets of the sting have an organ at their base, which may be called the *piston*, and which appears to be peculiar to this group; it has a true piston action. The two stylets of the sting may move simultaneously or alternately; but, in either

* Amer. Natural., xviii. (1884) pp. 567–73 (4 figs.).
† Comptes Rendus, xcix. (1884) pp. 477–9.
‡ Ibid., p. 206.

case, each stroke of the piston forces out a drop of poison, and at the same time a fresh afflux of liquid is produced at the base. The apparatus, then, is at once aspiratory and injecting; it has the form of a syringe with a perforating canula, and by its two pistons *à parachute*, it drives out by the canula the liquid which it draws in at its base.

Anatomy and Functions of the Tongue of the Honey Bee (Worker).*—T. J. Briant minutely describes and figures the structure of the tongue of a worker honey-bee, and makes the following observations regarding its use by the insect.

If a bee be put to a large drop of honey, it will be found to open slightly the whole of the organs of the tongue, and with a scarcely perceptible motion to suck in honey, no doubt by means of the muscular pharynx. Flowers, however, do not ordinarily contain nectar in such abundance, and in order to obtain the conditions more nearly approaching those in nature the honey should be presented smeared thinly on glass. The bee will clear off every trace of honey and leave the glass clean. This is done by the bee applying the lower and outer portion of the tongue to the glass. The long joints of the labial palpi just touch the glass, the shorter joints being bent outwards at right angles. The tongue is then extended and retracted with great regularity and some speed, and to the author it appears that the extension is a somewhat slower movement than the retraction. When the tongue is in this position the "ladle" will be turned with its concave side downwards, and that surface of the tongue which is split will be upwards. The pressure on the surface of the glass will move the rod to the opposite side of the tubular portion of the tongue in that part of it which is being pressed against the glass. This will cause the two membranes to form a trough, which will of course be opened on its upper surface; and it seems impossible to the author to suppose that the honey does not pass into this trough. As the tongue is being retracted, the rod which was pressed against the inner side of the tongue will pass over to the front side, and so considerably enlarge the trough made by the membranes in the upper portion of the tongue, and the edges of the slit in the outer wall being closely united by interlocking hairs, the result will be the creation of a vacuum which will draw up the honey from the lower portion of the tongue. The tongue is then again extended; but now the salivary chamber is enlarging as the tongue is protruded, and the honey is so carried up still higher and into the mouth, whence it is once more drawn up by the muscular pharynx.

This, however, will not account for the bee being able to remove minute traces of honey. The hairs of the tongue will sweep backward the honey, that is to say, will drive it away from the mouth, towards the end of the tongue itself, and the ladle-shaped organ will then serve, as the tongue is being withdrawn, to collect and drive into the tongue the honey thus collected. When within the tongue, the capillarity of the narrow groove, assisted by the action of the salivary chamber, will

* Journ. Linn. Soc. Lond. (Zool.), xvii. (1884) pp. 408-17 (2 pls.).

afford a means, which the larger opening would not afford, of the smallest particle of honey being sucked up. These observations seem to the author to support the theory which he propounds that the honey is drawn into the mouth through the inside of the tongue by means of a complicated pumping action of the tongue itself and its closely contiguous parts, and not in any sense by lapping.*

"**Ignivorous Ant.**"†—G. Rafin describes "a species of ant which he has observed in the island of St. Thomas, and which he proposes to call *Formica ignivora*. A large fire of wood having been kindled at a certain distance from the ant-hill, he is able to affirm that the ants precipitated themselves into it by thousands, until it was completely extinguished."

Aquatic Lepidopterous Larvæ.‡—W. Müller-Blumenau has examined *Cataclysta pyropalis*, the larvæ of which live in water, but do not resemble the only known example, *Paraponyx stratiolata*, in the same way of breathing by gills. The larva, which is 1·4 cm. long, has a flattened body, attenuated posteriorly. The gills are in the form of unbranched tubular appendages of the second and third thoracic and of all the abdominal segments; they are arranged in an upper and a lower group; the number of gills varies somewhat. The stigmata of the tracheal system are, as a rule, all closed, but are easily to be distinguished by a black oval dot; just as in other larvæ with tracheal gills, as described by Palmén, the stigmatic branches are completely closed. The larvæ are ordinarily found attached to stones, and are rather more frequent in stagnant than in running water. They form for themselves a chamber with delicate but closely spun walls, and they do not leave this, as a rule, until they attain to the imaginal state. The spaces at the edge of the cocoon only serve as a means of exit for the fæces; they live on the diatoms and other unicellular algæ which grow on the stones to which they attach themselves. They almost always fix themselves by their backs to the stone, and in correlation with this we observe that they present the remarkable condition of having their dorsal surface pale, and their ventral dark. This is not, however, to be regarded as a protective adaptation, but as the result of an earlier condition in which the whole of the larva was darkly pigmented; the paleness of the back is due to the want of light.

After an account of the pupa and of the homes in which it dwells, the author passes to some other species of the same genus, all of which are Brazilian. These are much less common, and their specific characters are not yet fully worked out, but there are probably five species. The gills, which are always unbranched, never attain to the

* In this theory the author follows, though he does not quote (no doubt not being aware of it) the suggestion of J. Spaulding in Amer. Natural., xv. (1881) pp. 113–9, see this Journal, i. (1881) pp. 442–3. "In conveying the nectar from the flower to its mouth the bee probably uses the rod and sac as a suction and force-pump."

† Comptes Rendus, xcix. (1884) p. 212.

‡ Arch. f. Naturgesch., l. (1884) pp. 194–212 (1 pl.).

relative length seen in *C. pyropalis*, but they are always more numerous. The covering of the pupa contains air-spaces in its outer division, which are connected with that of the inner, but as the stones or algæ forbid any exchange of gas with the exterior, this can only be effected by the spaces in which the water is able to pass; this explains how it is that we sometimes find the air-chambers on the side of the house which is attached to the stone.

Maxillary Palp of Lepidoptera.*—A. Walter has made an examination of the maxillary palp in one hundred and one species of Lepidoptera, of which he gives careful accounts. This palp is found in a series of stages of reduction, from the lowest forms of the Microlepidoptera to the Rhopalocera; at one end, in *Micropteryx*, we find it with as many—six—joints as in any insects, and in *Lycæna*, at the other end, there is no sign of it. It follows from these observations that there is no number of joints which is characteristic of the whole order as has been supposed by Burmeister; on the other hand, the maxillary palp has always a constant number of joints, the same position and the same appendage in a given species; there does not appear to be any sexual dimorphism. On the whole, then, it is an organ of considerable value in the determination of the affinities of genera.

All the lower orders of insects with which it is reasonable to connect the Lepidoptera have a well-developed maxillary palp, of from four to six joints. The author gives a table of the groups of Lepidoptera, starting with the Microlepidoptera, and showing that the three-jointed Nocturna have given off forms with two joints or one; the Geometra, Sphingidæ, and Hesperidæ have one.

Development of Viviparous Aphides.†—O. Zacharias differs in some points from Metschnikoff who in 1866 investigated the subject of the development of the Aphides. Some of the errors of the earlier observer are attributed to his failure to use the "method of rolling" by means of which we may get different aspects of the embryo. In the mature embryo two retort-shaped bodies are to be seen on each side, and not one as Metschnikoff reported; the result of this discovery is, for the first time, to bring the parts of the mouth of the Aphides into homology with the corresponding organs of other insects; for their retort-shaped bodies result from the modification of the mandibles and maxillæ. In addition to the "procephalic lobes" of Huxley there is a median plate which is produced from the ventral part of the cephalic hood; the author proposes to call it the mandibular plate; he thinks that Huxley mistook the cephalic for the abdominal end of the body. The brown masses of substance which in *Coccus hesperidum* correspond to the secondary vitellus of *Aphis rosæ* were distinctly seen to form two long cords which open into the rectum; they are the Malpighian vessels. A full memoir is promised.

* Jenaisch. Zeitschr., xviii. (1884) pp. 121–71.

† Zool. Anzeig., vii. (1884) pp. 292–6. Cf. Ann. and Mag. Nat. Hist., xiv. (1884) pp. 54–6.

Systematic Position of Pulicidæ.*—K. Kräpelin finds that there is a certain parallel between the buccal organs of the fleas and of the higher Rhynchota, while their other anatomical characters show that the fleas are less closely allied to the Diptera than to the Rhynchota; they cannot, however, be placed with them in the same order, and it is necessary to form a separate division, for which Latreille's name of Siphonaptera may be used; their sucking tube is formed by a dorsal and two lateral channels (labrum and mandibles), the anterior portion is alone inclosed laterally by the multiarticulate palpi of the labium, and, at the base, besides the latter, by the lamelliform palpigerous maxillæ. While in both Diptera and Rhynchota the efferent salivary duct is unpaired, there are two in the Siphonaptera; there is no sucking stomach, or pair of halteres as in the Diptera, there are no wings, as there may be in the Rhynchota; there are no facetted eyes, as in the Diptera, but the metamorphosis is complete whereas it is usually incomplete in the Rhynchota.

γ. Arachnida.

Development of Spiders.†—W. Schimkewitsch's chief results are as follows:—The cells produced by the cleavage of the egg do not all form pyramids radiating outwards from a central cavity; some remain within the latter and fill it up; each "pyramid" contains several protoplasmic masses and is homologous with a polynuclear cell; each pyramid, as Ludwig has shown, is separated into two layers, one forming the primitive ectoderm, the other the primitive endoderm. The cells of the ectoderm collect into a mass on the ventral surface of the egg, the cumulus primitivus; later the mesoderm arises from a region of the ectoderm which corresponds to the primitive streak; in front of the cumulus is the blastoporic aperture; the mesoderm arises from the endoderm as well as from the ectoderm. The mesenteron is at first a closed sac, its cavity filled with the primitive endoderm cells; two ingrowths take place into the mesenteron dividing it into two cavities; the upper of these is the cavity of the heart, the lower that of the mesenteron in a more restricted sense; the blood-corpuscles are partly endodermic and partly mesodermic; and in the adult there are two forms of blood-corpuscle. The aorta is formed by a cutting-off of the dorsal section of the gut.

With regard to the appendages, the upper lip is derived from two rudiments erroneously described by Kronenberg as antennæ; the lower lip similarly arises in two portions. Both unite to form the rostrum which corresponds to that of the Pycnogonida. The nervous system originates as two distinct cords from the ectoderm, these approach each other and include an invagination of the ectoderm, which, however, plays an unimportant part in the formation of the nervous system.

* Festschrift z. 50-jähr. Jubiläum d. Realgymnasiums d. Johanneums, Hamburg, 1884. Cf. Ann. and Mag. Nat. Hist., xiv. (1884) pp. 36–53 (1 pl.).

† Zool. Anzeig., vii. (1884) pp. 451–3.

Anatomy of Spiders.*—Dr. M. Bertkau deals principally with the anatomy and histology of the digestive tract which is described in some detail; the various glands in connection with the alimentary system are also treated of, and there are some interesting notes upon the so-called coxal glands which have lately been described by Lankester in the king crab; these glands were erroneously supposed by Wassmann and others to be salivary glands, but it appears that they have in reality no relation to the digestive system. In *Atypus* the coxal gland of either side extends from the hinder end of the cephalothorax as far as the base of the first pair of legs, and is imbedded in the lateral prolongations of the endoskeleton between its two upper wing-like processes; the posterior extremity of the gland is prolonged into the fourth pair of legs together with the stomachal diverticulum; there is, however, no aperture uniting the two. The whole gland is covered by a layer of longitudinal and transverse fibres which unite into a cup-like structure attached to both body walls between the dorsal surface and attachment of the legs; the gland tissue projects for a short way into these cup-like structures; the gland itself is much coiled within its sheath. In the group of the Tristicta the gland forms a simple tube not at all coiled. No external aperture was discoverable in adult examples, but in young specimens of *Atypus* the gland was found to open on to the exterior between the dorsal part of the integument and the base of the third pair of legs. The coxal glands are clearly a rudimentary organ and since their secretion is cast out on to the exterior of the body, they are excretory organs in the wider sense of the word. Perhaps the prolongations of the gland towards the exterior, already referred to, are indications of a metameric arrangement, in which case its analogy with the "segmental organs" becomes more conspicuous. The disposition of the coxal glands has some bearing upon the classification of spiders; the fact that they are always comparatively complicated (through folding) in the Tetrasticta seems to show that this group is a natural one; and in the same way the Tristicta all agree in having a simple unfolded coxal gland. Since the gland must be considered as a rudimentary organ its less complexity in the Tristicta indicates that the group should be placed lower in the system than the Tetrasticta.

Anatomy of Epeira.†—W. Schimkewitsch gives a detailed account of the anatomy of this spider. After a brief historical introduction the author describes in order the various organs of the body, comparing their structure with that of other Arthropoda. The eyes, previously investigated by Grenacher and Graber as well as others, are described, and the results given tend to show that Grenacher's description is more accurate than Graber's; the dimorphism of the eyes discovered by the first observer is remarked upon; the study of the central nervous system and its branches shows that the "antennæ" of insects are not represented in spiders; the rostrum in spiders corresponds to the

* Verh. d. Naturhist. Vereins d. Preuss. Rheinlande u. Westfalens, xli. (1884) pp. 66-77.

† Ann. Sci. Nat. (Zool.), xvii. (1884) 94 pp. (8 pls.).

labrum of insects and the cheliceræ of the former to the mandibles of the latter. The circulatory as well as the muscular system approaches that of *Limulus*, but the resemblance is to be explained, not by community of descent, but by the general similarity of shape. The presence of a sac-like pericardium, the walls of which are continuous with the pulmonary veins, recalls the dispositions met with in Crustacea where the branchial veins are similarly prolongations of the pericardium; but this identity probably results from the disposition of the respiratory organs, which in both groups are localized on the lower surface of the abdomen. That this explanation is just, seems to be proved by the fact that in the Opilionidæ, where only tracheæ are present, the heart is not furnished with a pericardium.

Spiders are furnished with "lungs" as well as tracheæ, while in the scorpion only the former kind of respiratory organ is present; the Opilionidæ as well as the Acarinæ have only tracheæ. Schimkewitsch disputes the opinion of Milne-Edwards that the lungs of scorpions are comparable to modified branchiæ of *Limulus* and suggests rather that they have been formed by coalesced bundles of tracheæ, such as are to be found in many caterpillars; he considers, however, that the ancestors of both scorpions and mites breathed by means of "lungs" and that the tracheæ of the mites are a more modern development. In no case do the respiratory organs of spiders show any resemblance to those of *Limulus*.

The generative organs show a great likeness to those of the Pycnogonida. The genital glands in both groups are in the form of a U, and situated above the intestine; the position of the ovaries in the legs in the Pycnogonida is quite secondary; moreover, there is a general correspondence in the appendages; the rostrum of the Pycnogonida is entirely comparable to the upper and lower lip of spiders, while the mandibles correspond to the cheliceræ. In support of this homology it is stated that the cheliceræ in some spiders, at any rate at a certain stage of development, are composed of three joints as are the mandibles of the Pycnogonida. The four pairs of legs are quite similar in the two groups, and the palpi also. With regard to the ovigerous limbs of the Pycnogonida, it seems at least probable that they are the maxillæ of the spider. In fact these two groups have probably descended from a common ancestor; the Pycnogonida being in some respects arrested in development (articulate mandibles, free thoracic segments) and in other respects modified (rudimentary abdomen).

Auditory and Olfactory Organs of Spiders.*—F. Dahl proposes to classify spiders according to the character and disposition of the auditory hairs on the limbs of these animals, as follows:

1. Tibia with two series of auditory hairs, metatarsus with one hair, and tarsus with a rudimentary pit or depression free from hairs: e. g. *Epeiridæ*, *Uloboridæ*, *Theridiidæ*, and *Pholcidæ*. 2. Tarsus with no rudimentary depression for auditory hairs, usually

* Arch. f. Mikr. Anat., xxiv. (1884) pp. 1–10 (1 pl.). Also transl. in Ann. and Mag. Nat. Hist., xiv. (1884) pp. 329–37 (1 pl.).

bearing a number of hairs like the metatarsus and tibia: e. g. *Territelariæ*, *Dysderidæ*.

The remaining members of this class are further subdivided according to the presence of one or two series of auditory hairs on the tarsus. A single series is characteristic of *Amaurobiidæ*, *Agalenidæ*, *Philodromidæ*, *Thomisidæ*, and *Attidæ*. Two series occur in *Drassidæ*, *Anyphænidæ*, and *Lycosidæ*.

Dahl has satisfied himself that these auditory organs can appreciate not only sound, but also variations of atmospheric pressure, such as winds.

An olfactory organ is stated to exist on the maxillæ. On the surface in front of which the mandibles work to and fro is a soft flat tract, of a sieve-like appearance, beneath which occur a number of long, polygonal processes, apparently fused, but in reality separate, which are in connection basally with a stout nerve-filament. Rather by a process of exhaustion than from direct evidence as to their function, Dahl affirms that this organ is olfactory in nature. It is universally found in Arachnida, though in different stages of development, being most fully developed in *Pachygnatha*.

Anatomy of Pentastomum protelis.*—W. E. Hoyle gives a detailed account of the anatomy of a new species of *Pentastomum* (*P. protelis*) from the mesentery of *Proteles cristatus*. The most interesting fact relates to the condition of the male sexual organs; the vas deferens passes down as far as the vesicula seminalis, and comes into actual contact with it, though no communication between the two existed; this is in harmony with Leuckart's discovery that the generative organs of *Pentastomum* are formed of two distinct portions: (1) a mass of cells segregated from the general tissue of the embryo, and (2) an external invagination; it is probable that in the species described, the junction between these two portions takes place at the point where the vas deferens comes into contact with the vesicula seminalis, and it is not a little remarkable that this species should present such a striking embryonic feature when the remainder of its organization has attained such a comparatively advanced stage of development.

The paper concludes with some remarks on the subdivision of the family Pentastomidæ; and the author is of opinion that the two genera *Linguatula* and *Pentastomum* ought to be separated, and gives the following definitions:—

Linguatula. Body flattened; body-cavity sending out lateral processes into the annuli; hook gland diffuse; opening of œsophagus into the extremity of the intestine; testis double; vesicula seminalis single.

Pentastomum. Body cylindrical; body-cavity even, without lateral prolongations; a hook gland on either side of the intestine; testis unpaired; vesicula seminalis single (?)

F. Jeffrey Bell† suggests that this is the immature stage of *P. polyzonum* which is found in large snakes.

* Trans. Roy. Soc. Edinb., xxxii. (for 1882-3) pp. 165-93 (2 pls.).

† Ann. and Mag. Nat. Hist., xiv. (1884) pp. 92-3.

Pycnogonids of the Faeroe Channel.*—P. P. C. Hoek describes the Pycnogonids dredged by the 'Triton' in 1882. Eleven species were collected, one of which, *Pallenopsis tritonis*, is new. The cold-area species found in the Atlantic occur also in the Arctic Ocean; one species, *Nymphon longitarse*—does not appear to have its distribution determined by the temperature of the water it inhabits. Within the limits of the genus *Pallenopsis* there are species with three-jointed, and others with two-jointed mandibles; the former are of the more ancient type, as is shown by their condition in *Ascorhynchus* and *Colossendeis*, where, being larval or rudimentary, they have not been strongly influenced by circumstances, and so retain their original number. The original condition is seen in the deep-sea species, while the shallow-water forms have two-jointed, and more robust, mandibles. While *Nymphon stroemi* has a number of small eggs, *N. macrum* has a few in each egg-mass, and these are large.

Development of Limulus.†—J. S. Kingsley begins his account after the formation of the blastoderm. At this time there is a single layer of cells surrounding the yolk, in which are scattered nuclei. The mesoblast arises as a single sheet on the ventral surface. Its cells come largely from the blastoderm, but some arise from the yolk nuclei. The mesoblast soon forms two longitudinal layers, one on each side in the neighbourhood of the limbs. The cœlom is formed by a splitting of the mesoblast, and at first consist of a series of metameric cavities extending into the limbs. The supra-œsophageal ganglion arises by an invagination of the epiblast. The heart arises as two tubes in the somatophore, which later unite. The mesenteron does not appear until after hatching. The amnion of Packard is the first larval cuticle, and bears a resemblance to the amnion of the Tracheata. A second cuticle is formed and moulted before hatching. The eyes appear on the dorsal surface at the same time that the limbs appear on the ventral. In these characters *Limulus* agrees essentially with the Tracheata, and has nothing in common with Crustacea.

δ. Crustacea.

Rate of Development of Carcinus mænas.‡—G. Brook has for more than two years been making observations on the rate of development of the common shore-crab, and every cast shell has been carefully preserved and labelled. Only one ecdysis was observed to occur between the end of October and the beginning of February, and the majority of ecdyses happen in the summer months. It appears to be impossible to judge the age of any particular specimen or the number of ecdyses which it has passed through from a casual observation of it on the sea-coast. Two given forms ("A" and "B") might, two years after hatching, be one 28 mm. long by 35 mm. broad, and the other 45 by 56 mm. Mr. Brook points out that it is probable that in confinement young *Carcini* do not develope with exactly the same rapidity

* Trans. Roy. Soc. Edinb., xxxii. (for 1882–3) pp. 1–10 (1 pl.).
† Science Record, ii. (1884) pp. 249–51.
‡ Ann. and Mag. Nat. Hist., xiv. (1884) pp. 202–7.

as in their natural haunts; his careful observations of dates and measurements are, however, of considerable importance. He observed a more rapid change from the larval to the true Brachyuran form than that gradual alteration described by Spence Bate in his classical paper on the Development of Decapod Crustacea.

'Challenger' Isopoda.*—F. E. Beddard gives a preliminary notice of some of the Isopoda collected during the voyage of H.M.S. 'Challenger.' Sixteen species of *Serolis* were dredged, nine being new species. Four are deep-water forms, the remaining new species having been dredged in shallow water off the coasts of S. and E. Australia. The geographical distribution of *Serolis* is "limited and peculiar," being almost entirely confined to the Antarctic hemisphere. The deep-sea forms have a wider range than the shallow-water species, although none have as yet been found north of the equator.

The differences noted between deep- and shallow-water forms occur (1) in the epimera (especially the 6th pair) which are much more elongated in the deep-water forms than in other, and (2) in the eyes.

In deep-sea forms of *Serolis* Mr. Beddard found that no veritable retinula was ever developed. A vitreous body is represented, and the cornea may, or may not, be facetted. In shallow-water forms, on the other hand, the eyes are invariably well developed, and resemble those of other Isopoda. These facts are interesting as bearing on the theory of "abyssal light," the presence of eyes in the deep-sea forms (one of which was dredged from 2040 fathoms) serving to enable these animals to perceive the light emanating from phosphorescent Alcyonarians. Fuller details will appear in the forthcoming 'Challenger' Memoir on the Isopoda, now in the press.

The Cryptoniscidæ.†—R. Kossmann first directs himself to the question of the relation of the sexes in these parasitic Isopoda and comes to the conclusion that the mature males retain their larval form and have swimming feet on the pleon; the f male, however, is not fertilized until it has passed through a metamorphosis, and become fixed and greatly degenerated. This is not, at the same time, the whole of the story: Kossmann is convinced that both forms are only the developmental stages of one and the same individual: in other words, the Cryptoniscidæ exhibit protandric hermaphroditism; and so far remind us of what obtains in the allied Cymothoidæ.

The chief part of what remains of the digestive apparatus after degeneration appears to be the homologue of the so-called liver of the rest of the Crustacea; but it has not a hepatic function, its lumen receives the food of the parasite, which is identical with the blood of the animal on which it is parasitic; the food is here digested and absorbed. The "liver" of other Crustacea is likewise not a hepatic organ, the name was erroneously given to it on account of its coloration. Hoppe-Seyler and Krukenberg have discovered in it ferments which have a diastatic, a peptic, a tryptic, and a fat-reducing property, and M. Weber has applied to the organ the name of hepato-pancreas;

* Proc. Zool. Soc. Lond., 1884, pp. 330–41.

† SB. K. Preuss. Akad. Wiss., 1884, pp. 456–73.

Frenzel, however, has shown that it has no biliary constituents. Kossmann calls it a *glandula intestinalis* or *intestinum glandulum*, and regards it as a reservoir of enteric function with a secreting, and at the same time, absorbing epithelium. Sections of the hind-gut reveal a lumen which is stellate in form, owing to the projection of papillæ into it. The fat-body appears to undergo early degeneration, and the renal masses which it contains in the earlier larval stages disapppear; with this change we probably have to correlate the altered mode of obtaining nutrition. The author is unable to give any evidence as to the production of a highly odorous substance by the rectal vesicle, on which Fraisse has reported; on account of the feeble development of his own olfactory sense.

Antennary Gland of Cytheridæ.* — W. Müller-Blumenau has discovered that *Elpidium brossoliarum* is able to secrete a sticky material, while in water; the observations made in connection with this discovery led him to the belief that the animal was able to spin, and that the spinning organ was placed in the second pair of antennæ. The organ so well known to be present at the base of this pair of appendages has been supposed to be poisonous in function, but no direct observations have ever been made in support of this view, and it is opposed by the delicate nature of its flagellum, which could never be supposed to be capable of inflicting a wound. When the animal is found hanging to glass its anterior end is always nearest to the glass, and the creature takes an oblique position. The author points out the difficulties presented by the habits of the animal in determining the question which he has investigated, but it would seem to be certain that the antennary gland is possessed of the power of secreting an attaching thread.

'Challenger' Cirripedia.†—Dr. P. P. C. Hoëk, taking Darwin's Monograph as a basis of departure, gives (1) a sketch of the development of our knowledge with regard to the number of the genera and species of Cirripedia known, their geographical and bathymetrical distribution; (2) a summary of what has been added to our knowledge of the anatomy, embryology, &c., of the group; and (3) a discussion of the different opinions published with regard to the classification of the group, especially since the discovery of the so-called Cirripedia Suctoria or Rhizocephala.

Out of 78 species of Cirripeds represented in the 'Challenger' collection only 19 had been previously recorded, and 59 are named and described now for the first time. In 1854 Darwin gave the number of known Cirripeds as 147, and since then only some 18 new species have been recorded. Of the 34 genera of Cirripedia at present known the species of 28 have never been observed at a depth greater than 150 fathoms. Two have been found from the shore to 400 fathoms (*Alepas* and *Pœcilasma*). *Balanus* occurs from the shore down to 510 fathoms. *Dichelaspis* ranges down to 1000 fathoms; and finally only two genera

* Arch. f. Naturgesch., l. (1884) pp. 213–6.

† Report of the voyage of H.M.S. 'Challenger.' Zoology, viii. (1883) 169 pp. (13 pls.).

(*Scalpellum* and *Verruca*) have been observed at depths greater than 1000 fathoms. The occurrence of these two latter genera in the greater depths of the ocean coincides in a striking manner with their palæontological history, but Dr. Hoëk has not been able to identify any of the recent species with the extinct forms described by Darwin, Bosquet, and Reuss.

Of the genus *Scalpellum* only 11 species were known up to the cruise of the 'Challenger'; over 40 species were added to the list as the result of the cruise. The majority of the species are inhabitants of deep water; indeed *Scalpellum* appears to be the only genus of the stalked Cirripedia which is to be often met with at great depths. It is also worthy of note that the observation of Darwin made with regard to the number of specimens of Cirripeds during the Cretaceous period may be made for the recent species of *Scalpellum*: "The number of species is considerable, the individuals are rare." While the species found during the 'Challenger' cruise amounted to 43, 26 of these are represented by a single specimen only; 4 are represented by 2 specimens; 5 by 3; 2 by 4; and only 6 species are represented by more than 4 specimens. The study of the complemental males found in some of the species of *Scalpellum* has given some very interesting results, but we are promised a more detailed treatment of the organization of these little creatures in a supplementary memoir, which will deal with the anatomy of the group. The largest species of the genus known has been called *S. darwinii* and only a single specimen was dredged.

Of the genus *Verruca*, 10 species, of which 6 are new, were found. They are among some of the most interesting forms of animal life collected during the expedition, and proved that the number of recent species is much greater than had been to this time supposed to exist, and that the genus has a true world-wide distribution. Of the six stations which yield *Verruca* one belongs to the Northern Atlantic, three to the Southern Atlantic, one to the Pacific, and one to the Malay Archipelago. By these discoveries the range in depth has been immensely increased; the greatest depth known to Darwin for *V. strömia* O.F.M. was 90 fathoms, but the six new 'Challenger' species inhabit depths of from 500 to 1900 fathoms. Of the genus *Balanus* 9 species are referred to, and 5 described as new; and of the genus *Chthamalus* 1 new species is described.*

Vermes.

New Pelagic Larva.†—J. W. Fewkes points out that before any intimate connection between the Vermian and Polyzoan phyla can be satisfactorily made out, a larger number of intermediate larval forms of one group or the other must be found. Such a larva, which seems to him to fill in part the gap in our comparison of the larval Annelid and the young Polyzoan, he has taken several times, and although at present ignorant of the adult form which it attains, it seems of more than

* See Nature, xxix. (1884) pp. 522-3 (1 fig.).
† Amer. Natural., xviii. (1884) pp. 305-9 (4 figs.).

ordinary interest as having to a greater extent than any known larva, characteristics of the young of both the group of Chætopods and that of the Marine Polyzoa. Of all known worm larvæ it has the closest likeness to *Mitraria*. It is, however, still very far removed from it in many points of structure. The Polyzoan larva which it approaches most closely is *Cyclopelma*, the young of *Loxosoma*. It has many affinities with *Cyclopelma* as well as with *Mitraria*, and seems intermediate between the two.

A detailed description with four figures is given, and it is pointed out that it has one highly characteristic Polyzoan feature. The ciliated belt is reflexed over the lower half of the body in the same way that a homologous structure is turned back in *Cyclopelma*. The spines appended to the posterior region of the body are probably temporary, and are homologous with the embryonic setæ in *Spio*, *Prionospio*, and several other genera. They approximate nearer the setæ of *Mitraria* as far as position goes, although they are not mounted on any special prominence, and arise from the posterior body region which bears the terminal ciliated prominences. In *Mitraria* there are no eye-spots similar to those which have been described in the new larva. In the young *Loxosoma* there are two well-marked ocelli.

As only a single stage in the development was found, while there is no doubt we have a larval Annelid, it is impossible to say to what family of Chætopoda it should be referred.

Head-Kidney of Polygordius.*—J. Fraipont confirms the greater number of observations of Hatschek on this simple Annelid, and adds to them the results of his studies on a new species, *P. neapolitanus*. The secretions noted by Hatschek are considerably larger in the new species and resemble drops of fat. When the organ attains its highest degree of development there are ordinarily two infundibula at the extremity of the vertical branch and three at the end of the horizontal branch of the organ. In some larvæ a third branch is to be detected, at the end of which there are one or two funnels. There appears to be a considerable amount of variability in the number of the funnels, and, consequently, in the general appearance of the organ. Fraipont finds that the excretory canal is not in direct communication with the body-cavity by the intermediation of the funnel. The radiating sides which support the infundibular membrane are hollow canaliculi which terminate blindly at their free end and open behind into a polygonal space which is only in relation with the lumen of the excretory canal. These canaliculi vary greatly in number—from three to six; they may be straight or curved in various directions.

The excretory infundibula of the larva of *Polygordius* do not seem to have any close or real resemblance to those of Rotifers, Trematodes, or Cestodes; the large excretory canals correspond phylogenetically to the large canals of these forms, the canaliculi which end blindly represent the remnant of the system of canals of the second order which are found in many Rotifers, and in nearly all Platyhelminths; the fine canaliculi of the latter are not found in Rotifers, while the

* Arch. Biol., v. (1884) pp. 103-10 (1 pl.).

true infundibula of Rotifers and flat-worms are never developed at all in *Polygordius;* the infundibula of this Annelid are, rather, homologous with a part of the excretory canaliculi. The comparison of the transitory head-kidney of the larva of *Echiurus* with that of the larva of *Polygordius* is very instructive, and the only differences lie in the fact that in the former the fine canaliculi are not connected by a membrane, and that these are remnants of the terminal infundibula. The author hopes he has rigorously identified the corresponding parts of the head-kidney in *Polygordius* and *Echiurus* with the excretory apparatus of Rotifers and Platyhelminths. He states, in conclusion, that his results have been independently confirmed by Dr. E. Meyer, who is working at Naples.

Nervous System of the Archiannelidæ.*—J. Fraipont publishes some interesting facts concerning the structure of the central and peripheral nervous systems in the three genera *Polygordius*, *Saccocirrus*, *Protodrilus.*

In all the Annelida proper, the central nervous system, though originating in the ectoderm, becomes subsequently disconnected with it and separated by the muscular layers of the body-wall. In *Protodrilus* it retains its embryonic position, and is not even separated by a membrane from the circumjacent epidermis; the cells found on the lower surface of the nerve-cord are but little differentiated and pass gradually without any break into those of the epidermis. The central ganglia, however, are surrounded by a special sheath, but like the ventral cord lie in the epiderm itself. In *Polygordius* the two halves of the ventral cord are united closely together as in the higher Annelids, otherwise they are arranged as in *Protodrilus*, the cerebral ganglia are divided into three regions, two anterior, one median, and two posterior ganglia. They are covered by a delicate membrane which isolates them from the epidermis within which they lie and from each other. The anterior ganglia supply the tentacles and the posterior the ciliated fossæ. In *Saccocirrus* the nervous system is in the same rudimentary condition; the cerebral ganglia are more condensed and not isolated as in *Polygordius.* In all three genera a rich nervous plexus lies within the longitudinal muscles of the body-wall, which is in connection with the ventral chain as well as with certain of the superficial epidermic cells. The paper terminates with a discussion on the origin of the nervous system in Annelids and its relation to that of *Chætognatha.*

Anatomy of the Hirudinea.†—A. G. Bourne bases his memoir on the study of forms belonging to ten genera.

Under the head of external characters he addresses himself to the question, How far in the series of Hirudinean genera do external characters express the metamerically segmented nature of their organization? He takes as an example *Pontobdella muricata*, and describes the internal and external characters of a normal somite;

* Bull. Acad. R. Belg., viii. (1884) pp. 99-120.

† Quart. Journ. Micr. Sci., xxiv. (1884) pp. 419-508 (11 pls.).

Branchellion and the extreme form *Hirudo* are next discussed; the first and last are almost identical in their external characters.

The cells of the epidermis may become glandular or sensory; the former are either superficial and mucous, or more deeply seated, when they may be salivary, clitellar, or prostomial; the functions of these last stand in need of further investigation. The muscular system is next described, and its cells stated to be very long, and in some cases much branched; there is a cortical layer which, in transverse section, is seen to exhibit longitudinal fibrillation, and a granular medullary substance with a large oval nucleus. The connective substance differs in the extent of its development in different genera, and the amount of it is in direct proportion to the "limpness" of the leech. The cells of which it consists undergo ento- or ecto-plastic metamorphosis; in the former case the cell retains its rounded form, and we may have vacuolated cells, or fat-cells; the most common representatives of the latter are the elongated or branched corpuscles, which can be easily studied in *Hirudo*, though best in *Pontobdella*. A third case is called that of ect-ento-plastic metamorphosis, and here the cell developes pigment; in the simpler conditions the cells take no part in the formation of a vascular system (Rhyncobdellidæ); in the Gnathobdellidæ the cells take part in the formation of a vascular system, botryoidal tissue, vaso-fibrous tissue; the mode of development is best studied in *Aulostomum*. Vacuolation to form capillaries is a mode of entoplastic metamorphosis. It is found that all the forms of connective and vasifactive tissue may be derived from an indifferent connective-tissue corpuscle. The phenomena they exhibit lead on to the general question, Is there any well-founded distinction to be drawn between spaces in the animal body with regard to their relations to the cell or cells surrounding them?

Mr. Bourne points out that some of the spaces in the animal body, for example, the contractile vacuoles of Protozoa, the ducts in the nephridial cells of leeches, and so on, are obviously formed by actual metamorphosis of the cells themselves, and are to be contrasted with such spaces as the lumina of invaginated gastrulæ, which are formed outside cells; we may, then, distinguish between endocytic and paracytic cœlosis. Both these processes of lumen formation (cœlosis) may be direct, the lumen appearing at once, or indirect, the appearance of the lumen being delayed.

The single vascular fluid of the Hirudinea corresponds to both cœlomic and red vascular fluids as found in the Chætopoda. In the Rhyncobdellidæ the blood is colourless, in the Gnathobdellidæ it is red, the plasma containing dissolved hæmoglobin. The author enters in great detail into the characters of the cœlomic spaces, and prefaces it by saying that by the word "cœlom" he understands "a space or set of spaces excavated in the mesoblast and distinct from blood-vessels, such as is the body-cavity of Chætopoda and Vertebrates," and he does not "undertake to discuss whether such space is a pseudocœl or an enterocœl in the Hertwigs' sense, or may be something altogether unprovided for in the artificial and valueless system of those authors." The Gnathobdellidæ are to be distinguished from

the Rhyncobdellidæ by the disappearance of all traces of a lateral sinus and of the dilatations connected therewith, as well as by the loss of all traces of the dorsal and ventral vessels; the lateral vessels and their connection with the dorsal and ventral sinus-system communicate only by a newly developed botryoidal tissue, which may play an important rôle, by forming a secondary cœlom. The communication between the existing cœlom and the true vascular system occurs either by vessels terminating with an open mouth, which is apparently provided with a sphincter in certain portions of the cœlom (e. g. the lateral dilatations and the branchiæ); or vessels may acquire a connection with new spaces forming in the connective tissue, which communicate on the other hand with small cœlomic remnants. The former method is characteristic of the Rhynco-, the latter of the Gnathobdellidæ.

After discussing in detail the characters of the nephridia of different genera, Mr. Bourne states his general conclusions with regard to them; he finds that they "present a serial arrangement with regard to their metameric repetition." The simplest condition is seen in *Clepsine*, where the nephridium in all cases opens into the cœlom on the one hand and to the exterior on the other.

The author concludes with a discussion of the question whether the Hirudinea are Platyhelminths, or more closely related to the Chætopoda. An answer to such a question must be based on a knowledge of (1) the amount of variability in any particular system of organs within the group itself, (2) the adult conditions of the systems of organs in the group as compared with other groups, and (3) the ontogenetic history of individual genera.

The last is not here used; as to the first, we note similarity of structure in many points, but variability in the characters of the anterior sucker, in the number of annuli forming a somite, and in the amount of cœlom present. "The curious distribution in the amount" of variability points to the very archaic nature of the group; the genera now living seem to have had an ancestor which presented as high a development of each system of organs as is found in any single genus of living Hirudinea.

Mr. Bourne thinks that it is quite impossible to prove that the Leeches are more highly developed Triclada or degenerate Chætopods. "The genetic relations are indirect and not direct." They present a resemblance to the Platyhelminth (1) in the possession of median genital pores; (2) in the suckers, to a certain extent; (3) in the general arrangement of muscles; and (4) in the structure of the pharynx of the Rhyncobdellidæ. They differ from Chætopods in the absence of parapodia and setæ, though the latter are, it is to be noted, absent from *Polygordius* and *Branchiobdella*. They agree with some Chætopods in the presence of a clitellum and in the habit of forming cocoons. The metamerism of the two groups may have been acquired separately and be due to different causes.

No definite statement as to the affinities of the Leeches can be given until we know the developmental history of the cœlom in them and in the Platyhelminths; the balance of evidence is certainly in

favour of their having had a common ancestor with the Triclada, but whether the Leeches have advanced or the Triclads degenerated is a problem that has yet to be solved.

External Morphology of the Leech.*—C. O. Whitman, as all who have worked at the species of Hirudinea will allow, justly refers in strong terms to the superficial and slovenly manner in which the diagnoses of species have been drawn up. He points out that no one appears to have suspected the existence of segmental sense-organs in the leech, and much less their serial homology with eyes. In the present essay he attempts, further, to show that the rings and somites form the only proper basis of classification.

The segmental sense-organs are in the form of papillæ, of which there are twenty-six transverse rows—one for each somite; they are, also, so disposed as to form eight longitudinal rows—two median, four lateral, and two marginal; the first may be regarded as the metameric equivalents of the first pair of eyes. While the true eye consists of a cylindrical mass of cells, three or four times as long as wide, in which the central portion is made up of peculiar large glassy cells, with a vacuolar central space, probably filled with some kind of fluid, the sections of the segmental papillæ present all the same elements, with the exception of a pigment-cup. The originals of the papillæ may have represented sense-organs of a more or less indifferent character, of which a few at the anterior have become light-perceiving organs, while the rest have either remained indifferent, or become specialized in another direction. Suggestions are made as to the relations of these organs to the segmental sense-organs of the lateral line in fishes.

A comparative study of *Hirudo* and the genera allied thereto is next entered on, and a careful definition of the genus *Hirudo* is given. The investigation of the abbreviated somites shows that abbreviation is greatest at either end of the body; the first six somites have lost seventeen rings, the last four eleven; this abbreviation is not, however, an actual loss, it is only a sacrifice in the interest of the rings retained; at the anterior end there has been a higher development of the sense-organs, at the posterior a greater development of muscles. It is very interesting to note that it is the non-papillate rings that have been suppressed; the abbreviation is believed to be still going on, and not to be equally rapid in different genera.

The author gives a table indicating his views as to the relationship of the genera, and in a postscript refers to Mr. Bourne's recent work, in which, he points out, there is no discussion as to the nature of the segmental papillæ, and in which the number of somites is determined by that of the ganglia.

Action of a Secretion obtained from the Medicinal Leech on the Coagulation of the Blood.†—Prof. J. B. Haycraft describes a series of experiments on the action which a secretion, obtained by solution from the medicinal leech, has on the coagulation of the blood, as

* Proc. Amer. Acad. Sci., xx. (1884) pp. 76–87 (1 pl.).
† Proc. Roy. Soc., xxxvi. (1884) pp. 478–87.

the result of which he finds that the leech secretes from its mouth a fluid which destroys the blood ferment without producing any other observable change in the blood. This fluid injected into an animal produces but slight constitutional disturbance, and is eliminated by the kidneys. The action on the rabbit is the same as on the dog; on crustacean blood it is inert. It has no action on the curdling of milk. It slightly hastens the clotting of myosin, and hastens rigor mortis.

Organization of Echinorhynchi.*—A. Säfftigen recommends that *Echinorhynchi* be killed slowly by being placed in a 0·1 per cent. solution of osmic acid, when they die in an expanded condition. Osmic acid is also the best reagent for histological investigations generally, but chromic acid and borax carmine are the best for a study of the nervous system.

The subcuticula is described as being composed of a complex plexus of fibres, a granular ground substance being altogether absent. The muscular character of these fibres is one which their general arrangement would lead us to accept. The author thinks, with various preceding writers, that the lemnisci are direct continuations of the subcuticula of the neck.

The true muscular tissue serves as the material from which most of the organs are built up; when extended, it is seen to form a continuous layer interrupted only by small spaces, and, as a rule, containing a large number of nuclei; indeed the structure appears to be syncytial. This tissue presents many points of resemblance to that of Nematodes, for, as in them, it consists of a fibrillated differentiated contractile substance, of a medullary layer, which is formed of a plexiform protoplasm, in the spaces in which there is a muscular fluid, and which contains nuclei, and of a structureless refracting membrane, which corresponds to Schneider's sarcolemma.

After a full discussion of the muscular system, the nervous system is dealt with; the cells of the cerebral ganglia are said to be proportionately larger, and, with the exception of the ovarian and seminal elements, are almost the only cells in the body which have a distinct peripheral contour. The central portion of the ganglion is occupied by a plexiform protoplasm with numerous vacuoles and some nuclei; the peripheral ganglionic cells are ordinarily unipolar, and are often in connection with nerves. The anterior median nerves are one to three in number, there is a paired lateral anterior and a similar posterior nerve-trunk. The distribution of these nerves is described.

The account of the genital organs commences with a discussion of the so-called ligament, the muscular nature of which has been already recognized by Greef; it forms a closed cylinder with a simple wall, the histological structure of which is similar to that of the muscular layers of the body; the account of the genital organs is very full.

In a concluding note Säfftigen directs attention to a recent paper by Mégnin, with many of whose results he does not find himself in accord.

* Morphol. Jahrbuch, x. (1884) pp. 120–71 (4 pls.).

Entozoic Worms.* — Dr. v. Linstow's annual paper on this subject gives descriptions of forms already known, at any rate by name, as well as accounts of new species. Twenty-six species are, in all, discussed, of which nine are new. There are some interesting observations on the widely distributed *Gordius aquaticus*, in which the author makes some criticisms on the account given by Villot.

Nervous System of Trematodes.†—From the observations of E. Gaffron it appears that in *Distomum isostomum* the nervous system consists of six longitudinal trunks connected together by a complicated system of commissures; there are three limbs on either side, one ventral, one dorsal, and one lateral. They unite anteriorly to form a dorsal cerebral commissure, which lies above the anterior part of the œsophagus. From the two lateral enlargements four nerve cords are given off, two anteriorly and two posteriorly. The ventral and dorsal longitudinal trunks undoubtedly correspond to the lateral nerves of *D. hepaticum;* at the hinder end of the animal they converge and pass into one another, while the lateral nerves remain separate. Six transverse bridges lying one behind the other, unite the ventral, dorsal and lateral trunks, and give rise to a wide-meshed nervous plexus in which are placed the viscera and generative organs. The ventral sucker is innervated by strong branches given off from the dorsal and ventral nerves. The minute structure of the nervous system offers no deviation from that already described by Lang.

Rhabdocœla from the Depths of the Lake of Geneva.‡ — G. Duplessis-Gouret, who attaches very great importance to the animals discovered at great depths either in sea or fresh water, gives an account of the Rhabdocœla of the Lake of Geneva; of these about a dozen species were found, of which one-fourth are new (? first found in the Lake of Geneva). There is evidence of their affinity to very ancient forms, and proofs that they are the remnants of a marine fauna.

The first worm mentioned is *Macrostoma hystrix* of Œrsted; the second *Microstoma lineare* Œrst.; this is remarkable for the complete absence of rhabdites from its integument, and for their replacement by what the author calls trichocysts; these are not, however, comparable to the organs so named by Allman in *Paramœcium*, but to the nematocysts, as they are ordinarily called, of *Hydra;* the author thinks that this discovery is of special importance in relation to the views of Lang as to the affinities of the Turbellaria and Ctenophora. Ciliated pits on the side of the head remind us of the similarly named parts in the Nemertinea. There is no anus, which is usually stated to be present in this genus; the intestine is provided with muscular walls and executes peristaltic movements—a phenomenon unknown in any other Rhabdocœle. The sexual organs are of the simplest character, and the sexes are distinct. The ovary

* Arch. f. Naturgesch., l. (1884) pp. 125–45 (3 pls.).

† Schneider's Zool. Beiträge, 1884, pp. 109–14 (1 pl.). Cf. Biol. Centralbl., iv. (1884) pp. 425–6.

‡ Arch. Zool. Expér. et. Gén., ii. (1884) pp. 37–68 (1 pl.).

is simple, unpaired, and devoid of any uterus or copulatory pouch. The testicular products do not seem to be formed by any special gland, but are merely developed in the peri-enteric portion of the mesoderm.

The third species, *Prorhynchus stagnalis*, has no eyes, and its skin has no rhabdites, but, in their places, there are a number of unicellular glands; the ciliated pits are less deep than in *Microstomum*. The next species described is the *Gyrator hermaphroditus* of Ehrenberg, *G. cæcus* of Graff.

Otomesostoma morgiense is most interesting on account of its frontal auditory vesicle, which is in direct relation to the bilobate cerebral ganglion; it is perfectly round, and its spherical otolith is suspended in a clear and homogeneous liquid; it is always completely at rest. On either side of the vesicle there are triangular pigment-spots, and it is possible that the organ has, at one and the same time, the function of an auditory and optic apparatus.

Mesostoma productum, *M. lingua*, *M. rostratum*, and *M. trunculum* are next described. *Typhloplana viridata* is the only species in the lake which is known to be of a green colour. This is due to the presence of unicellular parasites, which have a symbiotic relation to the worm.

Vortex intermedius is a new species, the testes of which are paired and compact, and open into a large bilobate seminal vesicle. The newness of the species is a matter of doubt; it may be only a variety of *V. truncatus*.

Plagiostoma lemani (= *Planaria lemani* Graff) is regarded as being the most important discovery among the deep-sea invertebrates of the lake. The intestinal tube has no muscular layer or special tunic of connective tissue, but rests directly on the mesoderm. There is, in fact, between the intestine and the skin nothing but a vast space which is filled up by a reticulated connective tissue with distinct nuclei where the fibres cross one another. The digestive sac is lobulated, the proboscis is protrusible, and the sexual organs follicular in character; by all these points this species shows itself to be intermediate between the Rhabdocœla and the Dendrocœla.

The author concludes by stating that this list of species is not to be regarded as being a complete catalogue of the Rhabdocœla of the lake.

Physiology of a Green Planarian.*—A. Barthélemy gives an account of his observations on *Convoluta schultzii*, in which especial attention is given to the chlorophyll-corpuscles, the physiology of which has already been investigated by Geddes. The author is inclined to look upon their presence as an example of the symbiosis of a unicellular alga and an acœlate worm, and he objects to the experiments of Geddes on the ground that they were carried on on a very large superficial area of Planarians. He finds himself that the bubbles of gas arise from fragments of sand or debris, and not from the animal; and, he asks, how could it be otherwise, when there is a continual

* Comptes Rendus, xcix. (1884) pp. 197–200.

movement of the vibratile cilia, which would oppose the formation of gas bubbles, and in the absence of any internal cavity in which the gas cou'd accumulate or circulate ?

"In reality, no vegetable or animal which is completely aquatic ever gives off gas under normal and regular conditions, and *Convoluta* offers no exception to this rule. In the presence of an excess of carbonic acid aquatic plants only give off oxygen when they present air passages where the leaves are detached from the stem, or when there is a layer of air on their surface." When there is an abnormal quantity of carbonic acid *Convoluta* deposits in its mesoderm very small grains of amyloid matter; it is killed when the excess of carbonic acid is too great. *C. schultzii*, then, absorbs through its cuticle carbonic acid in dissolution, which the chlorophyll decomposes in producing oxygen. This is wholly or partly utilized by the animal, in such a way that, if oxygen is expired, it can only be in very small quantities, and, under normal conditions, not in the gaseous state; the mode of respiration has a striking analogy to that of submerged aquatic plants.

Echinodermata.

Structure of Echinoderms.*—C. F. Jickeli has a preliminary note in which he states that he has made experiments confirmatory of the doctrine of Carpenter as to the nervous system of *Comatula*. He finds that a single arm gives no response when the ambulacral groove is touched with a needle or stimulated by an electric current, but that the moment the needle touches the point at which the axial cord lies the arm is strongly flexed, and the pinnulæ move actively. A single cirrus when stimulated appears to be thrown into a tetanic condition. Many of the author's experiments are in exact agreement with those of Carpenter. After the removal of the visceral mass irritation of the capsule produces a synchronous contraction of all the arms. If a few drops of osmic or acetic acid are put in the water the "torso" moves as actively as an uninjured animal.

The author describes the structure of the cirri, and the processes which pass from the "spongy organ" into them. The observations of P. H. Carpenter that nerve-branches pass into the dorsal and the ventral muscles is confirmed. A series of sections shows that the ambulacral nerve diminishes in extent as it approaches the intestine, and finally disappears. Attention is drawn to the fact that Götte describes the epithelium of the so-called ambulacral groove of *Comatula* as being endodermal in origin.

A third nerve-centre is described as being present in the connective tissue, and as forming a pentagonal cord around the mouth. The lateral cords are connected by branches with one another at the angles of the pentagon, and they extend along the water-vascular system. Each of these cords gives off lateral branches at regular distances, and these innervate the water-vascular system and the papillæ of the tentacles. Other well-developed branches are also

* Zool. Anzeig., vii. (1884) pp. 346-9, 366-70.

given off to the ventral integument of the body, where they are lost in a fine nervous plexus. Ludwig's view of the glandular character of the tentacles appears to be incorrect. They have 3–4 sensory hairs and a centrally-placed slowly-moving flagellum. From these observations it would follow that the tentacular papillæ are complicated sensory organs.

Nervous System of Antedon rosaceus.*—This paper of Prof. A. Milnes Marshall is of especial interest after the recent communications † of Dr. Carpenter and Dr. Herbert Carpenter. After a short account of the general anatomy of *Antedon*, and an historical sketch of what has been done with regard to its anatomy and physiology, the author passes to an account of his own experimental investigations. The normal position of *A. rosaceus* is fixed; when it swims about it does so by strongly flexing the proximal half, and then extending the whole arm, the distal half of which is thrown out somewhat like a whip-lash or the line of a fly-rod. Irritation of the oral pinnules, however slight, causes them to be firmly fixed over the disk; if an *Antedon* be detached and placed with its oral surface downwards it will right itself almost at once. If an arm be cut off it will retain its vitality for many hours, and at first exhibit strong movements of flexion.

The first series of experiments were made on the *Effects of Removal of the Visceral Mass.* A large and vigorous specimen after evisceration swam about the tank actively, and, after a period of rest, again began spontaneously to move about; this experiment is the same as one of Dr. Carpenter's and proves that the co-ordinating mechanism which regulates the complex swimming movements of the arm is entirely without the visceral mass. The destruction of the direct connection between the sub-epithelial bands of the several arms renders it doubtful whether these bands have any regulating influence. Another experiment showed that the nervous connection between the sensory influence of any one of the arms or pinnules and the muscular system is outside the visceral mass. A third experiment gave evidence that the co-ordinating centre of the complex muscular movements is situated in the calyx.

The Power of Regeneration of Eviscerated Specimens has been observed in a series of specimens, on which the author promises fuller details; it is already clear that the power of regeneration in *Antedon* exceeds even that which is well known to be possessed by Holothurians.

The Functions of the Central Capsule were seen by experiment to be such that irritation causes strong flexion of the arms, and there is clearly a direct physiological connection between the capsule, and the muscles of the arm; and it is further clear that the sub-epithelial bands form no part of the central mechanism. Removal of the central capsule destroys the co-ordinating mechanism between the arms.

The Axial Cords were found to be the means of communication between the distal end of the arm and the motor mechanism; in other

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 507-48 (1 pl.).

† See this Journal, *ante*, p. 501.

words, the axial cord conveys impulses centripetally; and it appears also to be the sole means of afferent communication. As to their motor functions the results are similar, division of the axial cord destroying motor communications. The two arms of each pair are connected with each other by a transverse commissure.

The Sub-epithelial Bands appear to be nerves, and have probably a special and subordinate function in connection with the ambulacral tentacles and epithelium.

The author concludes with some observations on the morphology of the nervous system of Crinoids. He considers that the sub-epithelial bands are homologous with the radial nerve-band of an Asterid, and he looks upon the antambulacral nervous system (i. e. the central capsule, and axial cords with their branches) as being derived from the antambulacral part of the primitive nerve-sheath which invested the body, and not as an entirely new set of structures. The external and internal plexuses of *Echinus*, with their connecting fibres in the substance of the calcareous test, offer us an arrangement not altogether unlike that of the Crinoid. The difference, it must be remembered, between Crinoids and the rest of the Echinoderms is very great; not only is the Crinoid condition primitive, it is also highly specialized.

Nervous System of Crinoidea.*—Dr. W. B. Carpenter recapitulates the history of his inquiry into the nervous system of Crinoids, and indicates the points in which the histology and anatomical distribution of the fibres, which he has thought to be nervous, support his view. The theoretical homology of the relations between Crinoid and other Echinoderms is opposed by such facts as:

1. The absence of any branches from the sub-ambulacral nerves to the muscular apparatus of the Crinoidea generally.

2. The absence of sub-ambulacral nerves from those pinnules of *Antedon* which are most distinguished by their sensory endowments.

3. The absence of the same nerves from a large proportion of the arms of *Actinometra*, which, nevertheless, take their full share in the co-ordinated swimming movements of these animals.

4. The continued performance of these movements by *Antedons* from which the whole visceral mass, including the oral ring, has been removed, and by arms whose sub-ambulacral nerves have been cut near their base.

A point of great interest is the existence of a definite nervous system with very little histological differentiation; there is no definite distinction between ganglionic centres and nerve-trunks; almost every part of the apparatus is, probably, capable of originating as well as of conducting. That the axial cords are not mere conductors seems to be proved by the performance of active spontaneous movements by arms detached several days before from the body.

Dr. Carpenter refers to the views of his son and of Prof. Perrier who have supported his views from the anatomical side, and to the physiological experiments of Prof. Marshall and Dr. Jickeli.

* Proc. Roy. Soc., xxxvii. (1884) pp. 67-76.

Asteroidea of the Norwegian North Sea Expedition.*—D. C. Danielssen and J. Koren here give in a handsome and connected form, the results of their studies on the starfishes collected by the Norwegian North Sea Expedition, which have been separately published from time to time. The work is illustrated by fifteen plates as beautiful as those in preceding essays by the same naturalists. Reference is made to the difficulties of diagnosing the species, owing to the paucity of material, or the rarity of specimens for comparison, or the scattered condition of papers on the group, and their general lack of illustrations. The collection contained 41 species belonging to 20 genera; of these 11 species and 4 genera are new.

In face of the views held by various naturalists as to the significance of Prof. Perrier's discovery of *Caulaster pedunculatus*, it is interesting to note that Danielssen and Koren think that Perrier is correct in supposing that his new form is a connecting link between the Crinoidea and Asteroidea; their observations on their genus *Ilyaster* confirm the supposition. In the developmental stages of the Echinodermata the Crinoid represents the oldest and the Asteroid the youngest stages in the process.

Mimaster, a New Asterid.†—W. Percy Sladen describes a new and magnificent starfish, *Mimaster tizardi*, which is remarkable for presenting indications of affinity to several groups of starfishes. The arrangement and appearance of the paxillæ recalls *Solaster;* but the skeleton, in place of having its abactinal portion consisting of a closely reticulated calcareous framework, in which the paxillæ are borne, has it formed of paxillæ alone, the bases of which are closely placed, and occasionally overlap; this is the structure which has hitherto been supposed to be distinctive of the Astropectinidæ. *Mimaster* resembles the Goniasteridæ in the adambulacral plates, the ambulacral spines, and the mouth plates; the ventral plates recall those of the *Asterinidæ*, and have some likeness to the arrangement in the *Goniasteridæ*. The genus appears to be most closely allied to *Radiaster*, lately described by Perrier; but there are striking and important points of difference between them. The present form was collected by the 'Knight Errant' in the Faeroe Channel at a depth of 555 fathoms.

Amphicyclus, a New Holothurian.‡—Prof. F. Jeffrey Bell gives an account of a new genus of dendrochirotous Holothurians, for which he proposes the name of *Amphicyclus japonicus;* it is remarkable for having the ambulacral suckers arranged in regular rows (stichopod), together with the tentacles in two circles, fourteen in the outer, and ten in the inner; it seems to be most closely allied to *Actinocucumis*, with a stichopod arrangement of suckers and from 18–20 tentacles.

The author proposes to rearrange the Dendrochirotæ, by first taking note of whether the arrangement of suckers is regular

* 'Den Norske Nordhavs-Expedition 1876–8. XI. Asteroidea.' fol., 1884, 118 pp. (15 pls.). (In Norwegian and English.)

† Trans. Roy. Soc. Edin., xxx. (for 1881–2) pp. 579–84 (1 pl.).

‡ Proc. Zool. Soc. Lond., 1884, pp. 253–8.

(stichopod) or scattered over the surface of the body (sporadipod); some of the stichopod forms are armed with a rich supply of calcareous plates in their integument, and these are distinguished from the unarmed forms. Having thus arranged the genera in three groups, he takes as his second point of distinction the character of the tentacles; of which there may be ten radial and subequal, or ten radial, of which one pair is smaller than the other four; or more than five pairs. A phylogenetic table is given showing the affinities of the genera in relation to these co-ordinates.

Cuvierian Organs of the Cotton-Spinner.*—Prof. F. Jeffrey Bell gives a technical account of this almost unknown British Holothurian, which is of interest as being the only true—that is aspidochirotous (or with shield-shaped tentacles)—member of the class which is known to occur in the British seas.† The organ of most importance is that which produces the sticky secretion from which these animals have obtained their name, and which makes them objects of much dread to the Cornish fishermen. The producing or Cuvierian organs are described as forming a solid mass which occupies a large portion of the body-cavity, and which is made up of a number of separate tubes; a small coiled portion was found lying in the cloaca as if ready for ejection. A small piece of a tube measuring only 2·5 mm. was found, even after twenty years' immersion in spirit, to be capable of extension to twelve times its own length; while, when treated with water, the attenuated thread swells up to seven times its own breadth. "We can thus understand that an animal at whom these threads are thrown should, as it attempts to escape, lengthen the threads which, at the same time, coming into contact with the water, would be swollen out transversely as they were extended longitudinally." Prof. Bell thinks that the observations confirm the view of Semper as to the protective or offensive character of these organs, which by Jäger and most later anatomists have been thought to be renal in function.

In a subsequent note ‡ Prof. Bell states that six threads, any one of which was only barely visible, were capable of supporting a weight of nearly a thousand grains; and § quotes a letter from a correspondent to say that the black Holothurians near Porto Fino emit a tangled mass of white threads so sticky and in such quantity, that it was difficult to free the hands from them.

Porifera.

Vosmaer's Sponges.—The sixth part of this work ‖ (pp. 145–76 with plates XV.–XVIII.) has been published. The skeletal system is here entered upon, and, after an account of various systems of

* Proc. Zool. Soc. Lond., 1884, pp. 372–6.
† *H. intestinalis* of Norway has been found in the Minch.
‡ Nature, xxx. (1884) pp. 146–7.
§ Op. cit., p. 194.
‖ See this Journal, *ante*, p. 397.

classification, the characters of the spicules are described. Useful tables give the synonyms of the very various names applied to these bodies, and the author describes his system of formulation or rather stenography.

Protozoa.

Nuclei of Infusoria.*—In several Infusoria Dr. C. F. Jickeli has observed the extrusion of "polar bodies," a process entirely similar to that known to occur in the ovum; as in the case of the ovum these bodies are extruded from the greatly enlarged nucleus. In *Stylonychia mytilus* and other forms, the same observer has noted a multinuclear condition produced by the division into a number of irregularly sized fragments of the original nucleus; this may occur previously to any conjugation; it was found possible to produce the same effect by artificial means; examples of *Paramœcium caudatum* kept for eight days in the dark always showed this phenomenon, but the nucleolus remained unaltered. On the other hand a condition occasionally supervenes where the nucleus has entirely disappeared. During division the so-called nucleolus assumes the spindle form, but the nucleus does not; neither of these bodies however initiate cell-division which is always recognizable in the first place by the changes in the cell-protoplasm itself. The conjugation of Infusoria is a subject which has engaged the attention of many naturalists and their results are very conflicting; it appears that in some exceptional cases three individuals may fuse together, though more generally two; when this has taken place the Infusorian remains motionless for a time; the changes which follow commence in the cell-protoplasm and only subsequently extend to the nucleus; in those forms which possess a nucleolus the latter becomes widely separated from the nucleus at the commencement of conjugation or even before, but is connected with it by a fine thread; the nucleolus divides into a number of bodies, and in *Paramœcium* at any rate it is quite clear that there is an exchange between these two individuals of their nucleolar bodies; no such exchange was observable in the case of the nucleus.

New Infusorian—Ctedoctema acanthocrypta.†—Dr. A. C. Stokes has found on *Lemna* an Infusorian to which he gives the above name and the following diagnosis:—

Ctedoctema, gen. nov. (Greek, *ktedon*, a comb; *ktema*, a possession). Animalcules free-swimming, more or less ovate, persistent in shape, entirely ciliate; oral cilia diverse to those of the cuticular surface; oral aperture ventral, located at the posterior termination of a longitudinal, ciliated, adoral depression or groove which bears on its right-hand border a row of large acutely curved setose cilia, gradually diminishing in length towards the oral aperture which they surround, and with their distal extremities conspicuously thickened; several long setose hairs projecting from the posterior extremity of the body,

* Zool. Anzeig., vii. (1884) pp. 491–7.

† Amer. Natural., xviii. (1884) pp. 659–66 (4 figs.).

usually a single one being distally curved; contractile vesicle single, posteriorly placed; trichocysts large and numerous.

C. acanthocrypta, sp. nov. (Greek, *akantha*, spine; *kruptos*, concealed). Body elongate ovate, widest and rounded posteriorly, tapering to an obtuse anterior apex, subcylindrical, slightly compressed, the length twice to two and one-half times the breadth, a hemispherical sarcode bubble usually present on the left-hand dorso-lateral border; cuticular cilia long, fine, setose, a single postero-terminal seta usually distally curved; oral aperture ciliated, remote from the anterior apex, placed at the posterior termination of a shallow, narrowly ovate, ciliated, adoral groove centrally and longitudinally traversing three-fourths of the ventral surface, and bearing on its right-hand margin a flexible comb-like appendage composed of large, coarse, non-vibratile cilia, thickened distally and diminishing in length as they approach the oral aperture, which they surround, the adoral groove also bearing near its left-hand margin a row of long, fine, vibratile hairs, and throughout its entire length a series of long vibratile cilia, somewhat fascicled anteriorly, and shortening as they approach the mouth; contractile vesicle single, subterminally located near the right border; nucleus ovate, mesially placed in the anterior body-half; trichocysts large, straight, apparently prismatic, tapering to an obtuse point, and bearing distally two or more minute, radiating, linear processes. Length of body 1/1000 in.

The author thus deals with the question of reproduction:—"That reproduction is by transverse fission goes without saying. But if only that, imagine, if you can, what becomes of all the complex ciliary arrangement about the oral region. The creature to be fashioned from the posterior half of the mature body must have not only a ciliated adoral sinus, and the comb-like appendage, all of which simple division crosswise would give, but it must somehow obtain that ciliary fascicle at the anterior apex of that sinus. The posterior termination of the old *Ctedoctema's* groove has no such tuft to give the new creature, and the latter cannot, at least does not, exude sarcode filaments that shall stiffen into cilia. Then, when and how? Oh, it is so simple and so easy when it is once thought of! But no one ever would think of it without seeing it.

It is in this way. The cilia of that comb deliberately unite laterally and form a membrane. The anterior cilia of the sinus unite with it and lengthen the membrane to the front, the newly-formed tissue being widest somewhat in advance of its centre, and narrowing toward both ends. The animal then separates across the middle, forming two Holotrichous creatures, each with a perfectly smooth, unwrinkled membrane vibrating somewhat obliquely along the centre of its ventral surface, the free edge of this tip-tilting tissue being distinctly and strongly thickened. What scheme of classification has a place for them now? If they and the systematist should have a temporary encounter, what would he do with them? Would each be a fresh-water *Lembus*? Such questions give them no trouble. They at once proceed to form their ciliary appendages by splitting up their membrane to suit. The fringes unite to form the membrane,

the membrane divides to form the fringes, the thick edge then going into the thickened extremities of the adoral comb. In two hours, more or less, the sweet-water *Lembus* is a sweet-water *Ctedoctema*."

New Fresh-water Infusoria.*—Dr. A. C. Stokes also describes and figures some new genera and species of fresh-water Infusoria.

Loxodes vorax n. sp. resembles *L. rostratum* Ehr. superficially, but their anatomical differences are more conspicuous than their likeness. Its favourite diet is diatoms and small rhizopods.

Apgaria nov. gen. is probably near *Blepharisma* in systematic position. There are three species, *A. undulans*, *A. ovata*, and *A. elongata*. *Ileonema* nov. gen. *I. dispar* nov. sp. closely resembles in contour *Tracheophyllum apiculatum* C. & L. If from the latter the acutely conical anterior apex is removed and the flagellum of *Ileonema* be added, "the result would be a species of the genus now under notice, the likeness between the contrasted forms being also striking." The author thinks it may be considered a link intimately connecting the two orders of the Flagellata-Eustomata and the Cilio-Flagellata.

Solenotus nov. gen. approaches nearest to Stein's *Colponema*, but cannot be admitted into that genus by the absence of the anterior curvature, by the apical origin of the trailing flagellum, and by the presence of a dorsal instead of a ventral groove. Two species, *S. apocamptus* and *S. orbicularis*, are described.

Life-history of Stentor cæruleus.†—Prof. G. W. Worcester gives a detailed description of the development and life-history of *Stentor cæruleus*, which can hardly be satisfactorily abstracted. When first observed it appeared a motionless, intensely blue mass, containing what seemed to be a row of internal vacuoles, which later proved to be the moniliform endoplast of the mature infusorian. A larger vacuole was observed that subsequently became the mouth. The mass slowly changed its form, developing cilia at each extremity. The cilia eventually disappeared from one end, the shape was constantly varied, and in a little less than two hours it had put on the mature form and was swimming very rapidly. Conjugation with another specimen was then observed, each fastening itself by its posterior end to some object, their backs meeting, when they would roll over each other till their anterior extremities met. Conjugation lasted some moments when the specimens separated and swam away. The individual observed lost its bluish tint and became of a bronze colour. About an hour and a half after the conjugation it stopped suddenly, assumed a flat spread-out condition, whilst at the same time large vacuoles appeared throughout its entire mass. In appearance it was *amœba*-like and after a time small masses became detached and immediately assumed a globular form. The detachment of masses whilst in this *amœba*-like stage in other specimens was witnessed, as also their development into mature forms.

The main mass would in some instances disintegrate after portions

* Amer. Journ. Sci., xxviii. (1884) pp. 38–49 (10 figs.).
† Proc. Central Ohio Sci. Assoc., i. (1884) pp. 97–106 (4 pls.).

had been detached to form new individuals, nearly all the granular mass flowing out and leaving a row of egg-like bodies, the exact nature of which the author was unable to determine; he considers, however, that in them begins the cycle of life.

In one instance the specimen under observation only partially disintegrated, "the ciliated part and a little more" remaining intact and subsequently reforming into a perfect individual. Reproduction by the formation of internal embryos was also observed, likewise the rarer method by fission proper.

Prof. Worcester considers the primitive form to be that of a sphere and that the series of later forms assumed are so taken on by the creature in order to adapt itself more fully to its environment. The posterior end would seem to be appended more for locomotion and for the purpose of fixing itself. Conjugation must in some way play an important part in the rearranging of the protoplasm.

New Protozoa.*—O. Nüsslin describes four new Protozoa from a lake in the Black Forest. The first is a new genus of Rhizopoda, to which he gives the name of *Zonomyxa violacea;* it is defined as a large fresh-water Rhizopod, nearly spherical in form when at rest, and completely inclosed in a delicate chitinous investment, and as giving off, by a number of small violet vacuoles, a violet coloured protoplasm; it may or may not have nuclei, which vary in size and number. Large individuals have a diameter of from ·15 to ·2 mm. The chitinous investment has great contractile power, and is remarkable for its power of resisting the action of acids and alkalies, even when highly concentrated. The contained protoplasm is vacuolar or reticular, but has a homogeneous thickened periphery. Small violet vacuoles are scattered through the whole of the interior, but especially form a subperipheral zone; the colouring matter is extraordinarily sensitive to the influence of very dilute acids or alkalies. In addition to these coloured there are also colourless vacuoles, which cannot be strictly said to be contractile. Highly refractive bodies, resembling the "Glanzkörper" described by Greef in *Pelomyxa*, were also observed. A completely developed nucleus does not seem to appear until about the period of encystation, and thence a number are to be seen; the substance of which they are composed seems to be excessively soft, and their contents are made extraordinarily pale and almost homogeneous by the addition of 10 per cent. solution of acetic acid. It is particularly noted that some time after encystation, when the true nuclei have disappeared, and the protoplasm has lost its colour and vacuoles, large homogeneous protoplasmic masses appear; these, however, are not, as a rule, acted on by carmine, and do not appear to be of a nuclear nature. The movements of the body are of very various kinds; sometimes they creep like a flatworm or a leech; the varieties of branching seem to be beyond description.

After describing the process of encystation the author passes to a discussion of the systematic position of his new genus, and allocates

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 697–724 (2 pls.).

it between the two genera *Amphizonella* and *Pelomyxa* described by Greef; with the former it agrees in the mode of formation of its investment and of its pseudopodia, and in its violet colour; with the latter in the vacuolated character of its protoplasm, the possession of refractive bodies, and in the peculiarities of its nucleus.

The new species of Vorticellid next described is a species of *Vaginicola*—*V. bütschlii*—which is found attached to plants; the body has green granules, is rounded posteriorly, and has no stalk-like organ of attachment; the shell is more or less depressed, and has a lateral keel at its hinder end. The shell, which varies greatly in form, is in all cases to be recognized by its wide orifice; it is bright brown in colour.

Another new Vorticellid is *Epistylis ophrydiiformis*, which is extraordinarily elongated, is attached to low and very thin branched stalks, but is not rarely found separated. It is especially interesting from the possession of an organ which is connected, on the one hand, with the vestibule, and, on the other, with the contractile vacuole; this has the function of allowing the vacuole to empty itself into the vestibule. It may be called the reservoir-apparatus, as it is clearly a highly differentiated stage of the organ already seen in *Carchesium polypinum* (Greef), and three species of *Vorticella* (Bütschli). The reservoir is a rounded vesicle containing a spongy network of protoplasmic filaments, has a tubular neck-like appendage, and contains in its walls distinctly contractile bands, which appear to cross one another. The sack, which is connected with the contractile vacuole, expands on every systole of the vacuole. The bands on the surface of the sack must be regarded as contractile protoplasmic bands, which, on the principle of division of labour, have taken on the duties which, in other Protozoa, were performed by the protoplasm of the cell generally. On the whole, the reservoir may be regarded as a regulator of the movements of the contractile vacuole.

The last form described is *Amphitrema stenostoma* n. sp., in which the two orifices of the test are narrowed inwards in an infundibular fashion, but have no external circular ridge or any constrictions. The nucleus is large and vesicular. It appears to be most nearly allied to *A. wrightianum* of Archer, and the differences between the two forms are successively pointed out. Attention is directed to the fact that the pseudopodia are sometimes distinctly lobate, and sometimes as distinctly filamentar, and once pseudopodia of the two kinds were seen to be simultaneously extruded from either hole. The test seems to have the chemical character of the cell-membrane of the Desmidiaceæ. Foreign bodies, in the form of small stones and crystals, more rarely of diatom tests, are to be found closely packed, especially at one pole of the body.

'Challenger' Foraminifera.*—H. B. Brady's report treats fully of the classification of the Foraminifera, with a sketch of the gradual development of our knowledge from the time of D'Orbigny (1826) to

* Report of the Voyage of H.M.S. 'Challenger.' Zoology, ix. (1884) 800 pp. (115 pls.).

the present, and it has an elaborately compiled bibliography. The various classifications of the Rhizopods, from that of Dujardin in 1841 to that of Leidy in 1879, are glanced at. More details are given as to the various attempts at classifying the Foraminifera, and the author proposes a scheme differing in many respects, and often widely, from those given by previous writers, but one which, in its essential elements, is in no way incompatible with the different conclusions at which they had arrived. The nature of the investment of the animal —that is to say, the minute structure of its test—as an exclusive basis for the primary divisions of the order has been abandoned. While under all circumstances it furnishes important characters, and is even in some families quite distinctive, it is nevertheless a fact that, whilst there are certain groups which are invariably arenaceous, and some which are always calcareous and perforate, there are yet others in which no uniform rule obtains. The author omits any division of the order into sub-orders, not finding any easily recognized characters to serve as a basis for such subdivision, and he divides the order at once into families. These families are (1) Gromidæ, (2) Miliolidæ, (3) Astrorhizidæ, (4) Lituolidæ, (5) Textularidæ, (6) Cheilostomidæ, (7) Lagenidæ, (8) Globigerinidæ, (9) Rotalidæ, (10) Nummulinidæ. The Gromidæ, a family composed chiefly of fresh-water organisms, "have been a source of considerable trouble, on account of the want of accuracy and detail in the published descriptions of a number of types more or less closely allied to the group, and only such genera have been included as are known to have long, reticulated pseudopodia."

One of the most interesting subjects in reference to deep-sea deposits is their direct connection with the pelagic species of Foraminifera. As a rule these forms are not of pelagic habit; on the contrary, probably 98 or 99 per cent. of the known species or varieties live in the sand or mud of the sea-bottom, and possess no powers of floating or swimming; but, on the other hand, some few forms, belonging to eight or nine genera, do most certainly pass their existence either in part or in whole at the surface of the ocean, or floating at some depth below that surface. These forms are found, too, in immense profusion, and a relatively very large mass of the oceanic deposits consist of their calcareous shells. A list of the at present ascertained pelagic forms is given. The most prominent genera are *Globigerina*, *Pulvinulina*, *Hastigerina*, and *Pullenia*. The question seems still unsettled as to whether the species are exclusively pelagic, passing the whole of their time living at or near the surface, or whether they can or do pass a certain portion of it on the sea-bottom. Mr. Brady adduces a series of facts which tend to the inference that the Foraminifera which are found living in the open ocean have also the power of supporting life on the surface of the bottom-ooze, and further, so far as our present knowledge goes, there is at least one variety of the genus *Globigerina* which lives only at the sea-bottom; but the author is most cautious not to express any dogmatic opinion on the subject.

In dealing with the composition of the test, the presence of a

considerable percentage (6 to 10) of silica has been established as existing in the arenaceous forms. The substance secreted for the incorporation of the foreign bodies which cover the test has been proved to be composed of ferric oxide and carbonate of lime in variable proportions, the former being often in considerable excess. It is not without interest to note the presence in some of the porcellanous forms of a thin siliceous investment. A few *Miliolæ* from soundings of a depth of about four and a half miles, with somewhat inflated segments, scarcely distinguishable in form from young thin-shelled specimens of a common littoral species, were found to be unaffected by treatment with acids, and upon further examination it became apparent that the normal calcareous shell had given place to a delicate homogeneous siliceous investment. While immersed in fluid, the shell-wall had the appearance of a nearly transparent film, and this when dried was at first somewhat iridescent.

A list is given of those stations from which soundings or dredgings were obtained in sufficient quantity to furnish good representative series of Rhizopods, and maps are appended showing the tracks of the 'Challenger,' with these stations marked, as also of the areas explored by the 'Porcupine' and other northern expeditions.

Any generalized summary of the details of the new forms would be impossible. Of the several hundred species described and figured, over eighty are here noted for the first time, and this without counting numerous well-marked and named varieties, or the numerous new forms already diagnosed in Mr. Brady's preliminary reports.

The family Astrorhizidæ is the one which has received the largest number of additions; indeed our acquaintance with the larger arenaceous Rhizopods is almost entirely derived from the various recent deep-sea explorations. A knowledge of the life-history of these forms is still needed to place the classification of the group on a secure basis, and as some few of the forms are inhabitants of comparatively shallow water, their investigation would seem to be well worthy of the attention of observers at some of our zoological marine stations. Many other problems to be solved are also pointed out in this report, the extreme value of which will be recognized by all students of biology.*

Copulation in Difflugia globulosa.†—But few observations have been recorded on the copulation and conjugation of Rhizopoda. An instance of this phenomenon has been studied by Dr. C. F. Jickeli who gives the following description of it. Two examples of *D. globulosa*, one distinguishable by the greater transparency of its shell, were observed to attach themselves together by the mouth aperture; from this point four long and mobile pseudopodia extended themselves; in 24 hours the animals were still firmly attached, but the pseudopodia had vanished; after the lapse of another 24 hours the shells had become detached. On investigating the two by means of reagents, it was found that the shell of the individual formerly recognizable by its

* Nature, xxx. (1884) pp. 533–4.
† Zool. Anzeig., vii. (1884) pp. 449–51.

greater transparency was entirely empty, while the protoplasm of the other contained two entire nuclei, and another partly broken up into fragments. This process appears to be undoubtedly a kind of copulation, though the actual coming together of the two individuals was not observed; it is evidently no case of division and the only possibility is that it might be equivalent to a rejuvenescence; this objection may, however, be refuted by the observation of the active pseudopodial processes and by the breaking up of one of the nuclei, and also by the fact that it was not the more transparent but the more granular individual which finally retained the whole protoplasm of the two; moreover in other individuals of the same species the most careful search failed to show more than one or two nuclei. It appears therefore that (1) copulation takes place among Rhizopoda as well as among Infusoria; (2) during the process there is a stage of diminished vital activity in both groups; (3) as a result of the process there is a breaking up of the nuclei.

Development of Stylorhynchus longicollis.*—The results of A. Schneider's researches on the development of this Gregarine, may be thus summed up:

Stylorhynchus longicollis passes through most of the stages of its development, and often even acquires the characters of the adult, in the interior of an epithelial cell of the intestinal tract of *Blaps*. This fact shows that Giard is not justified in drawing a distinction between Gregarines as forms living in cavities where they are free and Psorosperms as being intracellular parasites. One and the same epithelial cell may contain a varying number of inhabitants, which may either be separated from one another, or united in groups; in the latter case they are more or less deformed by the pressure they exert on one another. The parasites may be found between the nucleus and the nuclear membrane. At first they are identical with the forms known as Coccidia, and, in their development, four stages are to be distinguished; in the first they are simple cells with a solid nucleus, in the second the nucleus becomes vesicular, in the third they have the form of segmented cells with a nucleus in the proximal segment, and in the fourth they are segmented cells with a nucleus in the distal segment.

The segmentation of the body, which is at first purely external and superficial, precedes the migration of the nucleus from one to the other pole. The septa in the cell do not appear until after the migration of the nucleus. The cavity in the rostrum corresponds to the position occupied by the nucleus before its migration. The segment first produced is the fixation-apparatus of the adult; the next to appear is the deutomerite or distal segment, then the protomerite, and then the neck.

Strictly speaking, the first segment buds off the rest, and the phenomenon of spontaneous mutilation is, morphologically, comparable to the act by which a bud is separated from the mother-cell. In *S. longicollis* development is direct, for there is no alternate generation, or

* Arch. Zool. Expér. et Gén., ii. (1884) pp. 1–36 (1 pl.).

any change of host. The second parasite *Chytridiopsis socius*, which is sometimes found in the epithelial cell with *Stylorhynchus*, has nothing to do with the developmental history of the Gregarine.

Flagellated Organisms in Blood of Animals.*—T. R. Lewis describes certain flagellated organisms which he first detected in the blood of two species of *Mus*, and which have since been seen in other animals; the characters of these are given in detail. Notwithstanding many attempts a flagellum could be demonstrated at one end only. The author is wholly unable to explain the presence of these flagellated organisms in blood; for some time he was inclined to think that they were the spermatozoa of some parasite hidden in the tissues of the animal, but further observation showed that the contents of the segments of a tapeworm were much more sensitive than they to the action of water. Saville-Kent has named them *Herpetomonas lewisi*, but points out that further research "may possibly demonstrate their identity with the discharged spermatic elements of the minute nematodes, micro-filariæ, or other metazoic endoparasitic forms known to flourish amid the same surroundings."

Parasitic Proteromonadidæ.†—By way of a first contribution to a monograph of the parasitic "Infusoria," J. Künstler describes two new forms belonging to the Proteromonadidæ, which ranks as the lowest family in the Monads, and may be considered as occupying to a certain extent an intermediate position between some of the Schizomycetes and the Monads.

Two species constitute the family:—*Proteromonas Regnardi* inhabits the intestine of *Cistudo europœa* Schneid.; in which it swarms, often forming a considerable mass of intertwined individuals in the digestive tube. It is divisible into flagellum and body. The flagellum, often more than twice the length of the body, is single and placed at the anterior extremity of the body, with which it appears to be continuous, owing to its remarkable size at the base. In its minute structure the flagellum presents no exceptional characteristics, and the author found in it the same alternation of dense and aqueous portions that he previously described in other forms.‡ The body is about ·022 mm. in length and divisible into two portions. The posterior portion constitutes a sort of tail, and plays the part of a locomotor organ whose power is frequently increased by the existence of a caudal filament of extreme tenuity and often invisible. The anterior portion is more complex and colours intensely under certain reagents, such as hæmatoxylin. The examination of the surface ordinarily presents bosses and folds as if a loose membranous envelope were wrapped round an internal body.

The reproductive phenomena are very extraordinary. The anterior region of the body often exhibits swellings, most frequently situated on the dorsal face, but also often on the ventral. Some of

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 357–69.
† Ann. Sci. Nat. Bordeaux, ii. (1883) pp. 45–54 (2 pls.).
‡ Bull. Soc. Zool. France, vii. (1882) pp. 1–112.

these after attaining certain dimensions contract more or less at the point of attachment to the body so as to be sharply distinguished from it by a circular furrow. They sometimes form an annular swelling. The author considers that he has established with "a certainty nearly complete" that they give rise to new individuals. Multiplication also takes place by a species of transverse fission.

The other species described is *Giardia agilis* Künst.*

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Observations on Vegetable and Animal Cells.†—In the first part—the only one yet published—J. M. Macfarlane deals with the vegetable cell, and especially with that of *Chara fragilis*. The author has already shown that a nucleolus and a nucleolo-nucleus, or (as he now, at Prof. Rutherford's suggestion calls it) an *endonucleolus*, are essential parts of every growing vegetable cell. In stages where there are several nuclei, Mr. Macfarlane found that staining in eosin, &c., with previous decolorizing of the preparations, enabled him to see the nuclei better than with the osmic acid process. No definite observations were made on the endonucleus of *Chara*, on account of its having been too deeply stained. In every active embryonic cell, only one nucleolus is present in the resting state, and the action of reagents and its thick and viscid nature indicate that it is a vesicle containing richly differentiated protoplasm. The nuclear spindle or barrel is regarded as being merely a scaffolding thrown across the space between the halves of the dividing nucleus, and so helping the protoplasm in its work of depositing the septum. No definite spindle is to be seen in *Chara*.

There appears to be evidence that in all plants the multinucleolar is succeeded by a multinuclear condition, and the author regards it as a general principle that, after cell-formation has ceased, the cell-contents (especially the endonucleus and nucleolus) persist in their activity for a shorter or longer period; and this activity depends on the condition of nutrition of the cell.

In summing up, Mr. Macfarlane says, "It will be seen that I regard the building-up of cells to form a definite plant or the parts of it, as the result of a force radiating from the cell-centre, stimulating to division; and either that the energy giving rise to this force is equal to producing only a certain amount of tissue, or that it is inhibited or resisted by some external force, which prevents it forming an excess of tissue, when this would tend to pathological change, or to loss of individuality in the plant. The most exalted type of cell is

* See this Journal, ii. (1882) p. 804.

† Trans. Roy. Soc. Edin., xxx. (for 1881–2) pp. 585–95 (1 pl.).

one with abundant protoplasm containing a single nucleus, nucleolus, and endonucleus; a cell with vacuolated protoplasm, one nucleus, and two to four nucleoli is less exalted; the multinuclear state is most degraded."

Structure and Division of the Nucleus.*—L. Guignard has re-investigated the phenomena connected with the division of the cell-nucleus in the mother-cell of the pollen-grains, and in the ovary; the plants examined being chiefly monocotyledons—*Lilium Martagon*, *Allium ursinum*, *Alstrœmeria pelegrina*, *Listera ovata*, and others. At the time of division the nucleus is invested with a delicate membrane which behaves to reagents in the same way as the microsomes of the cytoplasm surrounding the nucleus. It is coloured by carmine and hæmatoxylin, while safranin scarcely reveals it; with slightly acidulated methyl-green it presents a double contour and a much more pronounced staining than the cytoplasm.

The author agrees with Strasburger—contrary to the opinion of Flemming—that when the nucleus is at rest it contains a single continuous filament, which, with the nucleoli, contains all the chromatin of the nucleus. At the moment of division the nucleoli disappear, the filament contracts, and then divides into a certain number of rods; these rods curve on themselves, and the two parts thus defined become more and more closely attached to one another; they then arrange themselves in a plane and form the nuclear plate. Almost at the same moment the membrane of the nucleus disappears, and the achromatic filaments then make their appearance, arranging themselves in the form of a barrel. In the next stage the rods divide longitudinally, and each of the halves moves to one pole of the barrel formed by the achromatic filaments. The filaments at each pole then unite end to end, and form the nucleus of a daughter-cell, going through in inverse order the series of transformations which took place in the nucleus of the mother-cell. The origin of the achromatic filaments he regards as still obscure.

Guignard regards the nucleoli not simply as denser parts of the substance of the nucleus, but as a special product of its metamorphosis and of the vital activity of the nucleus. They are not invested by a membrane, and are readily distinguished by their optical properties and their receptivity to staining, from the chromatic substance of the nucleus. In *Listera ovata*, hæmatoxylin stains them entirely a yellow red, while the filament becomes dark violet.

Formation of Endosperm in Daphne.†—E. Strasburger contests the statement of Prohaska ‡ as to the formation of free nuclei in the embryo-sac of *Daphne Blagyana*. He asserts that the structures described by Prohaska as free nuclei are not found in the parietal protoplasmic layer.

* Ann. Sci. Nat. (Bot.) xvii. (1884) pp. 5–59 (4 pls.). Cf. this Journal, iii. (1883) p. 864.

† Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 112–4.

‡ See this Journal, *ante*, p. 250.

Method of Bursting of Sporangia and Pollen-sacs.*—H. Schinz has investigated this subject. He regards the cause of the bursting to be peculiarly thickened "opening cells," which effect a bending of the wall of the anther or sporangium from their change of form on drying. This change of form is effected in two different ways:—(1) In *Encephalartos* by a strong thickening of the outer wall of all the peripheral cells, by means of a substance full of water, and the contraction of these parts in the tangential direction on drying; the anther-wall consists of three layers, the outermost layer causing the expulsion. (2) In all other structures, by a mode of thickening which causes a hinge-like motion of the actual cells; i. e. an approach of their outer margins next the epidermis on drying, resulting from the inner and side-walls of the cells being strongly thickened, the loss of water on drying affecting to the greatest extent the innermost layers which bound the cell-cavity. Of this latter mode there are three varieties, viz.:—(1) The sporangia of ferns; the wall consists of one layer; the opening-cells are converted into an annulus. (2) Gymnosperms, except Cycadeæ; the wall consists of one layer of scalariform opening-cells. (3) Cycadeæ, except *Encephalartos;* the wall consists of three layers; all the epidermal cells thickened after the manner of an annulus. (4) Angiosperms; the wall consists of three layers; the endothecium composed of cells thickened in the hinge-fashion, and alone taking part in the bursting.

Pollen from Funereal Garlands found in an Egyptian Tomb.†—C. F. White figures the pollen-grains and anther of *Papaver Rhœas* from the funereal garlands found in Egypt in the coffin of the Princess Nzi Khonson of the XXI. Dynasty about 1000 B.C., and compares them with drawings from recent gatherings of the plant. The former appear to be slightly the larger. Mr. White especially calls attention to the readiness with which these ancient specimens absorb water and expand into that subspherical shape so usual with pollen of simple form; with the peculiarity that the Egyptian assume the *three-lobed* shape common to many pollens, the furrows becoming deeper than when dry, instead of, as generally happens, being nearly obliterated when placed in water. No indication of the appearance of the pollen-tubes could be detected except that at one of the three points at which they would be produced, a small bubble of air was in several cases observed.

Swelling Properties of Vegetable Cell-membrane.‡—F. von Höhnel has tried a series of experiments on the capacity of swelling possessed by different vegetable fibres:—aloe, *Phormium tenax*, Manila hemp, flax, *Boehmeria tenacissima*, and hemp. He finds that, under long-continued swelling, fibres may first increase and then decrease in length. A dry membrane artificially compressed in the direction of its length acquires positive optical properties; it then increases in length under swelling in water and becomes again negative.

* Schinz, N., 'Unters. ü. d. Mechanismus d. Aufspringens d. Sporangien u. Pollensäcke' (3 pls.) Zürich, 1883. See Bot. Centralbl., xviii. (1884) p. 361.

† Journ. Linn. Soc. Lond. (Bot.) xxi. (1884) p. 251 (1 pl.).

‡ Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 41–51.

Epidermal Tissue of the Root.*—O. Juel finds, in several water plants, in addition to the ordinary elongated cells of the epidermis of the germinating root, other nearly cubical cells, from which spring root-hairs. The hypodermal layer of cells of the root may have the side walls of the elongated cells either parallel or convex with respect to one another. The short cells vary in width, and may be narrower or broader than the elongated cells; and looked at from the surface their outline may be circular, elliptical, square, or rectangular. The walls of the two kinds of cells appear to be of about equal thickness.

Lenticels.†—H. Klebahn does not find the absolute distinction, previously ‡ insisted on, between the closing layer and the intermediate layer in lenticels. The whole tissue outside the renewing layer he includes under the term intermediate substance; and this may occur in two modifications:—(1) It consists only of cork-cells, which leave intercellular spaces between them, which Klebahn terms *pore-cork;* (2) it consists of alternate suberized and non-suberized layers, while he calls the separate unsuberized layers *choriphelloid.* The cells of this tissue proceed centripetally from the renewing layer, and the cell-walls are either lignified or consist of pure cellulose; their thickness varies. All lenticels belong to one or other of these types.

Klebahn finds lenticels on the aerial roots of *Philodendron pertusum*, resembling those of the Marattiaceæ, and consisting of dense layers without intercellular spaces, the loose intermediate cells being suberized. He also finds lenticels on the medullary rays in *Vitis* and *Clematis.*

The chief function of lenticels is undoubtedly to facilitate the entrance of gases through the otherwise almost impermeable outer layers of the cortex.

Torsion of Twining Stems.§—F. G. Kohl believes he has established the fact, stated by Mohl, but doubted by Darwin and de Vries, of the sensitiveness of a twining stem to permanent lateral contact. He does not agree with Schwendener in regarding antidromous torsion only as normal, homodromous torsion occurring normally with thin supports, and then changing to antidromous when the support exceeds a certain thickness, or when the friction between the climbing stem and the support is increased.

Structure and Growth of Palms.‖—Branner gives some interesting results of original and apparently careful studies of the mode of growth of many palms.

The essential points of difference between these results and those obtained by other observers relate to the development of the fronds.

* SB. Bot. Gesell. Stockholm, Feb. 27, 1884. See Bot. Centralbl., xviii. (1884) p. 282.

† Jenaisch. Zeitschr. f. Naturwiss., x. (1884). See Bot. Centralbl., xviii. (1884) p. 236.

‡ See this Journal, *ante*, p. 78.

§ Pringsheim's Jahrb. f. Wiss. Bot., xv. (1884) pp. 327–60 (1 pl.).

‖ Proc. Amer. Phil. Soc., 18th April, 1884. Amer. Journ. Sci., xxviii. (1884) pp. 239–40.

The fronds are developed in connection with the *central* bundles in the phyllophore. In regard to the origin of the bundles, it is sufficient at present to say that they originate at the apex of the phyllophore, and are developed in it, with it, and as a part of it. von Mohl and Mirbel maintain that these bundles grow up into the phyllophore; Gaudichaud, that they grow downward from it, from the frond bases; von Martius, that they grow both up and down; while the author maintains that they are perfected in all directions at the same time, though the lateral growth continues to a certain extent after the longitudinal growth has ceased, and that they can no more be said to grow upward or downward than it can be said of the bones of the body that they grow outwards into the limbs. It is true that the general lengthening of the bundles takes place at the superior end, but there is a growth besides this. At the first appearance of the fronds at the apex of the phyllophore, the fibro-vascular bundles are already connected with them, and just as intimately as they are in the perfectly developed frond. The internodes at this point are very short, but the bundles are the same in number, and have exactly the same connections, direction and relation to each other that they have in later life. But in the perfected frond we find them larger, longer, and harder, and in the perfect stem the internodes are longer, the stem and bundles larger, while the whole plant has grown both longitudinally and laterally.

Honey-glands of Cruciferæ.*—J. Velenovsky has examined the honey-glands in about 170 species of Cruciferæ, and finds them only of subordinate use in classification; they are generally related to the habit of the plant, and the structure and form of the fruit. As a general rule, though not without exception, their size is in proportion to that of the flower. While the lower glands are never absent, though sometimes very small and almost rudimentary, the upper glands are not unfrequently entirely wanting.

Resin-deposits.†—T. Posewitz has investigated the mode in which the enormous deposits of resin in Borneo are formed. It is produced chiefly by trees belonging to the Abietineæ, Burseraceæ, and Dipterocarpeæ, the resin falling from the branches in large lumps, which become mixed with mud and transported by heavy rains to the neighbourhood of the sea. The remains of animals are found abundantly inclosed, both of insects and of other larger animals, land or marine, picked up during their transport. The author compares this with the modes of formation of peat and of amber.

Distribution of Food-materials in the Plant.‡—Berthelot and André find that insoluble mineral substances accumulate in the leaves and inflorescence in preference to any other part of the plant, the leaves being the termination of the circulation of fluids; they amount

* SB. K. Böhm. Gesell. Wiss., vi. (1884) (5 pls.). See Bot. Centralbl., xix. (1884) p. 9. Cf. this Journal, iii. (1883) p. 239.

† Földtani Közlöny (Buda-Pest) xiii. (1883) pp. 409–12.

‡ Comptes Rendus, xcix. (1884) pp. 428–31.

to from 20 to 25 per cent. of the total weight of the leaves. The absolute amount of mineral substances in the stem is considerable, but the relative amount is small, not above about 4 per cent. at the time of the death of the plant. The roots contain very little mineral matter, except when the plant has been deprived of inflorescence; it gradually decreases during the life of the plant.

Transpiration of Plants in the Tropics.*—V. Marcano finds that, in the tropics, plants evaporate in the night (from 6 p.m. to 6 a.m.) a quantity of water which is distinctly equal to that which they evaporate during the day. During the day this evaporation takes place chiefly between 6 a.m. and noon. The maximum is remarkable for its constancy and extent, being half or even three-quarters of that which is evaporated during the twelve hours of the day; it generally takes place after 10.15 a.m., and almost always before noon. From the maximal point to 6 p.m. the evaporation is very feeble. The hygrometric condition of the air does not seem to have any great influence on transpiration.

Although nocturnal evaporation from leaves has been denied by the great majority of vegetable physiologists, the proofs now adduced find support in the views of Boussingault, who speaks of hearing water continually dropping from the neighbouring trees, when bivouacking at night in the open air, and explains it by suggesting that transpiration from the green parts of plants has some share in causing the phenomenon.

Chemical Phenomena of the Assimilation of Plants.†—Dr. T. L. Phipson details the experiments which lead him to consider that peroxide of hydrogen plays a great and hitherto unsuspected part in the process of assimilation.

Histo-Chemistry of Plants.‡—In an interesting contribution to the "histo-chemistry" of plants A. Rosoll illustrates the light that can be thrown upon vegetable principles by studying them microchemically *in situ* in the plant.

The first plant mentioned is *Helichrysum bracteatum*, the yellow flower-heads of which are well known as a variety of "everlasting flowers." This yellow colour is very persistent; but when the dried flower-heads are dipped into borax solution to which hydrochloric acid has been added, the involucral leaflets become of a beautiful ruby red colour. Further investigation showed this yellow pigment to be a hitherto undescribed quinone-like substance, which Rosoll has named *helichrysin*. In the younger leaflets it exists in combination with protoplasm, whilst in the older ones it has its seat in the residual cell-contents. Helichrysin is soluble in water, alcohol, ether, and organic acids; insoluble in benzol, chloroform, and carbon bisulphide; is coloured purple-red by mineral acids and alkalies; and is precipitated by metallic oxides and their salts as a red-coloured

* Comptes Rendus, xcix. (1884) pp. 51–3. Cf. this Journal, *ante*, p. 87.
† Chemical News, l. (1884) p. 37.
‡ Monatshefte, v. p. 94. Cf. Bull. Torrey Bot. Club, xi. (1884) pp. 94–5.

extract. The same body appears to be present in *H. orientale*, *H. fœtidum*, and *Statice Bonduelli*.

Passing to the fungi, the organs of fructification of *Peziza aurantia* with their yellow disk and lighter outer side, were examined. It was found that the orange colour is due to a new yellow pigment, that has been named *pezizin*, which is present in the form of extremely minute drops, combined with an oil-like substance that occurs dissolved in the plasma of the paraphyses. The pigment, which occurs also in *P. convexula*, may be dissolved out by alcohol or ether.

Saponin was ascertained to occur in the living roots of *Saponaria officinalis* and *Gypsophila Struthium*, dissolved in the cell-sap, from which it can be separated in small amorphous white particles by treatment of thin slices of the root with absolute alcohol or ether. In the dried roots and in quillaia-bark it occurs as an amorphous white or grey substance. By treatment with concentrated sulphuric acid and exposure to air, which gives rise to a yellow, then a bright red, and afterwards a beautiful blue-violet colour, saponin can be detected in the contents of all the cells of the middle bark of *Quillaia saponaria*.

Pure Chlorophyll.*—A. Tschirch regards as pure chlorophyll only such as agrees in its spectroscopic properties with the chlorophyll of living leaves. This definition will exclude the chlorophyll of chlorophyll tinctures, chlorophyllan, alkaline chlorophyll and its derivatives, the blue-green substance obtained by the reduction of phyllocyaninic acid by powdered zinc, and phyllocyanin. Solutions of chlorophyll are of practical value, in consequence of their innocuousness, for colouring articles of food or condiments, but the colour is not very permanent. This is due, in the case of alcoholic extracts, to the vegetable acids being extracted along with the chlorophyll, which at once cause its transformation into chlorophyllan, or, in the case of the drying of leaves, to the destruction of the protoplasmic envelope which served to protect it in the living plant. The colour of the chlorophyll can be best preserved unchanged by making an alkaline extract, in which case chlorophyllan is not formed, but chlorophyllinic acid, which combines with the alkali to form a more persistent beautiful emerald green salt, fluorescing a dark blood-red.

Lime and Magnesia in Plants.† — Observations on plants of *Phaseolus multiflorus*, by E. v. Raumer, show that the functions of lime are connected with the building up of the tissues and the formation of the cell-walls, but that it is not concerned in the formation or transformation of starch. The office of magnesia, on the contrary, is to assist in the starch-forming process, and the development of chlorophyll. Magnesia is always present in the latter, and its presence is necessary to healthy growth and colour.

* Arch. d. Pharm., xxii. p. 129. See Bot. Centralbl., xviii. (1884) p. 327.

† Bied. Centr., 1884, pp. 46–8. See Journ. Chem. Soc.—Abstr., xlvi. (1884) p. 917.

Easily Oxidizable Substances in Plant Sap.*—K. Kraus describes experiments made on the sap contained in the tubers of *Dahlia variabilis*, which he cut into slices. The surfaces gradually became yellow, and with longer time the colour penetrated below the surface; the bulbs swelled, turning green in the light, and pale green chlorophyll-bodies appeared. The yellow tinged cells contained a yellow or reddish sap; the surfaces of the slices were not only yellow but showed red points and streaks, whilst in the interior of the cells there was a red colouring matter turned green by alkalies. The author thinks the change of colour is due to oxidation.

Action of Nitrous Oxide on Vegetation.†—H. Möller claims to have determined, as the result of a series of experiments, that nitrous oxide has no directly injurious influence on living plants.

Silicification of Organs.‡—S. Miliarakis has examined the silicified hairs of *Deutzia scabra*, *Loasa vulcanica*, and a number of other plants, chiefly belonging to the Urticaceæ, with the view of ascertaining whether growth continues after the silicification has taken place, which question he answers in the negative. The cystoliths of *Ficus* and *Urtica* he finds to be usually surrounded by a siliceous envelope; and in *F. Sycomorus*, besides the ordinary cystoliths, are others completely silicified.

Influence of Solar Rays on the Temperature of Trees.§—E. Ihne inserted thermometers at different depths into the trunk of a maple tree, also in a branch and twig. He found that on a fine clear day the variations of temperature were not large, the exterior layers were higher than the interior, and the sections of larger diameter were the warmer; but on the whole the variations were slight, and the temperature at all times of observation a considerable number of degrees above that of the surrounding atmosphere.

Thermic Constants in Plants.‖—The thermal constant of a plant, according to Oettinger, is the sum of the mean temperatures of the days of active vegetation from the commencement of growth to some definite phase in the plant's life, minus a certain initial temperature, different for different species, and determined by comparing the observations of successive years. Staub objects to this, that the development of a plant depends not only on the aggregate quantity of heat which it receives, but above all on the temperature during growth, which cannot be expressed by adding together thermometric measurements.

* Bied. Centr., 1884, pp. 45-6. See Journ. Chem. Soc.—Abstr., xlvi. (1884) p. 918. Cf. this Journal, *ante*, p. 255.

† Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 35-41.

‡ Miliarakis, S., 'Die Verkieselung lebender Elementar-organe bei den Pflanzen,' 30 pp., Würzburg, 1884. See Bot. Centralbl., xviii. (1884) p. 235.

§ Bied. Centr., 1884, p. 63. See Journ. Chem. Soc.—Abstr., xlvi. (1884) p. 917.

‖ Botan. Jahresber., iii. (1884) p. 131. See Journ. Chem. Soc.—Abstr., xlvi. (1884) p. 1067.

Chemical Changes in their Relation to Micro-Organisms.*—Prof. E. Frankland distinguishes between two kinds of chemical action—(1) that in which substances brought into contact mutually undergo chemical change, and (2) that in which chemical change is effected in one substance by contact with another, which itself apparently suffers no alteration.

The following definitions are proposed to distinguish animal and vegetable organisms:—(1) A plant is an organism performing synthetical functions, or one in which these functions greatly predominate; it transforms actual into potential energy. (2) An animal is an organism performing analytical functions, or one in which these functions greatly predominate; it transforms potential into actual energy. All micro-organisms appear to belong to the second class. Oxidation is the essential condition of life. There are, however, many other chemical transformations in which potential becomes actual energy, and which therefore can support life. The author describes the chemical changes produced by a large number of micro-organisms, and points out that there is no break in the continuity of chemical functions between micro-organisms and the higher forms of animal life. It is true there are apparently certain sharp distinctions between them. The enormous fecundity of micro-organisms and their tremendous appetites seem to separate them from the higher orders of animals. But this distinction is only comparative. It must be borne in mind that an animal like a sheep converts much of its food into carbonic acid, hippuric acid, and water, thus utilizing nearly the whole of the potential energy, while the micro-organism as a rule utilizes only a small portion. Those micro-organisms which have been chemically studied produce, like the higher animals, perfectly definite chemical changes. "The position of these organisms in nature is only just beginning to be appreciated. It may safely be predicted that there is no danger of their being spoiled by the petting of sentimentalists, yet these lowly organisms will receive much more attention in the future than they have done in the past."

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Comparative Morphology of the Leaf in Vascular Cryptogams and Gymnosperms.†—F. O. Bower points out that if the doctrine of Sachs and others that the living stem and leaf are to be regarded only as expressions denoting certain relationships of the parts of the *shoot*, be correct, the same mode of morphological treatment ought to be applied to both. In treating of the leaf, authors have not attached most importance to the mode of origin and sequence of appearance of its several parts; parts have been distinguished that are not morphologically co-ordinate. The author finds that there is no justification

* Nature, xxx. (1884) pp. 549–50. (Report of discussion at the Montreal Meeting of the British Association.)

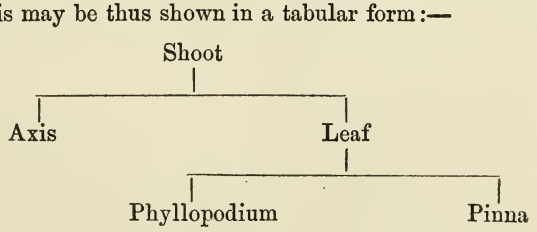
† Proc. Roy. Soc., xxxvii. (1884) pp. 61–5.

for this inconsistency in the mode of treatment of axis and leaf. The axis is, therefore, recognized by a distinct term, and the name *phyllopodium* is proposed for the main axis of the leaf, exclusive of its branches; the relation of the pinna to the phyllopodium is similar to that of the leaf to the axis. In complicated leaves we may distinguish a *hypopodium*, a *mesopodium* which is the equivalent of the petiole, and an *epipodium*, the equivalent of the upper part of the phyllopodium, exclusive of its branches. This method of study is shown to be natural by the investigation of the development of leaves in the lower vascular plants.

In a series of types of Vascular Cryptogams and Gymnosperms it was found that, in the simplest forms, the Hymenophyllaceæ, the branching is dichotomous; in most Leptosporangiate Ferns the branching of the leaf is at first monopodial; the Osmundaceæ are remarkable, and probably unique, for having the two-sided apical cell replaced by one which is three-sided and conical. In the Marattiaceæ the phyllopodium is from the first a solid structure. In the Cycadaceæ the apex of the phyllopodium is covered by a definite layer of dermatogen.

There is, then, a progressive differentiation of the phyllopodium as a supporting organ, and of other members of a higher order, which develope as flattened organs. That of the former will perhaps throw light on the mode of origin of the axis as a structure bearing leaves. "As the phyllopodium gradually asserts and, in the higher forms of the above series, maintains its identity among the branches of the leaf, so the axis may have differentiated itself as a supporting organ from among members similar to itself in origin and development."

Apical growth, which in the simpler forms is sometimes unlimited, becomes restricted as we ascend the series; in the higher vascular plants it ceases at an early stage, and there is a much greater degree of intercalary growth. It is concluded that the recognition of the phyllopodium and treatment of the whole leaf as a simple branch or as a branch system is in accordance with the true nature of the leaf as seen in all vascular plants. The relation of the pinnæ to the phyllopodium is similar to that of the whole leaf to the axis which bears it; and this may be thus shown in a tabular form:—



Apex of the Leaf in Osmunda and Todea.*—F. O. Bower has found in the young leaves of *Todea superba* and of *Osmunda cinnamomea* that the apex is occupied by a well-marked *three-sided*, conical, apical cell, from the three sides of which segments are cut off in regular

* Proc. Roy. Soc., xxxvi. (1884) pp. 442-3.

succession. This cell is so placed that one side faces the ventral side of the leaf, while the remaining two sides are obliquely disposed with regard to the dorsal side of the leaf. No clearly marked marginal series of persistently active cells has been found giving rise to the pinnæ, as has been stated to be the case in typical ferns, and there appears to be no strict relation between the points of origin of the pinnæ and the segments cut off from the apical cell. The pinnæ arise in acropetal order. The presence of a three-sided apical cell in the leaf of a fern appears to supply an intermediate step towards the more complex leaf of the *Marantaceæ* and *Cycadeæ*, and it is believed that this is the first described case of a clearly marked three-sided apical cell occurring in the leaf of any plant.

Rabenhorst's Cryptogamic Flora of Germany (Vascular Cryptogams).—This division of the new edition of Rabenhorst's great work has been undertaken by C. Luerssen; and three parts of this most important contribution to cryptogamic literature are now issued. Luerssen classifies the Pteridophyta or Vascular Cryptogams under three classes, the Filicinæ, Equisetinæ, and Lycopodinæ. The Filicinæ are again divided into Isosporeæ and Heterosporeæ, and the Isosporeæ into Leptosporangiatæ (true ferns) and Eusporangiatæ (Ophioglossaceæ). In the parts now published the sub-order Hymenophyllaceæ is treated (one sp. only, *Hymenophyllum tunbridgense*), and of the sub-order Polypodiaceæ the genera *Polypodium*, *Gymnogramme*, *Notholœna*, *Cryptogramme*, *Adiantum*, *Cheilanthes*, *Pteris*, *Pteridium* (*Pteris aquilina*), *Blechnum*, *Scolopendrium*, *Athyrium*, and a part of *Asplenium*.

Muscineæ.

Braithwaite's British Moss Flora.—Since we last noticed this work,* Parts III.–VIII. have been published, including the Polytrichaceæ (5 pls.); Fissidentaceæ (3 pls.); Leucobryaceæ (1 pl.); Dicranaceæ (13 pls.); and Tortulaceæ, Part 1 (6 pls.).

It is hardly necessary to say that there is no falling off in the text or plates as the work progresses. It is fully up to the expectations formed concerning it before publication, and the text is in every respect worthy of the reputation of the author. He and the draughtsman divide between them the honour of the plates, which are perfect both in drawing and execution.

Hobkirk's British Mosses.†—This is a new edition of a now well-known handbook, which indeed is the only modern complete guide to the British Mosses. Of these 129 genera and 576 species are described, with full diagnostic characters and notes of locality. An alteration has been made in regard to classification, as the author no longer follows Bruch and Schimper (through Wilson), but adopts that of Jäger's 'Adumbratio Muscorum,' which, however, makes the preliminary synopsis by no means so simple. For collectors of British mosses the book is indispensable.

* See this Journal, iii. (1880) p. 670.

† Hobkirk, C. P., 'A Synopsis of the British Mosses,' 2nd ed., 8vo, London, 1884, 240 pp.

Characeæ.

Cell-division of Characeæ.*—A. Cagnieul has investigated the mode of cell-division in the cells of *Nitella intricata* and *opaca*, and does not agree in all respects with the observations of Johow.† It is true that in the cells of the internodes the division of the nucleus takes place by simple constriction, but this is never followed by actual cell-division. It is difficult to interpret in the same way the mode of division of the nucleus in the terminal cells of the stem and branches and in the nodal cells. In the mother-cells of the antherozoids the division of the nucleus can be followed with great ease. The increase in length of the filament composed of antheridial cells is always much more rapid than the multiplication of the cells themselves, from which it results that the longer axis of the cells is always very long in young antheridia, very short in those that are nearly mature. The nucleus has a very evident nucleolus, and after the application of reagents (chloride of mercury, picric acid, osmic acid, pigments, &c.), a moniliform filament of chromatin is seen. When segmentation is commencing and the nucleus is dilated, the filament of nuclein, now visible without the use of reagents, is sharply divided into fragments. Soon afterwards the nuclear plate is formed, and from this moment the spindle of segmentation, composed of a very large number of filaments of achromatin, is very clear. This spindle is almost always directed towards one of the diagonals of the optical view of the cell. In the next stage the cell-plate divides in two; and the two halves, composed of filaments curved into the form of a V, are directed towards the poles of the spindle; this latter at the same time turning on itself to an angle of 30° or 40°, until its axis coincides with that of the cell. The nuclear plate is soon formed, and a nucleolus makes its appearance in each of the newly formed nuclei.

Fungi.

Phosphorescent Fungi.‡—F. Ludwig has examined under the spectroscope the light given off by phosphorescent fungi, especially *Trametes pini*, *Agaricus melleus*, *Xylaria hypoxylon*, *Collybia tuberosa*, and *Micrococcus Pflugeri*, and finds its spectroscopic character to differ in different species. He maintains that the spontaneous phosphorescence is equal in intensity by day and by night.

Parasitic Hymenomycetes.§—According to H. Mayr, the two species of *Polyporus* found commonly on birch-stems, *P. betulinus* and *P. lævigatus*, are true parasites, the mycelium which springs from the spores having the power of penetrating uninjured living cells and turning their contents brown. The mode in which this parasitism is effected is described in detail in both species. The author describes the singular phenomenon that when both parasites attack the same stem, a solid dark-brown hard division-wall is formed, separating the two entirely from one another.

* Bull. Soc. Bot. France, xxxi. (1884) pp. 211–3.
† See this Journal, ii. (1882) p. 79.
‡ Zeitschr. f. Wiss. Mikr., i. (1884) pp. 181–98.
§ Bot. Centralbl., xix. (1884) pp. 22–9, 51–7 (2 pls.).

Mode of Bursting of the Asci in the Sordarieæ.*—W. Zopf has investigated the mode in which the ascospores are expelled from the ascus in this section of the Pyrenomycetes, by placing the perithecia, entirely intact, with the substratum, in a drop of water, when the expulsion can be watched in all its stages. When ripe the asci are nearly cylindrical, but slightly apiculate, and shortly stalked. At the commencement of the ejection of the spores they gradually lengthen, and also become considerably wider in their upper part, the lengthening going on until the apex of the ascus projects, in the form of a beak, through the neck-canal of the perithecium, and even beyond its opening. At this moment the ascus suddenly bursts below its apex, and the spores are ejected into the water, the rest of the ascus shrivelling up, and the spores remaining attached in a row. The numerous asci in the perithecium expel the spores successively in the same way. The spores in all cases remain attached in a single mass to the apex of the ascus, and in one or more rows, according as their number is 4, 8, or 64 in an ascus. In the sub-genera *Eusordaria* and *Bertia* this is effected by means of a tail-like appendage at each end of each spore, by which they are all attached together; in *Hypocopra* and *Coprolepa* by means of a gelatinous envelope inclosing the whole mass of spores; and in each case they are by the same agency firmly attached to the apex of the ascus. This appendage to the spores is not, as was supposed by Woronin, a thickening of the membrane of the spores themselves, but is derived from a portion of the protoplasm of the ascus not used up in the formation of the ascospores; and the gelatinous envelope is due to the same origin. The paraphyses within the ascus play also some part in the ejection of the ascospores, by giving a direction to the course of growth of the ascus, by serving as a reservoir of water, and by exercising a direct pressure on the ascus, and thus assisting in its rupture.

Actinomyces.†—H. Karsten describes the structure of this parasitic fungus, which is found chiefly as an endophyte in the tongue and jaws of cattle. Organisms agreeing with certain conditions of development of this parasite are also found in swine and in men. *Actinomyces* makes its appearance in the form of globular pale yellow tufts, consisting of a quantity of interlacing branches, about 1 mm. or more in diameter. These tufts readily break up into a number of wedged-shaped pieces, consisting of a pedicel-cell which divides into from two to nine short branches, each bearing at its apex from one to three bodies described by Harz as gonidia, but which may possibly be bodies containing gonidia. In the jaw-bones of cattle occur forms with slenderer hyphæ and smaller gonidia, the result probably of insufficient nutriment, and these agree with the forms found in swine and in men.

* Zopf, W., 'Zur Kenntniss d. anatom. Anpassung d. Pilzfrüchte a. d. Funktion d. Sporenentleerung,' Halle, 1884. See Biol. Centralbl., iv. (1884) p. 385.

† Flora, lxviii. (1884) pp. 393-6.

Harz, the discoverer of this fungus, places it in the Hyphomycetes, a section of Gonidiomycetes; but Karsten regards it as having greater affinity with *Entomophthora* and *Exobasidium*.

Rhizomyxa, a New Phycomycete.*—A. Borzì describes a new parasitic fungus, found on the roots of a large number of herbaceous plants, especially on those of *Capsella bursa pastoris* and *Stellaria media*. The vegetative body of *Rhizomyxa* consists of a simple naked plasmodium, with scarcely differentiated parietal layer, and with from 10 to 30 small nuclei, granules of protoplasm, and vacuoles; the plasmodium approximating very closely in form to that of the cell on which it lies, even when this is an elongated root-hair. As soon as the parasite has consumed the protoplasm of this cell, its reproduction commences, which takes place in two ways, asexually by swarm-cells and spores, sexually by fertilized oospores.

The formation of swarm-spores takes place by the transformation of the entire plasmodium into a zoosporangium. It contracts somewhat and invests itself with a thin wall of cellulose, the contents become homogeneous and finely granular, and the vacuoles disappear. The nuclei increase rapidly by division, and the whole of the protoplasm breaks up into a number of portions, which escape from the zoosporangium and the nutrient cell, and become zoospores. The escape is effected by means of a protuberance from the zoosporangium, which pierces the wall of the adjoining cell. The zoospores are spherical, with a short beak and one cilium, colourless, and contain a small nucleus. Their motion is not affected by light, and lasts for about a quarter of an hour. They then either perish, or, if in favourable circumstances, perforate the wall of the cells of the root or of root-hairs; they become invested with a thin cell-wall, out of which the protoplasmic contents escape in the form of an amœba into the cell of the host; and this myxamœba then developes into a new plasmodium. This may then again produce zoospores or ordinary spores, which are at first naked masses of protoplasm, but afterwards become invested in a cell-wall. These spores may then either develope into small zoosporangia containing only one or two swarm-spores, or their cell-wall becomes very thick, and a mass of them hibernates within the host in the form of a cystosorus, resembling that of *Woronina polycystis*. Their further development was not observed.

The sexual reproductive organs spring from plasmodia in no way different from those that produce swarm-spores. The plasmodia destined for this purpose become elongated and at length assume a club-shaped form. This then divides by a wall of cellulose into two cells, a larger spherical one, the oogonium, and a smaller oval one, the antheridium, which remain attached to one another; both contain several nuclei. The protoplasm of the oogonium now becomes differentiated into two layers, separated by a thin membrane, the central denser one of which is the oosphere, and alone takes part in the impregnation. The antheridium then puts out a cylindrical protuberance, which enters

* Borzì, A., 'Rhizomyxa, nuovo Ficomicete,' 53 pp. (2 pls.) Messina, 1884. See Bot. Centralbl., xix. (1884) p. 1.

the oogonium, attaches itself firmly to the investing membrane of the oosphere, finally pierces it, and the entire contents of the antheridium becomes absorbed by the oosphere, which now becomes invested with a double membrane, and assumes the character of an oospore.

The systematic position of *Rhizomyxa hypogœa* is regarded by Borzì as referable to the Ancylistaceæ, near to *Lagenidium*, *Mycocytium*, and *Achlyogeton*; but it also has many points of resemblance to the Chytridiaceæ, especially to *Woronina* and *Olpidiopsis*.

Effect of Light on the Cell-division of Saccharomyces.* —L. Kny has carried on a series of experiments on this subject, as the result of which he comes to the conclusion that cell-division takes place in *Saccharomyces cerevisiæ* as actively in moderate light as in darkness.

Behaviour of Blood-corpuscles to Pathogenous Micro-Organisms.† — The observations which E. Metschnikoff has made on *Daphniæ* have given results, which, if they are confirmed, seem to be of the greatest importance in the knowledge of parasitic diseases and their treatment.

The author observed a disease in the *Daphniæ*, produced by the penetration and development of a fungus which eventually kills the host. Inoculation experiments on healthy *Daphniæ* showed that the cells of the fungus were attacked by the blood-corpuscles in the interior of the organisms, and finally overcome. Both spores and gonidia showed changes of form which resulted in their complete destruction. On the other hand, the blood-corpuscles suffered from the parasites, as some of them were seen to burst up into several pieces, whereby the gonidia were freed from the parent-cell. It was further observed that blood-corpuscles in the neighbourhood of fungus cells dissolved and completely disappeared. The number of the blood-corpuscles dissolved increased in proportion to the advance of the disease.

Metschnikoff concludes from his observations that "the infection and disease of the *Daphniæ* consist in a struggle between two living organisms, the fungi and the blood-corpuscles. The former are lowly organized unicellular plants; the latter are the lowest tissue-elements, and show the greatest resemblance to the simplest organisms." The issue of this struggle varies at the commencement of the infection by spores, the latter are mostly killed, and the blood-corpuscles obtain the upper hand. But when the disease has already broken out, the parasites gain the mastery. The first is generally observed in mature *Daphniæ*, which, although capable of infection, do not commonly take it; the second in young individuals which generally succumb to the parasite.

Metschnikoff connects these results with some observations on the diseases caused by fungi in the higher animals.

* Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 129–44.

† Arch. f. path. Anat. u. Physiol., xcvi. (1884) p. 177. See Naturforscher, xxvii. (1884) p. 232.

Micrococci of Pneumonia.*—F. Strassmann has a brief communication on his experiments with the sputa of pneumonia patients, which started with the view that, if the fungi are, as Friedländer has shown, most richly and regularly found in the bronchial exudation of the dead body, they ought also to be found in that which is expectorated during life. The author found that his expectation was fulfilled. In the examination of a number of non-pneumonic sputa diplococci were found, which apparently came from the buccal cavity; these are only with difficulty to be distinguished from the micrococci of pneumonia. As the cocci of pneumonia are to be found twenty-four or thirty-six hours after the crisis, the author thinks that they do not suddenly disappear, like the spirilla of recurrent fever.

Micro-organism of Zoogloeic Tuberculosis.†—L. Malassez and W. Vignal have now succeeded in satisfactorily staining zoogloeæ, and they find that those that are best stained are small isolated zoogloeæ; others can only be partly coloured, the staining affecting only their periphery; others, again, cannot be stained at all. The authors think that the parts susceptible of colouring are those which have been most recently developed, and which are in the best condition of nutrition.

Stained specimens were seen to consist of a mass of small elongated grains, ·6 to 1 μ long and ·3 μ wide; they are disposed in linear rows, which are looped, and cross one another; the grains are micrococci. Differences in coloration were seen to be associated with notable differences in structure. In the periphery of zoogloeic tuberculosis one may see (1) very small zoogloeæ, which only differ from those just described by their smaller size, and by forming masses less dense, and of less regular contour; (2) long undulating bands, which are often curved; (3) very short rectilinear groups, which are either isolated or united into small masses; (4) diplococci and micrococci, either isolated or in groups.

The similarity in structure and the existence of intermediate forms proves that all the various kinds belong to the same micro-organism as the large zoogloeæ; and this view is confirmed by a study of their development. The series starts with the micrococci and diplococci. Loss of colourability, dissociation of the mass, the conversion of the elongated into spherical micrococci, and the increase in the amount of the interstitial substance, are signs that the parasite is dead, or has passed into a condition of latent activity.

The fact that granulations in which, till the use of their new methods, no zoogloeæ could be distinguished, can now be seen to contain micrococci, and that sometimes small masses or long chains do not become stained, seem to the authors to show that the zoogloeic organism need not always pass through the whole of its development before passing into the latent stage, and leads, too, to the suggestion that there may be lesions in which all these small forms would remain uncoloured, in which case they would doubtless escape detection, and the nature of the tuberculosis would be misunderstood.

* SB. Jenaisch. Gesell. f. Naturwiss., 1883 (1884) pp. 16-17.

† Comptes Rendus, xcix. (1884) pp. 203-5.

Microbe of Typhoid Fever of Man.*—M. Tagon commenced his experiments on the microbe of typhoid fever by injecting the blood from a patient dead of typhoid under the skin of rabbits, pigeons, and other animals; the malady was never transmitted. Drinking of the blood did not have mortal effects, nor did other direct means of poisoning have any result. It was different, however, when the microbes were cultivated in various liquids. At the end of twenty-four to forty-eight hours the typhoid microbe rendered turbid the cultivation fluid; if this was injected under the skin of the rabbit, white rat, or pigeon it had no effect; the dog or cat might be attacked by a mortal disease, but the guinea-pig died within a period varying between twenty minutes and forty to forty-five hours; in the last-named animal the characteristic lesions were always to be detected. The blood of a guinea-pig so killed was not mortal to other guinea-pigs, nor to rabbits, cats, or pigeons; but if a drop is cultivated it is soon very virulent towards other guinea-pigs, and dangerous for dogs or cats, but indifferent to the rabbit or pigeon. After several successive passages in cultivation and in the body of a guinea-pig, the microbe becomes certainly mortal to cats a month old. The blood of such a cat is very virulent for rabbits only, but the blood of a poisoned rabbit will not kill other rabbits until, at any rate, it has been cultivated.

The typhoid microbe is then "un petit être à transmission," just like certain parasites which pass part of their existence in one and the rest in another animal. It differs from the microbe of anthrax, or chicken-cholera, or the septic vibrios which are reproduced without transition in one organism; it has a more complicated life-history, for two appropriate media are necessary to its existence.

Under the Microscope, with a magnifying power of 1000 diameters, it has the form of small granulations and of short and very mobile rods, which, were it not for their small size, would have a considerable resemblance to the septic vibrio; some of the granulations have very fine prolongations, which are extremely mobile; in other cases there are rounded spores and short rods, which may be seen to segment, and to produce granulations in their interior and at their extremities.

Bacillus of Cholera and its Culture.†—An outbreak of cholera last July at Bonn gave Prof. Finkler and Dr. Prior an opportunity of applying Koch's method to the study of the comma-shaped bacillus which showed a remarkable resemblance to that of Asiatic cholera cultivated by Koch. It was found associated with large masses of the spiral-shaped organism, but with no other germ of specific appearance. These forms could not be detected in preparations of normal or any other pathological excreta under the same method of treatment. But after several failures a comma bacillus was obtained, which in its nourishment, period of evolution, and temperature, behaved exactly like

* Comptes Rendus, xcix. (1884) pp. 331–4.

† Nature, xxx. (1884) p. 626. Report of the Magdeburg Meeting of the Association of German Naturalists and Physicians.

corresponding cultures obtained by Koch from true cholera. Still, differences occurred in respect of the successive stages of evolution, which inferentially affects the question of the permanent form of the germs. After some time they become thicker, and assume the form of a whetstone, while at both extremities spore-like forms make their appearance, and take the shape of spore-bearers. Both spores are presently extruded from the spore-bearers, and begin to crawl about under the Microscope. They assume the form first of straight, then of crooked rods, which develope into spirals of diverse shape, length, and curvature. Becoming thicker and swollen, these spirals in their final evolution seem to consist exclusively of small comma bacilli. But whereas the comma of Asiatic cholera, at least according to Koch's investigations, developes no permanent form, these acquire a stability in the spore state capable of resisting the process of putrefaction. Their behaviour, however, when being desiccated or subjected to chemical agents has not yet been tested by Professor Finkler. Between the prepared specimens of cholera nostras and true cholera bacilli exhibited under the Microscope, no optical difference could be detected. Owing to the attitude of most German physicians, who regard it as a patriotic duty to hold Koch's doctrine as unassailable, while the German scientific journals persistently ignore the objections urged by eminent foreign investigators against the theory, Prof. Finkler's statements have naturally excited considerable sensation. In any case a severe blow was given to the assumption of Koch's infallibility, although Prof. Finkler and Dr. Prior have so far failed to determine the true pathogenetic and pathognostic functions of their cholera nostras comma bacillus, as completely as Koch has for his Asiatic cholera comma bacillus.

Prof. E. Ray Lankester* does not "hesitate to say: (1) that Koch's comma bacillus is *not* comma-shaped; (2) that it is *not* a bacillus but a spirillum; (3) that although it does sometimes (but not always) occur abundantly in the intestines of cholera patients, there is not a tittle of evidence to show that it causes cholera, no experimental attempt to produce cholera by its agency having succeeded. These conclusions are derived from Dr. Koch's own statements. While Dr. Koch is, as was to be expected, perfectly candid and convincing in the account which he gives of his observations, the extraordinary feature in his report is the dogmatic declaration that this organism, which is not in any way proved to possess disease-producing powers, nevertheless must and shall be henceforth regarded as the cause of cholera. Dr. T. Lewis, who for many years studied microscopically the intestines and evacuations of cholera patients in Calcutta, has demonstrated, since the publication of Koch's report, that the so-called comma-shaped bacillus is identical in form with one occurring commonly in the mouths of healthy persons."

Dr. Koch is said to have succeeded in communicating cholera to a number of rabbits by inoculating them with pure cultures of the

* Pall Mall Gazette, 6th October, 1884, pp. 1–2. See also 'Times,' 19th Nov., 1884.

"comma" bacillus. The rabbits at any rate sickened and died with symptoms resembling those of cholera, and the intestines were found to be infested with the "comma" bacilli.*

On the other hand Dr. Klein, who is studying the cholera question in Calcutta, is reported to be satisfied that Koch's bacillus is not the cause of the disease, and has swallowed a number of the microbia without any evil results.†

Influence of Culture Fluids and Medicinal Reagents on the Growth and Development of Bacillus tuberculosis. —Dr. C. T. Williams gives the results of a series of experiments the object of which was to determine the conditions under which the *Bacillus tuberculosis* Koch grows and multiplies, and to examine its behaviour under the influence of certain medicinal agents and reputed antiseptics.

The sputum of patients in advanced phthisis was used for experiment, spread on cover-glasses, the staining process employed being the Weigert-Ehrlich modification of Koch's original method.

Between 200 and 300 specimens were thus examined with an Abbe condenser and an F (1/12) immersion lens, giving a magnifying power of 550 diameters. Higher powers up to 1390 diameters were employed for investigating the structure of the bacilli.

The methods adopted to ascertain the increase or diminution of the bacilli were:—1st, to count the numbers present in a series of fields of view, at least six, and often twelve, being counted, and in doubtful cases the whole slide was carefully gone over before a conclusion was arrived at; 2nd, to note the length of the bacilli and the presence or absence of well-marked divisions in these preceding their multiplication; 3rd, to observe whether the bacilli were isolated or in groups.

In every case a standard for comparison was first taken from the sputum and the number of bacilli counted; the rest of the sputum was divided into portions of 20 to 30 minims, mixed with solutions of various medicinal and other agents, and then kept in a Page's incubator at a uniform temperature of 38° C., for periods of from forty-eight hours to eight days.

The following cultivation fluids were used:—

Syrup solution of the strength of 2 drachms of syrup to 1 ounce of water; hay infusion; Pasteur's solution (without sugar); beef solution, 1 ounce of meat to 2 ounces of water; beef solution, ½ ounce of meat to 2 ounces of water; pork broth (Klein); also distilled water and the subjoined medicinal agents in solution were mixed, in generally equal proportions, with the sputum, and kept at the same temperature as above; solutions of quinine in strength varying from 2 gr. to the ounce to 10 gr. to the ounce; solutions of arsenous acid ½ gr. to the ounce, and 1 gr. to the ounce; solutions of boracic acid, 1 part in 30 and 1 part in 15; solutions of iodine, 1 part in 12; solutions of perchloride of mercury, 1 gr. to the ounce.

* Micr. News, iv. (1884) p. 290.
† Journ. of Sci., vi. (1884) p. 694.
‡ Proc. Roy. Soc., xxxvi. (1884) pp. 510–2.

The result of the experiments showed that the tubercle bacillus is characterized by great durability of structure, as evidenced by its not being destroyed by the strong acids used in the various processes for its detection, and by its little tendency to decomposition. It does not multiply in distilled water, but does so largely in beef solutions. Arsenic, boracic acid, and perchloride of mercury do not interfere with its development, but rather promote it. Quinine and iodine (especially the former) appear to entirely arrest its growth and destroy its power of multiplication.

Chemical Properties of Bacillus subtilis.*—G. Vandevelde finds that *B. subtilis* is an organism which can live in the ferment-stage for a long time. He was induced to investigate the subject by the contradictory statements that had been made; to obtain the organism he adopted the method of Roberts and Buchner, which consists in immersing hay in as small a quantity of water as possible, and maintaining it for about four hours at a temperature of 36°; the liquid having been poured off and brought to a density of 1004, is placed in vessels of which it fills only half; these, after having been firmly closed, are subjected to heat sufficient to boil the water; the water is then kept for an hour at a temperature of 36°, and after thirty hours there is a rich supply of *B. subtilis*. The organism multiplies rapidly in a suitable cultivation-fluid, and the author thinks that it does so at the expense of the dissolved oxygen; when this is used up the microbes make their way to the surface, where they live and multiply by absorbing oxygen. Experiments made with various chemical reagents proved that the microbe was able for long to play the part of a ferment; if the experiments of Buchner should be confirmed, the transformation of *Bacillus anthracis* into *B. subtilis* is the transformation of an organism that can only live for a short time without free oxygen into another which can for a long time produce the heat necessary for its life while decomposing fermentescible substances. *B. subtilis*, after it has transformed carbohydrates into lactic acid, has a strong tendency to form butyric acid at the expense of the lactic.

Vandevelde has been able to detect nuclein in *B. subtilis*, but he has not yet found any traces of cellulose.

Supposed identity of Hay-bacteria and those of Cattle-distemper.†—A. Prazmowski contests the view of Buchner ‡ that these two bacilli are different forms of development of the same organism. By careful culture he claims to have observed important points of difference in their structure and development.

In the hay-bacterium, *B. subtilis* Cohn, the rods, whether isolated or united into chains, grow into long segmented or unsegmented pseudo-filaments, which form a pellicle on the fluid, and in which the spores are formed, each segment of the pseudo-filament elongating, and forming within it an elongated strongly refractive spore. These

* Arch. Biol., v. (1884) pp. 127–51.
† Biol. Centralbl., iv. (1884) pp. 393–406.
‡ See this Journal, iii. (1883) p. 832.

become free by the dissolution of the membrane of the mother-cell, fall to the ground, and germinate when brought into a suitable nutrient fluid. After from one to two hours the spores swell to twice their volume, lose their refrangibility, and put out the young rod laterally, i. e. at right angles to the longer axis of the spore. This rod then lengthens rapidly, frees itself from the membrane of the spore, and swims free, the membrane showing evident thickenings at both ends.

The bacterium of cattle-distemper, *B. anthracis*, exhibits several variations from this in its development, and especially in the mode of germination. Under similar conditions to those of *B. subtilis* the spores of *B. anthracis* lose their refrangibility much more rapidly, and in the course of 15 or 20 minutes, swell up to several times their original volume. They then present a close resemblance in appearance to the young rods of *B. subtilis;* but they germinate only after from one to two hours, and then the young rod always breaks through the spore-membrane at both ends, growing in the direction of its longer axis, then growing rapidly and increasing by division. After attaining a certain length it throws off the membrane, which is a thin delicate envelope of equal thickness throughout.

Although regarding these two forms as distinct species, Prazmowski agrees with Buchner and Pasteur in stating that, under certain conditions of culture, the bacteria of cattle-distemper may produce non-pathogenous forms agreeing with the pathogenous in their morphological characters and the history of their development.

Bacterioidomonas sporifera.*—Under this name J. Künstler describes a parasite inhabiting the cæcum of *Cavia*, and possessing characters that connect it with the Schizomycetes as well as with the animal kingdom. In outward appearance it presents an oval form slightly flattened from head to tail, and when fully developed attains a length of about 24 μ. It progresses tolerably rapidly and with a rectilinear movement by means of a long flagellum implanted at the anterior end of the body. When once the difficulty of staining it with reagents is overcome its structure under a high power is seen to consist of a peripheral layer forming an enveloping membrane of nitrogenous nature, and a pale protoplasmic interior presenting a finely stippled aspect. In the centre is a rounded corpuscle of finely stippled protoplasm, destitute of nucleolus, and presenting none of the characters which render certain nuclei so complex. This nucleus is not always single, individuals frequently being found which have one at each extremity.

Reproduction takes place by the development of spores within the interior of the body, whence they are liberated through the rending of the body-wall. A flagellum subsequently forms, and they would appear to be capable of increase by division. Ordinarily they twist themselves little by little into a tendril-like form, when they resemble a thick *Spirillum*.

The nutrition of *Bacterioidomonas* takes place by imbibition; no

* Journ. de Microgr., viii. (1884) pp. 376-80 (1 pl.).

trace of buccal opening being observed, and the substance of the body never contains foreign corpuscles. The excess of nutritive material absorbed is disposed in the protoplasm under a peculiar and remarkable form—like dissolved starchy material, that turns blue by the action of iodine.

Bacterioidomonas sporifera has, the author thinks, "perhaps a common origin with the Bacteria; but its evolution has not followed the same direction, and it has retained some of the essential appanages of animality."

Rabenhorst's Cryptogamic Flora of Germany (Fungi).—The two most recent parts received of this publication (14 and 15) commence the description of the Ascomycetes. The Gymnoasceæ are treated in full, including the genera *Exoascus* (13 species), *Endomyces*, *Eremascus*, *Gymnoascus* (3 species), and *Ctenomyces*. Next in order come the Pyrenomycetes, beginning with the sub-order Perisporiaceæ, divided into the two families Erysipheæ and Perisporieæ, and including the genera *Sphærotheca*, *Erysiphe* (11 species), *Podosphæra*, *Microsphæra*, *Phyllactinia*, *Uncinula*, *Thielavia*, *Dimerosporium*, *Magnusia*, *Cephalotheca*, *Zopfiella*, *Anixia*, *Eurotium* (8 species), *Aspergillus* (4 species), *Penicillium* (1 species), *Zopfia*, *Perisporium* (15 species), *Lasiobotrys*, *Apiosporium* (15 species), *Capnodium*, *Asterina*, and *Microthyrium*. The Hypocreaceæ are carried on as far as the genus *Nectria*.

Worthington Smith on Diseases of Field and Garden Crops.*—Under this title W. G. Smith publishes an exceedingly useful account of the majority of the diseases to which plants are subject, especially those caused by fungi, but including also the ailments due to the attacks of nematoid worms; as well as a very full description of the parasitism of the clover-dodder. It is copiously illustrated by woodcuts.

Myxomycetes with Pseudo-plasmodia.†—O. Brefeld proposes to divide the Myxomycetes into two principal types:—Myxomycetes aplasmodiophori, forms without any plasmodium or with pseudo-plasmodia; and Myxomycetes plasmodiophori, forms with true plasmodium. The former are undoubtedly the simpler type, and may be again divided into the Guttulinæ with sessile, and the Dictyosteliaceæ with stalked sporangium. The Guttulinæ, which occur on dung in various forms, are the starting-point of the Myxomycetes, and must be regarded as among the simplest forms of Thallophytes.

The Dictyosteliaceæ consist of the two genera *Polysphondylium* and *Dictyostelium*, of which Brefeld describes in detail two species, *P. violaceum* and *D. mucoroides*.

Polysphondylium, a new genus established by Brefeld, differs from *Dictyostelium* in its verticillate lateral branches, springing from

* Smith, W. G., 'Diseases of Field and Garden Crops,' 353 pp. 8vo, London, 1884.

† Brefeld, O., 'Unters. aus d. Gesammtgeb. der Mykologie,' Heft 6, pp. 1–34 (2 pls.). See Bot. Centralbl., xviii. (1884) p. 193.

beneath the terminal violet sporangium; it occurs on horse-dung. The amœbæ appear among the spores in the same way as in *Dictyostelium*, and are provided with vacuoles and a nucleus. These amœbæ do not, however, coalesce into a true plasmodium before the formation of the sporangium; they can be separated from one another by the slightest pressure, and constitute what may be termed a pseudoplasmodium, from which the sporangium is directly formed. Almost before the amœbæ have entirely lost their pseudopodia the formation of the sporangium begins; a central portion of the mass of amœbæ becomes differentiated, and developes into the pedicel, each amœba becoming a pedicel-cell. As soon as the formation of the pedicel is completed, the remaining mass creeps to its apex and collects into a ball; each amœba becomes a spore, and the whole a pseudosporangium, which is at no time enveloped in a membrane.

Lichenes.

Relation of Lichens to the Atmosphere.*—G. Bonnier and L. Mangin have determined that under circumstances most favourable to their development, viz. in darkness, diffused light, sunshine, and at different temperatures from 10° to 32°, several lichens—*Cladoma rangiferina*, *Evernia Prunastri*, *Parmelia caperata*, and *Peltigera canina*—display, as the net result of the influence on them of the air, an absorption of oxygen and disengagement of carbon dioxide. It follows that, under the most favourable conditions, the action of chlorophyll does not compensate respiration; and that, as a consequence, lichens cannot obtain from the atmosphere all the carbon which they require for building up their tissues.

Algæ.

Algæ of the Red Sea.†—A. Piccone publishes a list of 235 algæ found in the Red Sea, mostly in the Bay of Assab, with descriptions of a number of new species and varieties. Four genera and not less than 99 species are peculiar to the Red Sea algal flora; and the general affinities are much closer with the forms of the Indian Ocean than with those of the Mediterranean. The great feature of the algology of the Red Sea is the enormous number of species and varieties of *Sargassum*, nearly all of them endemic; it is also characterized by the scarcity of diatoms, and of green algæ generally; the Laminarieæ are also altogether wanting.

Afghanistan Algæ.‡—Dr. J. Schaarschmidt gives an annotated list of 60 species of algæ collected in Afghanistan in 1880. They were found chiefly adhering to specimens of *Ammannia pentandra* Roxb., and forming fine bluish-green incrustations around the stems and on the leaves. Many interesting forms were found (perhaps

* Bull. Soc. Bot. France, xxxi. (1884) pp. 118–9.
† Nuov. Giorn. Bot. Ital., xvi. (1884) pp. 281–332 (3 pls.).
‡ Journ. Linn. Soc. Lond. (Bot.) xxi. (1884) pp. 241–50 (1 pl.).

Bacillariaceæ) in the small earthy particles remaining attached to the roots. One species, viz. *Hantzschia Amphyoxys*, was only found on the roots of *Anemone tetrasepala* Royle.

Conjugatæ.*—F. Gay publishes a monograph of the Conjugatæ of the neighbourhood of Montpellier. He describes the mode of growth as twofold: the ordinary growth of the Zygnemeæ and Mesocarpeæ, and the local growth or "reduplication" of the Desmidieæ. The modes of reproduction described are: parthenogenetic, as seen by Wittrock in the Mesocarpeæ, and by the author in *Spirogyra longata;* apogamous, also described by Wittrock and De Bary; and the ordinary sexual mode.

Floating Rivularieæ.†—E. Bornet and C. Flahault review all the algæ belonging to the Rivularieæ described as forming "flos aquæ," and conclude that they must all be referred to the genus *Glœotrichia*, many of them being forms of the species known as *G. pisum*. *Glœotrichia* is reproduced in two ways: by hibernating spores and by hormogonia. Algæ belonging to this group are much more constant in their form than Nostochineæ, such as *Tolypothrix*, *Scytonema*, and *Lyngbya*.

Sphacelaria.‡—V. B. Wittrock finds the rare alga *Sphacelaria cirrhosa β œgagrophila* Ag., on the east coast of Gothland, in the form of globular balls, 1–4 cm. in diameter, not attached, but rolling about free in the water. The balls consist of an immense number of radial threads matted together by their numerous branches, these are collected into two or three concentric layers, each of which appears to be the growth of a year. Two other algæ, a diatom and a *Cladophora*, are epiphytic on the *Sphacelaria*, and unite with it to make up the floating ball.

"Sewage-Fungus."§—A. W. Bennett has examined the organism known by this name to sanitary engineers, which appears in white flocculent masses in the effluent water from sewage works. He finds it to be identical with *Beggiatoa alba* Vauch., or a variety of that species, which is characterized by the remarkable property of eliminating sulphur from the organic or other substances present in the water. This sulphur appears as minute strongly refringent globules inclosed within the colourless filaments, and generally situated near to a transverse septum or the base of a branch-filament.

Growth of the Thallus of Coleochæte scutata.‖—L. Kny states that in the disk-like thallus of this alga attached to the sides of vessels, cell-growth and cell-division almost invariably take place more actively on the side most exposed to the light. He does not,

* Gay, F., 'Essai d'une monographe des Conjuguées' (4 pls.) Montpellier, 1884. See Bot. Centralbl., xviii. (1884) p. 353.

† Bull. Soc. Bot. France, xxxi. (1884) pp. 76–81.

‡ SB. Bot. Gesell. Stockholm, Feb. 27, 1884. See Bot. Centralbl., xviii. (1884) p. 283.

§ Proc. Brit. Assoc. Adv. Sci. (Montreal Meeting) Sept. 2, 1884.

‖ Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 93–6.

however, consider that this is due to the direct influence of light, but only indirectly, in the same way as Famintzin has shown in the case of *Spirogyra*.

Influence of Gravitation on the Movements of Chlamydomonas and Euglena.*—F. Schwarz has tried a series of experiments on this subject, from which he concludes that gravitation is the determining cause of the direction of the movements of *Euglena* and *Chlamydomonas* in the dark under certain conditions. This may take place in two ways:—Firstly, gravitation may act in the same way as light—as a stimulant, i.e. these organisms may be sensitive towards gravity in the same way as they are towards light; gravitation brings forces into play which place their longer axis in a certain direction, in which direction movement then takes place. Secondly, the objects may place themselves, in consequence of the excentric position of their centre of gravity, in the resting position, so that the anterior colourless end is turned upwards; gravitation would in this case cause an upward motion without acting as a stimulant.

If the calling forth by gravitation of phenomena of movement and growth is called geotropism, these movements may be regarded as geotropic; but the author proposes for this special phenomenon the term *geotaxis*, corresponding to the similar phenomenon of phototaxis produced by light.

Chytridiaceæ.† — K. Fisch has observed three new forms of Chytridiaceæ growing on green water-plants, one of them the type of a new genus.

The new genus (*Reesia*) is distinguished from all other genera of the order by the possession of zygospores, and is thus characterized:—Vegetative structure amœboid; reproduction by zoosporangia, with long neck projecting into the water, and uniciliated zoospores, which conjugate in pairs and produce resting-spores; these, on germinating, give birth to zygospores, which penetrate singly into the host. In addition to these zoospores are others not differentiated sexually which produce these reproductive organs directly. *R. amœboides* lives in the cells of *Lemna*.

The genus *Chytridium* he thus defines:—Zoosporangia of various forms and opening in various ways; zoospores not conjugating; in the summer producing again zoosporangia, in the autumn resting-spores; the latter, on germination, again producing non-conjugating zoospores.

Rhizidium has zoosporangia and resting-spores formed from a strongly developed much-branched cell or mycelium; zoospores not conjugating; secondary zoosporangia and resting-spores often produced in intercalary and terminal positions.

Fisch regards *Reesia* as the lowest form of the Chytridiaceæ, which he considers as related to the Ustilagineæ, through *Protomyces* as a connecting form, rather than with the Peronosporeæ.

* Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 51–72.

† Fisch, K., 'Beiträge zur Kenntniss der Chytridiaceen.' Erlangen, 1884. See Bot. Centralbl., xviii. (1884) p. 225.

Some further description is also given of *Pleocystidium parasiticum*, found in the cells of *Spirogyra*, which he regards as belonging to no recognized group, but most nearly related to the Chytridiaceæ.

Cooke's Fresh-water Algæ.—Dr. M. C. Cooke has now completed this excellent work, which no microscopist can be without. It includes descriptions and coloured plates of all the fresh-water algæ at present found in the British Islands, exclusive of diatoms and desmids.

Alga in Solutions of Sulphate of Magnesia and of Lime.*—Prof. E. Perceval Wright found a minute phycochromaceous alga in test solutions of sulphate of magnesia and of lime and of phosphate of soda, which, in certain lights, presented quite a green shade. These solutions were kept exposed to light, and were prepared with all due care. The algal form abounded in all, but in the phosphate of soda it developed much more rapidly, so as to present, on the solution being shaken up, a dense flocculent cloud. The form seemed allied to *Chroococcus*, and was immensely active in its cell-division and cell-growth.

Confusion between Species of Grammatophora.†—Dr. L. Dippel points out that confusion has arisen in regard to the test object *Grammatophora marina*, which he formerly described as having 25 striæ per 10 μ (now corrected by further examination to 22). The species, however, which he examined under this name is not the *G. marina* of W. Smith but of Kützing, and he has satisfied himself that the latter is identical with the *G. oceanica* of Ehrbg.

It is therefore *G. oceanica* Ehrbg. to which the earlier descriptions must be considered to apply, the name *G. marina* being reserved for the more coarsely marked species of W. Smith, which has only 15 to 16 striæ per 10 μ, as against the 22 striæ of the former.

There is also a very common confusion in the case of the rare *G. subtilissima* (Bailey?), equally as difficult for a test object as *Frustulia saxonica*. The form supplied to most microscopists is *G. macilenta* W. Sm., which in place of 34 to 36 striæ per 10 μ has only 25–28.

Depth at which Marine Diatoms can exist.‡—Count Castracane adduces reasons, founded on physical and biological considerations, for believing that the light of the sun may penetrate, in a very rarefied condition, to greater depths in the sea than has generally been supposed. The convex surface of the ocean enables it to be regarded as an enormous lens which collects the solar rays, and condenses them more or less in proportion to the convexity of the surface and to the depth. Within the bodies of echini obtained in the 'Challenger' expedition from latitude 41° 13′ N. and longitude 65° 45′ W., at a depth of 1345 fathoms, or 2400 metres, the

* Ann. and Mag. Nat. Hist., xiv. (1884) p. 211.

† Zeitschr. f. Wiss. Mikr., i. (1884) pp. 25–8.

‡ Castracane, Conte Ab. F., 'Profondità cui giunge la vita delle Diatomee nel mare,' 4to, Roma, 1884, 9 pp.

Count found the frustules of diatoms belonging to a number of distinct species and genera, the dominant form being a beautiful *Thalassiosira*, probably *T. Nordenskiöldii* Cleve.

Diatoms of Franz-Josef's Land.*—A. Grunow has had the opportunity of examining a number of diatoms from Franz-Josef's Land, as well as from an ice-block west of Matotschkin-Scharr. They differ from the diatoms at present known from arctic regions, and a number of new species are described. The fresh-water forms are very different from those obtained from deep soil, and much more closely resemble known arctic forms.

Structure of Diatoms from Jutland "Cement-stone."†—W. Prinz, whose previous researches on this subject we have recorded, has, in conjunction with Dr. E. Van Ermengem, undertaken a more elaborate investigation, principally on *Coscinodiscus Oculus Iridis* and *Trinacria regina* (and allied forms from the London clay), making sections by the grinding method previously described. The details and results are embodied in an exhaustive paper, which will be read with great appreciation by all who are interested in the subject. The plates are necessary to properly follow the paper, and these cannot unfortunately be reproduced here.

The short result of the authors' investigations is that not only do the valves of the diatoms examined consist of two laminæ, in the outer of which are hexagonal or circular areolæ, but that the exterior lamina is wholly made up (in the diatoms with hexagonal markings) of the honeycomb structure, entirely open at the top of the alveoli, and that the interior lamina only partially closes these openings, being itself perforated by circular holes at the bottom of each of the hexagons, which holes are bounded by a wall like a section of tube, which projects a little way through the lamina both outwardly and inwardly.

Prof. A. Grunow, *ante*, p. 436, stated his opinion to be that the perforations (which he agreed were proved by the authors to exist in the diatoms from Jutland cement-stone and London clay) were due to the fact that the diatoms had begun to undergo dissolution, the delicate closing membranes of the alveoli disappearing first of all. The authors consider ‡ that this dissolution is disproved by the fact of the preservation (in the cement-stone) of the delicate markings of *Janischia* and the existence of young incompletely silicified valves of *Coscinodiscus*, whilst the diatoms from London clay were covered with pyrites soon after death and before dissolution could have set in.

Dr. L. Errera, in a subsequent discussion,§ raised the question whether, notwithstanding the absence of siliceous membranes covering the perforations (which, however, he did not consider disproved), there might not exist in the living diatom a cellulose membrane

* Denkschr. K. K. Akad. Wiss. Wien, xlviii. (1884). See Bot. Centralbl., xix. (1884) p. 65.

† Ann. Soc. Belg. Micr.—Mém., viii. (1883) pp. 7-74 (4 pls. and 6 figs.).

‡ Bull. Soc. Belg. Micr., x. (1884) pp. 79-82.

§ Ibid., pp. 82-6.

which fulfilled that office. To this Dr. Van Ermengem replied that he "did not at all refuse to admit the existence of organic membranes covering the perforations."

Dr. J. D. Cox, in a criticism * of MM. Prinz and Van Ermengem's paper, considers that their conclusions are "so decisively and explicitly contradicted by the examination of these valves by other means, as to increase rather than diminish our doubts of the value of sections prepared as these have been. The difference is so radical, and so easy to test, that it challenges at once the attention of all who are accustomed to the use of the Microscope.

In the first of the plates which illustrate the paper is a figure of the interior plate of *Coscinodiscus* showing the 'eye-spots.' These are, by measurement, more than half the diameter of the hexagons. In *Triceratium favus* the hexagons are usually four or five to the thousandth of an inch, and the 'eye-spot' or perforation should, therefore, have a diameter of at least ·0001 in. But an amplification of only a hundred diameters would make this ·01 in., and it should, therefore, be easily seen with any good 2/3 objective. As a matter of fact, the 'eye-spots' in the separated inner plate of *Coscinodiscus Oculus Iridis* are so easily seen with a 4/10 objective and a 2-in. ocular, that I am in the habit of using this glass on the double nose-piece as a 'finder' when studying that shell in the large variety found in the Nottingham and Calvert County deposits. Therefore, in an opaque preparation of this shell, or of *Triceratium favus*, since we are able not only to get an amplification of 400 or 500 diameters by the use of high oculars with the glasses named, but by using a 1/4-in. with long working distance may considerably increase the magnifying power, the supposed holes in such shells are far within the limit of common observation by reflected light, and should easily be seen in such slides as Möller's opaque Cuxhaven diatoms which I have already referred to. The truth is, however, that with trifling care in the manipulation of the light, the continuous surface of the inner lamina of *T. favus* may be seen with a clearness which defies all scepticism, and if the glass is a good one, there need be no great difficulty in seeing upon its surface the finer system of dots which is independent of the hexagonal marking, as in the case of *Eupodiscus argus* also. The outer lamina will also be found continuous. There is no room for illusion in this matter. Broken shells are easily found, and some with holes broken in them, and the difference between a plane surface and a solution of continuity is too plain to be doubted. . . . Whether the inner or the outer plate of the valve is examined, the closing of the hexagons by a film is as apparent as in examining with the naked eye a real honeycomb which the bees have capped with wax."

Dr. Cox then describes a confirmatory experiment in which use was made of reflected and transmitted light at the same time. The object was a *Coscinodiscus* "having one of the laminæ in part broken away. It fortunately turned out, also, to be with the convex side up, and enabled me to make what I must regard as an *experimentum crucis*.

* Amer. Mon. Micr. Journ., v. (1884) pp. 66–9.

Its broken surface was peculiarly adapted to bring out the valuable qualities of the vertical illuminator. I first focused on the lower lamina, where the upper was entirely removed from it. This was not quite in contact with the cover-glass, and consequently could not be seen so easily as it otherwise would have been. The refraction of the light made it appear black (as a very thin transparent film on a black background), but the hexagonal outlines where the hexagonal walls were broken away, and the central circular areolæ were still to be seen with careful looking. I then turned to the thicker part of the shell, and here came an unlooked-for surprise. I immediately saw that there were two classes of appearances to be examined. 1st. In small patches over the surface from which the upper lamina had been removed the hexagonal walls stood up here and there like islands. These walls were evidently thickened and incrusted with a white substance apparently more porous than the silex, and this incrustation took the form of nodules at the angles of the hexagons, whilst it partly filled the hexagonal cell at the bottom, giving it a hemispherical or cup-like form. 2nd. Beyond the general line marking the fracture and removal of the upper lamina, and where it was still in place, the surface was smooth and in all respects of the same appearance as the lower surface seen on the first specimen. This I repeated and re-examined till I felt sure of my observations, and that there was no illusion about it. Three classes of appearances stood there as opaque objects, too clear for question: 1st, the black, lower lamina with faint hexagonal and circular markings; 2nd, the island-like portions of the hexagonal cells without the upper film, and incrusted with the white substance; and 3rd, the upper lamina surface, smooth and grey, with its darker hexagonal tracing and circles within.

But it occurred to me to add another test. Whilst the surface was still illuminated by the vertical illuminator I threw a beam of light through the achromatic condenser from the mirror below, and now had what seemed demonstrative evidence, making assurance doubly sure. The lower film was plainly seen, very thin, with shallow circular areolation, the hexagonal lines being almost invisible; the patches of cell-structure stood out vividly, less changed than the rest; but the unbroken part of the structure with both laminæ in place, made transparent by the strong, transmitted, bluish light (the condenser had a blue moderator), showed the internal structure exactly as in the island patches, whilst the fainter red beam of light from the vertical illuminator still marked the gleam of the upper surface by reflection, and the whole structure stood revealed. By turning on and off the transmitted light from the mirror the surface view or the internal structure could be seen in turn, and the fascinating experiment was repeated again and again."

As to MM. Prinz and Van Ermengem's statement that the centre of the "eye-spot," viewed by transmitted light, never shows any film, it is true that along a broken margin of a separated inner lamina of *Coscinodiscus* the eye-spot is usually found empty; but this, Dr. Cox says, is not always so, and in the unbroken portions of such a plate

proper attention to the correction of the objective will enable us to detect it in the robust shells found in the Nottingham earth.

"In the Nottingham slides all the parts of the gigantic disks are increased in size and thickness, and upon examining the interior plate we find within the hexagonal tracing: 1st, a narrow circle so thin as to be scarce distinguishable in colour from the empty field; 2nd, another narrow ring of pinkish colour, evidently thicker than the last; 3rd, another nearly colourless ring; and lastly, a small central part of appreciably pink tint. Nearly every broken valve will give some examples of the inner lamina projecting beyond the outer, and a patient examination will soon find examples in which the fracture, passing through the eye-spot so as to break off only an outer segment of, say, one-third its area, leaves the inmost spot, the pink 'pupil' of the eye, intact. I have verified this so often as to be able to assert it categorically. . . . As to the upper film, the same preparations give abundant evidence of its existence."

J. Deby also,* while not disputing that what the authors describe and figure did actually exist in their sections, nevertheless considers that their deductions are entirely erroneous, which has arisen in consequence of their having studied not living but fossil forms, which have lost not only the purely membranous parts but also a certain thickness of the siliceous layer. The dissolution of the silex of diatoms takes place with great facility, as he shows by an experience which occurred to himself, where some *Epithemia* in a vessel of brackish water with *Synedra* were found at the end of two months to have been entirely dissolved, doubtless furnishing the *Synedra* with the silex which they required for the formation of their valves. Mr. Deby has numbers of diatoms belonging to genera which the authors describe as having perforations, which undoubtedly have septa which close at each end the supposed orifices.

Structure of the Diatom-Shell.†—Dr. J. D. Cox gives the results of a series of repeatedly verified observations on this subject, using both transmitted and reflected light. With the former he preferred balsam slides illuminated by a narrow central pencil, and for reflected light the vertical illuminator was found invaluable. The objectives were of the largest aperture.

Triceratium favus he finds is formed of two laminæ connected by an hexagonal network, of which the areolæ are about as deep as the diameter of the hexagons. The inner of these laminæ is finely dotted with lines of punctæ radiant from the centre of the triangle, the outer lamina being very thin over the centre of each hexagon, to which it is firmly connected by the walls of the areolæ, which are thickened so as to give a hemispherical interior form to the upper end of each.

Eupodiscus argus may be considered, typically, as having a subhexagonal arrangement of areolæ in the outer lamina of the valve, the walls of these areolæ being extraordinarily thickened outwardly, making a rough honeycombed surface. The inner lamina has its

* Journ. de Microgr., viii. (1884) pp. 228-30.

† Amer. Mon. Micr. Journ., v. (1884) pp. 45-9, 66-9, 85-9, 104-9.

independent system of very fine circular dots in radiating lines, and some of these are seen at the bottom of the bright areolæ when the diatom is examined by transmitted light.

Coscinodiscus Oculus-Iridis has been fully dealt with *supra*, p. 941, in Dr. Cox's criticism of MM. Prinz and Van Ermengem's paper.

Leaving the bolder marked forms, in regard to which the existence of areolæ in the valves is so plainly shown by the lines of fracture that there has been little or no dispute about it for some years, Dr. Cox takes up the species and varieties which have much finer markings, and with which the difficulty begins. His remarks will be considered of such interest that we transcribe them in full.

"The most satisfactory method of examination will be found in a progressive study of specimens from each of the more important groups and families, beginning with those having the larger features and passing on to the more delicate. We shall first notice that in the great variation in size which occurs in all species of diatoms we have presented to us examples with a considerable range of diminishing areolæ also. In different individuals of the same size there is also often found much difference in fineness of areolation. The gigantic forms of *Coscinodiscus Oculus-Iridis* found in the Maryland deposits become as small as *C. radiatus*, and the latter is often found in recent marine gatherings side by side with *C. subtilis*, and of no greater size.

We are able, therefore, to follow the diminution of undoubted hexagonal areolæ from the greatest of these specimens, where the valves measure ·016 in. in diameter, till they are scarcely one-eighth as large. Then taking up *C. subtilis* with its hexagons in the larger valves as clearly marked in outline, we find another diminishing series, in which the sharpest scrutiny still leaves us in doubt when we pass from the hexagonal form to that of round punctæ. In this progression we find that the areolæ continue to be the weak places in the shell, the fracture following them in the smaller as in the larger examples. Examined by aid of the vertical illuminator, the surfaces of the valve continue to show the characteristic reticulation and 'eye-spots' as long as we can trace distinct form at all. As the hexagons become smaller we see by transmitted light that they show more colour when the tube is lowered a little, and they are thus brought a little within the focus. In the smallest of these in which we can clearly define the hexagonal outline, the spot becomes quite deeply red. If we next select a valve in which the dots are a little more distant from each other and evidently round (the scheme of marking and the marginal spines being the same as in the larger specimens), we shall find the same conduct with regard to colour when the objective is lowered or raised; that the fracture indubitably follows the line of the dots, and that under the vertical illuminator the smaller dry specimen is not distinguishable from the larger except in the roundness of the areolæ.

Pass now from *C. subtilis*, as we find it along our own coast in gatherings shown in Peticolas's slides from Jacksonville or Fernandina, Fla., to the *Odontodiscus subtilis* of Möller's type-plate or his slides of

gatherings from Wedel marshes, or those of Holland. We have Prof. H. L. Smith's authority for regarding this diatom as identical with *C. subtilis*, and it is, at farthest remove, only a variety of that species. No distinctly hexagonal areolation is seen here, but the punctæ are round, though often so closely set as to lead the eye very persuasively to the illusion of taking them for hexagons. Remembering Nachet's figure demonstrating the liability to mistake on this point, and using to the full the advantage our widest angled glasses have in seizing upon the surface, we shall soon satisfy ourselves that we have round areolæ in a shell of silex showing a pinkish tint. The light within the areola, when the outline is in sharp definition, is of the general pale greenish colour of the field. Depress the tube, and the dots become red spherules; decentre the light from the condenser a little, and they stand out like little balls. Among these valves I have found very numerous examples in which the fracture evidently follows the line of the areolæ. In one specimen a segment had been broken out, one side of it bounded by a regular radial line from the centre of the shell to the circumference. In it the next row of areolæ was plainly separated from the broken part by a line of silex of appreciable width, on the outer edge of which the little irregularities and indentations of the fracture showed where the divisions between the adjacent dots had been. In both the American and the European diatoms I have also occasionally found the two laminæ of the shells of this species separated partly or wholly, as has been noted in the larger species of *Coscinodiscus*, and in such cases the fracture of the inner lamina through the 'eye-spot' is even more demonstrably apparent than in the perfect shell.

The evidence from fracture of the valve and from the general appearance under the vertical illuminator, therefore, justifies the conclusion that the truest view of this diatom by transmitted light is that which we have when the objective is so adjusted that the punctæ appear to be sharply drawn circles in a film of pale pink colour, the circles themselves having a greenish-white light. We may consequently reject the red spherules in this case as the product of diffraction and interference of light. Another bit of experimental evidence on the subject is found in the way in which, on a slight motion of the mirror, the light will flash along behind a diatom, lighting up the areolæ as it passes, and making the comparative darkness of the thicker part of the shell apparent in a telling way. Dr. Greville refers to this in his description of *Aulacodiscus orientalis*,* as making it very evident that the areolæ in the clathrate framework of that beautiful diatom are really thin, window-like spaces, through which the light flashes. The effect is not easily described in words, but it will be recognized by all who have had much experience in studying diatoms under the Microscope.

Another species of diatoms will aid us to carry our induction a little further. In either of the gatherings I have mentioned we may readily find specimens of *Podosira maculata* (*Hyalodiscus stelliger* Bailey), and these will be found of very varying degrees of fineness

* Trans. Micr. Soc. Lond., xii. (1864) p. 12.

in the marking. In the European slides I have generally found them coarser than in gatherings from warmer seas, but they differ a good deal in the same place. The shell is made up of segments radiating from the large granulated umbilicus, and these segments are marked as if cut from sheets of perforated silex, and bent into place on the convex surface of the valve, the edges of the segments often showing lines of apiculi obscuring the suture. In the coarser specimens the areolæ are but little more difficult to define than in *Odont. subtilis*, and in broken ones the fracture may be unmistakably traced through the punctæ. The colour test shows also the same appearances as in the species last described. From this we may follow the increasing fineness of the marking till the dots run together into a diagonal striation rivalling the *Pleurosigmas*, and approaching (though with a considerable interval) that of *Hyalodiscus subtilis*.

As far as we can succeed in defining small areas and minute irregularities of fractured edges, we find the hexagons diminishing to dots and these to still finer punctæ, but they continue to have all the characteristics of an arrangement of areolæ between two laminæ. It is fair to conclude that in those specimens of *Podosira maculata* in which we cannot define the areolæ, they nevertheless exist, and we might add that it is at least probable that the same structure would be found in *Hyalodiscus subtilis* if our glasses were more powerful. I intend to continue for the moment, however, within the region of observation, and to postpone drawing conclusions till we have examined a greater number of species.

The *Actinocyclus*, in its different varieties, is a very interesting genus to study in connection with the preceding series. It is found with disks of less than ·001 in. in diameter, and running up to the splendid proportions of *A. Ralfsii*, measuring sometimes over ·008 in. In some of the smaller species the dots are comparatively large, and the disk will be found subdivided by six or more radial lines of areolæ, each line containing only six or eight of the large dots. In the larger kinds the rays are often fifty or more, with as many areolæ to the radial line. The segments are filled, of course, with similar areolæ, arranged upon a series of parallel lines. I think I may say that of all the species and varieties of this disk which I have examined, there is none of which I have not found examples of separated laminæ, showing inner and outer plates as in *Coscinodiscus*, none in which the line of fracture does not prove the dots in both plates to be the weak places. Some of the smaller disks with large areolæ are found in gatherings from the Samoa Islands and other places in the Indian Ocean. Möller's slides from the Baltic at Kiel give a large range of sizes and conditions. A preparation of *A. fuscus* (*Cos. fuscus* Norman) from Yarra Yarra, Australia, made by Wheeler, shows an unusual number of separated laminæ, an examination of which will confirm my assertion. The fossil earths of Nottingham and Calvert Co., Maryland, are full of *Actinocyclus*, and the deposits of Santa Monica and San Luis Obispo, on the Pacific coast, are rich in various forms of the same genus, with great range in the size of the punctæ.

There is a tendency in most of the species to accumulate silex upon the spaces between the areolæ, giving a roughened and irregularly granulated appearance to the outer surface of the disk. This condition also interferes with a satisfactory examination of the 'dots' by causing irregular refraction, &c. For this reason we need to select smooth and evenly marked specimens for one part of the investigation, though for another the roughened examples are most instructive. We find this thickened coating broken away in different degrees; sometimes leaving the shell smooth but perfect; sometimes taking with it the outer lamina, and leaving only the inner with its delicate punctation. The fact that the thickening is upon the interspaces between dots is additional evidence that the latter are areolæ, since they allow the light to pass when the thickened walls around them make a semi-opaque outline approximating the character of the shell in *Eupodiscus argus*. But among these roughened specimens I have more frequently found the separate inner lamina, and this when once caught by the glass, is always the most convincing proof of the scheme of marking of the valve; for the film is so homogeneous and even, and the dots upon it are diminished to so fine and regular punctæ that the eye is never dazzled, confused, or misled in following its delicate pattern.

The examination of the several species last referred to, under the vertical illuminator with higher powers, and as opaque objects with the 1/4 in. objective, is strongly confirmatory of the interpretation I have given. Reflected light may be made to flash from the surface of all the finer examples of *C. subtilis* as well as from *Actinocyclus* and *Podosira*, so as to show a glassy smoothness, with a play of iridescence in the thinnest specimens. This is true of both the convex and concave surfaces of the valves. No trace of projecting spherules can be seen in such an examination, though the dots of the shells are of such appreciable magnitude that they would be easily visible as protuberances if they were solid spherules. Indeed, with the vertical illuminator and a high power, siliceous fragments of broken sand-grains may often be seen lying upon the surface of these shells, very much smaller than the areolæ, and demonstrating by the ease with which they are seen, that if the dots approached hemispheres in form they also would be perfectly apparent. This, then, is another strong proof that these areolæ are contained between smooth and parallel laminæ.

If, finally, still using the vertical illuminator and a high power, we review the series of valves beginning with the boldest forms of *Triceratium* and *Coscinodiscus* and ending with the finest *Actinocyclus* and *Podosira*, we find certain appearances consistent throughout the whole range of examination. The areolæ, when the surface is carefully brought into focus and the cover correction accurately adjusted, are always an opaque white or grey, whilst the surrounding wall or solid part is darker, becoming even black when close to a dark background. The comparison which I have already made to ice upon a pond, when part of it is solid and clear and part of it porous, very aptly describes this appearance. There is no break in the series. From coarsest to finest the only change is that the areolæ grow smaller

in fact, and generally smaller also in comparison with the solid parts of the shell; but the light is reflected from the surface in the same way, and the experiment ends with a conviction that the differing methods of examination all lead to the same conclusion.

In examining diatoms as opaque objects with the middle and low powers, the appearances vary more than they do with the vertical illuminator, because, as the light is necessarily oblique, its variations of direction produce changes of appearance. Parts which look dead-white with the vertical light may appear dark, and the thicker portions of a shell also change colour; but the changes of manipulation of the mirror give so many variable experiments as to end in strong confirmation of the results reached by the other means. In opaque mounts the thinness of the shell is shown better than in any other form of preparation. From the dense *Eupodiscus argus* we find every degree of diminishing thickness till we come to an *Actinocyclus* lying upon the black slide, its flat disk as black as the background itself, except when the tiny white spots of the areolæ pick out the pattern of its marking, or the projecting ring of the valve marks its circumference. So a *Podosira* or *Cyclotella* will be seen, the merest soap-bubble with its play of colours and its manifest tenuity, speaking plainly of the extreme delicacy of the film of silex.

We will pass over the irregular disk forms for the present, and next consider some of the *Naviculæ*.

In studying the *Naviculæ* we begin with the large *Pinnularia*, where the size of the valves and the simplicity of the marking make easy the application of the criteria we have already established. Using transmitted light, the raphe is found to show the colour of the general background, whilst the smooth longitudinal portion of the valve next it is tinted with the pink colour which indicates thickening of the silex. The central nodule shows this in a higher degree, with lenticular effects. The costæ are pink in tint also, and in large specimens of *P. major* the interspaces between the ribs are often divided into what appear to be two large oval depressions, of which that next the mid-rib is the shallower, as is shown by its excess of colour over the outer one. The central nodule often extends considerably beyond the inner end of the median line, which is a little enlarged, and seems to terminate in a circular dot, which, by its bright light and freedom from colour, should be a depression reaching nearly or quite through the nodule. In a specimen of *P. alpina* from a Scotch gathering I have found a valve turned partly on one side, so as to give an obliquely transverse view through the valve, and in this the enlargement of the median line is plainly seen to extend like a tube through the thick prolongation of the central nodule. It is not uncommon to find broken valves of *Pinnularia* in which the costæ project boldly beyond the interspaces of which the thin film has been partly broken away. I have noticed a specimen of *P. divergens* in which the thin film has been almost wholly removed by some accidental grinding process and the costæ stand out along each side like the teeth of a comb. Prof. H. L. Smith has given me another similar example of *P. major*. The raphe appears to be like a channel having a very thin film at the bottom,

which is part of the firm silex on one side and laps under the other side in a way similar to the 'rabbit' in joinery.

Of the dotted *Naviculæ*, *N. lyra* may fairly be taken as the type. Its beautiful regularity of form, and the clearness and boldness of its marking make it a very profitable subject for careful examination. It is easy to get somewhat varied appearances by different uses of the light and changes of focus of the objective, but if we use the narrow central pencil of light and care in focusing, its characteristics will be found uniform and unmistakable. Its lyrate hyaline figure in the middle of the valve takes the pink tint. The dots are found to be between costæ which are fully as wide as the dotted interspace, and these have the same colour as the lyrate figure. Find a broken shell and focus carefully upon the broken margin. Oftentimes the costæ will be found to project beyond the interspace, showing its greater strength, and confirming the evidence to this effect which is found in its deeper colour. When the focusing gives us the costæ as well-defined ribs of even width, and a broken edge is also most sharply defined, the dotted interspace will approximate to a ladder-like appearance, the dots having a sub-rectangular form, and being separated from each other by septa considerably narrower than the costæ between which they lie. The term 'sub-rectangular' which I have used must not be taken too literally, for the figure of the dots is that of a circle somewhat flattened on four sides. Assuming that the median line is a groove in the valve, and focusing upon it so that the light coming through it shall correspond nearly to the general field, it will then be found that the dots nearest this line and most perfectly in the same plane show the same colour, an item of evidence that they, too, are thin places in the shell. But the line of fracture gives still stronger proof. I have before me a broken valve of *N. lyra*, in which a segment is entirely gone, bounded by the median line for, say, half the distance from the end of the shell to the central nodule. Then the broken margin runs irregularly off to the rim of the shell. On the other side a wide crack extends diagonally from the median line a short distance, then runs straight out to the rim. This crack (examined with a 1/15 objective) zigzags through the dots in the first part of its course, and in the straight part runs indisputably through the dots and between the straight costæ. The broken edge of the other side of the shell shows with equal clearness that the fracture is through the dots. I have many such cases noted, with great varieties of fracture but all indicating the same fact in regard to structure, viz. that the dots are the thin and weak places in the valve.

Another point to be noted is that whilst the radiant costæ of *N. lyra* are straight, making also straight transverse striation, when viewed with a low power, the longitudinal septa between the dots are not regularly continuous; consequently, when light is thrown transversely across the shell a low power shows longitudinal striæ, but wavy instead of straight. This is also the case with the striation of *N. firma*, *N. cuspidata*, *N. rhomboides*, and *Frustulia saxonica* when examined with high powers, and with the *Nitzschias* of the form of *N. scalaris*, *N. linearis*, &c., of which the coarser specimens show

distinct lines of punctæ between parallel costæ. It is characteristic, too, of the difference between the transverse and longitudinal striæ of *Surirella gemma*. It is certainly natural to conclude that the similar phenomena are due to similar structure.

In *Naviculæ* having strongly radiant costæ, some, like *N. peregrina*, show a similar dotted structure between the ribs, and in these cases the lines of separation between the dots are also much finer and less prominent than the costæ. In another class of *Naviculæ*, of which *N. sculpta* Ehr. is an example, the dots, whilst arranged in lines, do not have thickened costæ between the rows, but are like separate, sometimes elongated, punctæ in a shell of even thickness. In these, however, as in *N. lyra*, the line of fracture follows the dots, and the hyaline parts of the valve show the pink colour, so that both lines of proof still combine to show the dots to be the weak and thin places in the valve. A beautiful example of the latter sort is *Mastogloia angulata* Grun., which is not uncommon in Long Island Sound, and is found along the whole Atlantic coast. The shell is broad ovate, somewhat cuspidate, of smooth, even thickness, and the punctæ are arranged in oblique rows. With a medium power the effect is that of a delicate cross-hatching, much like that of *P. angulatum*. With a high power the dots are well separated, and, except as to arrangement, their appearance is similar to those of *N. sculpta*. As in the disk forms the diminishing size of the areolæ brought us gradually very near to the fine lines of *Hyalodiscus subtilis*, so among the *Naviculæ* we make a similar approximation to the delicate marking of the *Pleurosigmas*.

The use of the vertical illuminator upon these diatoms is hardly less decisive in support of the conclusions I have drawn than in the case of the *Coscinodisci*. A smooth surface, dotted with tiny bubbles, is the characteristic appearance of the shell, and these bubbles, in the larger kinds, cannot be distinguished from those which we have found in the disk forms, beginning with examples from the Nottingham earth, where the hexagons and round areolæ were found side by side upon the same valve. We may even take a step in advance. In Peticolas's slides of Richmond and Petersburg earths there are numerous examples of a coarse form of *P. angulatum* var. *virginicum*, in which the marking in the middle of the valve is coarser than at the extremities. In dry specimens of this shell a high power used with the vertical illuminator will separate the dots sufficiently to show a surface hardly to be distinguished from that of *Mastogloia angulata*, which I have noticed above. It is a smooth film in which the minute bubble-like dots have the same character, and differ only in size from those in *Actinocyclus*, or in the coarser smooth *Naviculæ*. In some broken specimens, also, the line of fracture could be traced through the dots.

In *Stauroneis pulchella* the areolæ are much longer in proportion to their width, and are contracted at the ends so as to take the 'oat-shaped' appearance by which they are commonly known. There is here found a difference in the appearance of the concave and convex sides of the valve, the former presenting the areolæ more

nearly as rectangles, and the latter giving more of the spindle shape. This is analogous to the difference noted in other genera, the outer view of hexagonal markings being usually nearly circular, whilst the inner shows the angles more clearly. In *Epithemia turgida*, as found in Möller's preparation from the Södertelge mud, the framework of the shell is a nearly rectangular lattice, the areolæ showing all the peculiarities of light which have been described in *Navicula lyra*, and the fracture often shows the ends of the framework sticking plainly out beyond the sides of the adjacent dots. The same may be seen in the elongated areolæ of *Amphora ovalis* of the larger varieties. In *Cocconeis splendidum* the hexagons are as distinctly formed as in *Coscinodiscus*, and in *C. scutellum* the areolation varies from coarse to fine with the diminishing size of the valves, giving a series analogous to those which are found in *C. subtilis*, and one in which the fracture is as plainly through the dots, whilst the evidence of relative thickness or thinness of the silex from the colour is as we have found it in other cases.

But to complete the list of species in which I have found the tests of fracture and of colour supporting the theory of areolation of the diatom shell, and contradicting that of solid spherules, would be too much like making a catalogue of all in which the details are large enough to give a well-defined outline to a broken edge. In the progressive series of fine markings we sooner or later reach the point where the thinness of a film causes it to be lost in the general background of the field, or where the prismatic edge of a fracture makes diffraction enough to fringe it with lines of colour or of apparent shadow, which make every cautious observer hesitate to affirm whether the boundary is in or beyond one of the striæ. The fringes move with the slightest motion of the fine adjustment, and the interpretation of what we see is more or less modified by the preconceived theories of the observer. I have intended to draw my examples of facts from specimens found clearly within this limit of doubtful discrimination. I am myself satisfied that in the coarser specimens of different species of *Pleurosigma* careful illumination and accurate adjustment of good lenses show the same characteristics of structure at broken edges of shells which I have described in the larger and bolder forms. In regard to this, however, I admit there is room for dispute. In the matter of the colour test, on the other hand, the evidence seems to me clear. If the objective is well adjusted, and the median line is brought into focus, so that it appears a greenish white line of nearly the same tint as the general field, the dots which are near enough to it to be in the same plane are found to have the same colour. In *P. formosum*, *P. balticum*, *P. attenuatum*, and the varieties closely allied to each, the reticulation seems to be thickened upon the outer edges of the lines, so as to leave a cup-like depression in the interstices, which is yet consistent with double laminæ below. We have seen that in *Eupodiscus* this thickening becomes so great as to be quite opaque. In *Aulacodiscus oregonianus*, and in *A. orientalis*, it is sometimes found thick enough to give a decidedly dark colour to the reticulation of the surface. In media of higher refractive

index than balsam this becomes still more noticeable. In the *Pleurosigmas* I have named, I think a similar thickening of the lines (much more delicate, but real) has taken place, and that this gives the strong cross-hatching which marks them. In the varieties more closely allied to *P. angulatum* the shell is smoother, and in some of these the surface, with high magnification, and both by transmitted light and under the vertical illuminator, is found to resemble very closely that of the distinctly areolated forms which have been described.

In conclusion, I will notice briefly a few of the less regularly marked diatoms, but which still seem to me to corroborate the view of their structure which I have maintained.

In a group of species allied to *Navicula prætexta* Ehr., including *N. Kennedyi*, *N. indica*, *N. clavata*, &c., the regular striæ are confined to narrow bands at the margin and along the median line, the intermediate space being either hyaline or mottled in varying degrees of distinctness. Specimens which have this mottling most distinct exhibit it as a system of rather large but faint dots, arranged in lines continuous with the distinct striæ at the margin, &c., but the dots in these lines are irregularly spaced as to distance. Occasionally an individual is found in which the dots are as sharply defined as in any of the smooth *Naviculæ*, and giving the proof that they are areolæ by fracture and by colour. Arranged in a series, therefore, they show us that the diminishing distinctness of marking is due to the progressive shallowness of the depressions in one of the laminæ of the valve, until from faintest mottling the dots disappear entirely, leaving the interior space smooth and hyaline.

The study of these last assists us in understanding the marking of *Heliopelta*. In this splendid shell we have, first, an outer lamina or film, finely punctate, making the appearance of diagonal cross-hatching upon each of the undulating segments. This film is sometimes found partially separated from the under one, much as the laminæ of *Coscinodiscus* are found. In the Nottingham and Calvert County earths I have found this separation extending over part of a segment of the shell, a whole segment, two or three segments, and in one instance the whole valve. In this last case the separate outer lamina is not distinguishable from the figure given as *Actinoptychus pellucidus* Grun., by Van Heurck, and I cannot doubt that this latter is a separated plate of a similar valve. The separation has included the central hyaline star figure in the shell as well as the dotted part, showing that the laminæ exist here also, notwithstanding the homogeneous transparence of this part of the valve. In the second place, the inner lamina is found to have a different marking in the undulating segments. Those projecting outwardly from the face of the frustule are areolated with a sub-hexagonal areolation, quite distinctly defined. Those which are depressed have usually a much shallower sculpture, of which the normal marking is an hexagonal arrangement of large shallow dots, but these are sometimes enlarged into a system of more distinctly marked equilateral triangles combined, so that the six form a regular hexagon. The difference between

the deeper and shallower areolæ in this case is similar to that which has been described in *Navicula prætexta*, &c., and when they are covered by the lace-like veil of the finely dotted film we have the beautiful and changeable effect which has proved so puzzling to observers. In whole valves of *Heliopelta* the larger areolæ will often be found showing in the central part of the shell where the fine dotting of the upper film does not extend over them, and their character may there be pretty satisfactorily determined, even if the separated laminæ are not detected."

After referring to the similarity of structure in *Halionyx*, and dealing briefly with a few other forms, Dr. Cox concludes with the summary of his results which will be found *supra*, p. 853.

MICROSCOPY.

a. Instruments, Accessories, &c.

Japanese Microscope.—Fig. 145 shows a modern Microscope made in Japan and purchased last year in Tokio. The Japanese workman must have evidently had before him one of the old forms of "conical" Microscope which were current in this country in the last century.

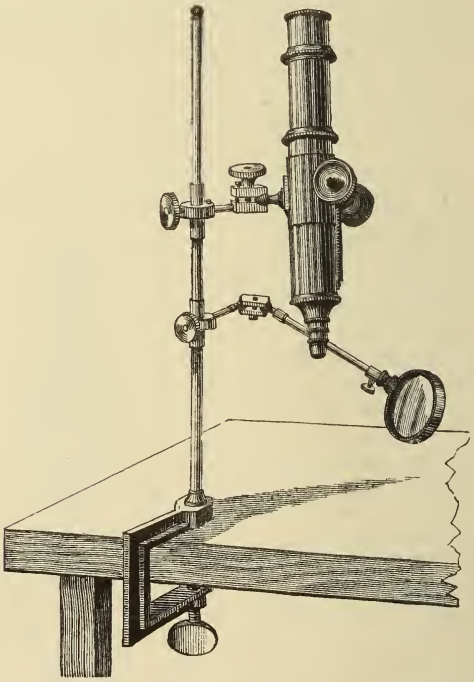
Fig. 145.

A special feature of the Microscope is its exceptional instability, the feet being made of thin and very springy pieces of metal, so that the whole instrument vibrates in every part at the least movement of the table. The four objects are inserted in a metal plate which slides from right to left in grooves in the stage. There is no provision, however, for shifting the plate from back to front, and so obtaining a view of different parts of an object in that direction. The body tube has 2 eye-piece lenses, and a single-lens objective of about 1/2 in. focal length. The metal of which the instrument is made is copper, coated with a black japan, the body tube being covered with leather figured in gilt. The plate immediately below the mirror can be rotated on the box beneath,

carrying with it the whole of the upper part of the instrument, the mirror remaining stationary. We imagine, however, that this movement is the result of defective workmanship, and was not designed as a means of providing oblique illumination.

Schieck's Corneal Microscope.—This (fig. 146) was designed by F. W. Schieck for the examination of the cornea. A steel standard (16 in. long) is secured to the table by a screw clamp. On it slide

Fig. 146.

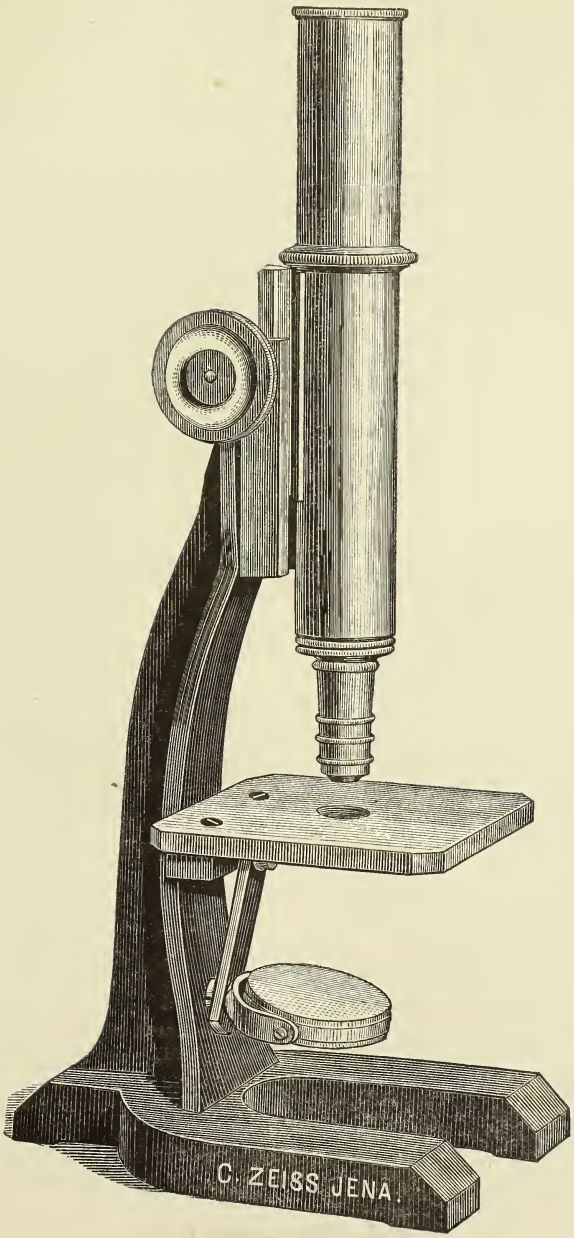


two arms which can be set at any required height by screws. The upper short arm carries the Microscope, which is connected with it by a ball and socket joint and clamp screw, so that great range of motion is obtained. A rack and pinion serves for focusing.

The lower arm carrying the condensing lens consists of two rods connected by a double ball and socket joint. The lens moves on a hinge and also rotates on the rod, a small screw, the point of which works in a groove encircling the end of the rod, preventing it from slipping off. For the lens a mirror having the same movements can be substituted.

Zeiss's No. X. Microscope.—This (fig. 147) is noticeable mainly for the manner in which the upright support is constructed. The limb is of the " Jackson " form, but is continued to the base, to which it is

Fig. 147.



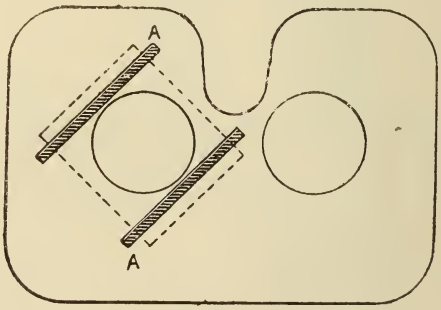
fixed. The stage is attached to the limb. The focusing is by means of rack and pinion only, without fine adjustment. The general design and construction are so simple that the instrument is issued at a very low price indeed.

Wray's Microscope Screen.*—L. Wray, jun., thinks that all who have ever used the Microscope must be painfully aware of the fatigue and distress which prolonged work with it causes to the eyes, and therefore describes a device which he has been trying with this object in view. When the eyes are exposed to a bright light, and one of them is then covered over, the pupil of the uncovered eye at once enlarges, and he believes this action of the iris to be the cause of the distress produced in the use of the Microscope, for the pupil of the working eye is unduly enlarged by the other eye being either shut or shaded by a black screen, consequently more light is admitted to the retina than it can comfortably bear, and the irises of both eyes are in a state of tension, the one tending to contract and the other to expand.

The way in which he counteracts this is by exposing both eyes to an equal light, by attaching to the eye-piece a cardboard screen, which has two holes cut in it, the one to fit on the eye-piece, and the other to allow a thin piece of even-grained white paper being presented before the eye that is not in use.

A back view of the screen is shown in fig. 148, with the paper removed. The two lines A A are intended to represent elastic

Fig. 148.



bands, by which the squares of paper are kept in place, as indicated by the dotted lines, one, two, or more thicknesses being used, according to the brightness of the field and translucency of the paper. The object being to illuminate both eyes equally, it will be found convenient to gum on one thickness of this paper, and to have two or three loose slips to adjust the amount of light.

The plan is one that any one can try for himself; but a more refined method of accomplishing the same thing is to have a ground

* Engl. Mech., xl. (1884) p. 180.

glass screen lighted with a small mirror, and a set of revolving diaphragms to adjust the amount of light.

At first it will seem strange to have a light before the eye not in use, but after a short time this will wear off, and it will then be found that far brighter illumination of the field can be borne when using this device than when closing one eye or employing a black screen.

Abbe's Micro-spectroscope.—This was described at p. 703 of Vol. III. (1880), with an outline diagram of its construction. Its special feature consists, it will be remembered, in the arrangement by which the position of the lines in the spectrum is determined by a direct reading of their wave-lengths on a scale in fractions of μ. The apparatus (half natural size) is shown in fig. 149, and the arrangement for widening the slit in fig. 150.

The tube J containing the prism moves on the excentric pin K so as to turn it away from the eye-piece when required for focusing the object. It is fixed in place by the catch L. The slit is in the

Fig. 149.

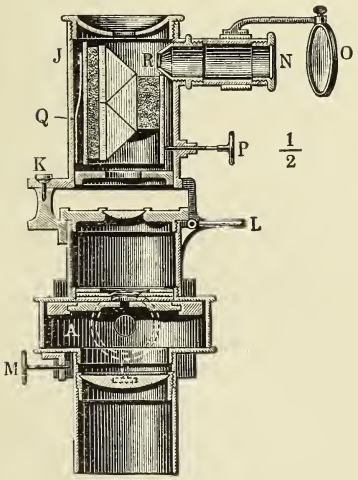
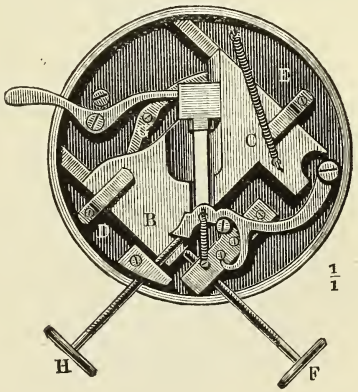


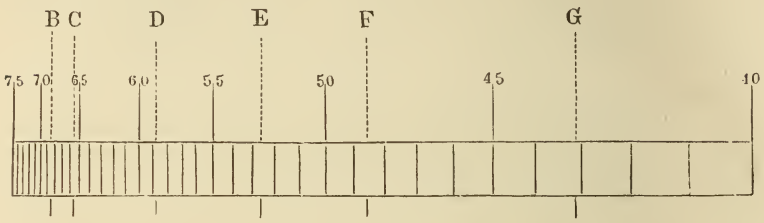
Fig. 150.



drum A, and is made wider or narrower by the action of F, which causes the plates B and C, connected by the lever-arm G and moving between the guides D and E, to approach each other symmetrically. H, on the other hand, regulates the length of the slit. The scale N (fig. 151) is illuminated by the mirror O, and its image is thrown on the spectrum by the objective at R. By the milled head P, which acts against the spring Q, it is set so that the Fraunhofer line D coincides with 0·589 of the scale. The screw M serves to secure the

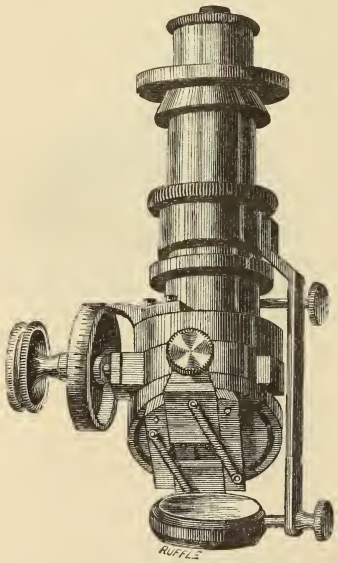
apparatus to the body-tube of the Microscope, into which it is slipped as far as the lower end of the drum A.

Fig. 151.



The comparison prism with its illuminating mirror is not shown, though the latter is indicated in fig. 149 by dotted lines. It is turned away from the slit by the lever-arm shown in fig. 150.

Fig. 152.



Engelmann's Micro-spectral Objective.*—This (fig. 152) was made by Dr. Zeiss for examinations by Prof. T. W. Engelmann's Bacteria-method.

It consists of a plane mirror, a slit, a collimator lens, and a direct-vision prism. The whole apparatus is 77 mm. long, and is applied beneath the stage, ordinary objectives according to the size of the spectrum desired being screwed on at the top to project a spectrum at the plane of the object under examination. Both sides of the slit are moved symmetrically by the screw with divided drum. This screw has two opposite threads on a common axis, so that the centre of the slit never changes its place. The drum gives the width of the slit in hundredths of mm. The smaller milled head moves outer slides to regulate the length of the slit.

In place of the prism a grating can be used, which would give an interference spectrum.

Mayall's "Stepped" Diagonal Rackwork.—Mr. J. Mayall, jun., has suggested the application to the coarse adjustment of a "stepped" diagonal rackwork for increasing the smoothness of the motion.

* See this Journal, ii. (1882) p. 661. Bot. Ztg., xv. (1882) pp. 419-26 (1 fig.). Pflüger's Arch. f. d. gesammt. Physiol., xxvii. (1882) p. 464, xxix. (1883) p. 415.

Fig. 153 shows the arrangement as first applied with three racks, the teeth of each part being set out of line to the extent of one-third their pitch and the spiral pinions being fitted to correspond with the racks. The effect is similar to what would be obtained by pitching the teeth of a single rack three times as finely, but at the same time retaining the strength due to the coarser pitch.

Mr. Mayall subsequently suggested that as the fitting of three

Fig. 153.

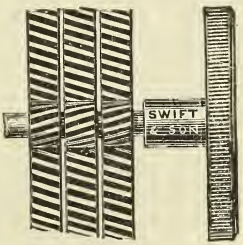
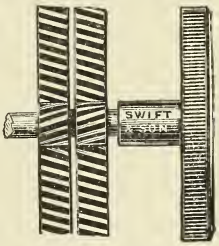


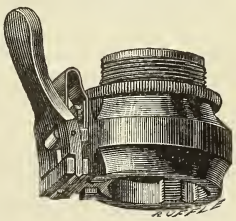
Fig. 154.



pinions on the same axis presented some difficulties of workmanship, these might be considerably reduced by using two racks instead of three, as shown in fig. 154, still retaining a considerable advantage over the ordinary single diagonal rack.

Fasoldt's Nose-piece.—Mr. C. Fasoldt's form of nose-piece (fig. 155) is somewhat similar in principle to that suggested by Mr. Curties.* The Society screw to receive the objective consists of three segments, one of which is on a movable piece which is acted on by a spring lever, a jam-nut enabling the lever always to be set at the most convenient point for working it, say in front of the body-tube. On pressing the lever the objective can be introduced, and if inserted so that the threads correspond, will not require any turning, but otherwise a fraction of a turn may be necessary. "The position of each objective when screwed up is readily found, and can then be marked so that it may always be inserted near this position."† The latter requirement would seem to introduce an element of difficulty, which it is the essential object of such contrivances to eliminate.

Fig. 155.



Spencer's Dust-protector for Objectives.‡—H. R. Spencer & Co. have patented a device to protect the interior and backs of objectives from dust. It consists of a thin piece of plate glass polished, and mounted in a ring screwed into the back of the objective. It is

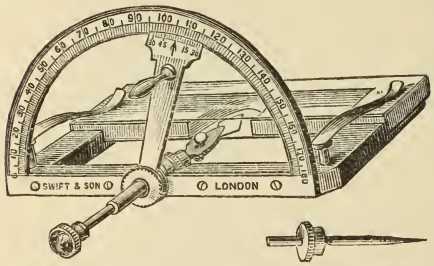
* See this Journal, iii. (1883) p. 572.
† Cf. Micr. Bulletin, i. (1884) pp. 42–3.
‡ Amer. Mon. Micr. Journ., v. (1884) p. 200.

claimed to be "a valuable addition to a lens, while not affecting the corrections or interfering with the performance of the objective in any way. The plan will especially commend itself to all workers who leave their objectives attached to the stands, as dust is sure to find its way to them, even under glass shades."

This device was adopted by the late F. A. Nobert many years since.

Swift and Son's Goniometer Stage.—This instrument (fig. 156) has been constructed by Messrs. Swift and Son for use with their petrological Microscope. It consists essentially of a pair of forceps attached to a pointer moving round a graduated semicircle. It is used as follows to determine the separation of the optic axes in biaxial crystals:—

Fig. 156.



A section of the mineral cleaved or cut perpendicularly to the first median line is placed in the forceps and the apparatus adjusted on the stage of the Microscope, so that the line joining the optic axes is inclined 45 per cent. to the crossed Nicols which are set parallel to the cross wires of the eye-piece, whilst the same line is at right angles to the direction in which the forceps point. The pointer is then turned till the darkest part of one of the "brushes" covers the intersection of the cross wires, when a reading of the scale is made. The pointer is afterwards turned in a contrary direction till the darkest part of the other brush covers the intersection of the cross wires, when a second reading of the scale is made. The difference between the two readings gives the apparent angle in air. The angle in oil or other liquid can be determined in the same way by setting the Microscope horizontally and adapting a small glass cell filled with oil or other liquid, but in this case it is requisite to use an eye-piece provided with a Nicol which rotates so as to allow of the polarizer and analyser being set at 45° to the vertical direction of the forceps.

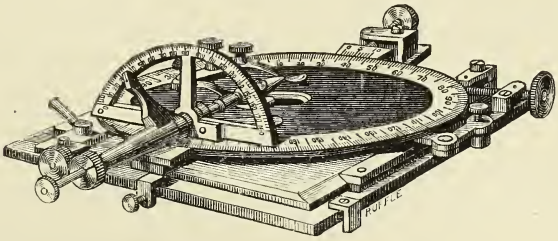
Very small sections of minerals may be attached by wax to the point of the forceps or to a needle fixed in their place.

Hartnack's Goniometer-stage.—The stage shown in fig. 157 has priority of date (by several years) over the preceding.

The base-plate lies on the stage of the Microscope, to which it is clamped by the small screw in the angle-piece below the semicircle, two other similar angle-pieces, but without screws, being fixed to the opposite and one of the remaining sides. On the base-plate are two slides moved by the milled heads at the back and right-hand side of the fig., giving lateral motions in two rectangular directions. The

upper circular plate can be rotated by the hand, or by turning the small handle shown on the left it is fixed, and then can only be rotated slowly by the adjacent tangent screw. The graduated semicircle and forceps are screwed to the upper plate, and can be removed

Fig. 157.

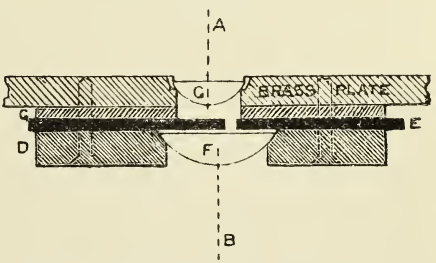


so as to leave the stage free. The movement of the index and forceps jointly is effected by the larger milled head on the axis of the forceps.

Osborne's Diatomescope.—Lord S. G. Osborne has forwarded to us his diatomescope, together with notes from which we have made the following description and diagram.

The apparatus (fig. 158) consists of a rectangular brass plate, 3 in. by $1\frac{3}{4}$ in., in the centre of which is a plano-convex lens G, with its plane face nearly flush with the upper surface of the plate. A thin metal disk C, having a central opening corresponding with the diameter of G, is placed beneath the plate to separate the upper from a second plano-convex lens F, which is mounted slightly out of the centre of the thick metal disk D, so that its axis B is a little at one side of the axis A of the lens G. The upper surface of D is grooved to permit a diaphragm-plate E, having a small square opening of 1/32 in., to traverse between the lenses.

Fig. 158.



The apparatus is placed upon the stage of the Microscope, and the slide is laid flat on the plate, with or without immersion-contact with G, and is held in position by two spring clips. A pencil of light suitably incident on F is refracted through the small opening in E to the curved surface of G, where it is again refracted, emerging from the plane surface more or less obliquely, according to the original incidence and to the position of the diaphragm.

We understand from Lord S. G. Osborne that the device has also been made to fit in an ordinary substage, where it is of course more serviceable than on the stage proper.

Mr. E. M. Nelson * somewhat severely criticizes the instrument. With it used dry, he can just get a dark field with an objective of 0·82 N.A., but the effect is far better with an objective of 0·8 N.A. "Therefore, as far as dark fields are concerned, it does all that is claimed for it. As regards the *quality* of the dark field, it fails, as every other illuminator, which only gives an oblique pencil in one azimuth, must fail. A diatom, to be shown critically on a dark ground, must be illuminated all round; one edge is always blurred when the illumination is from one side only. One will say then, that, if it is not good as a dark-ground illuminator, it must be a first-rate striæ resolver. This, however, is not the case. For an instrument to be a good striæ resolver it must be capable of varying the obliquity of the illuminating pencil. The strongest resolution is always obtained *just before* the field gets dark. Of course I am aware that the obliquity of the illuminating pencil may be varied to a small extent by dodging with the mirror; but that fidgety sort of business cannot be compared with the certain method of a central and focused condenser and a slot cut to a known depth. As mine is mounted, you can neither rotate the beam about the diatom, nor the diatom about the beam."

On this "F. R. M. S." says † that it "is unquestionable that the little device will do good service within the limits prescribed by its aperture. Mr. Nelson should not taboo it for not possessing powers beyond the scope of its designer. He would hardly consider it fair if the 'Nelson' Microscope-lamp were publicly condemned for not being provided with all the luxurious movements of the 'Dallinger' lamp. The construction of an illuminating apparatus of special convenience and efficiency is almost invariably a question of expense. Greater outlay would convert the 'Nelson' lamp into a 'Dallinger.' The 'Nelson' costs some five guineas; and yet is there any feat of microscopical illumination possible with it that could *not* be done with a sixpenny paraffin lamp and brown paper diaphragms in the hands of an expert—say, in the hands of Mr. Nelson himself?"

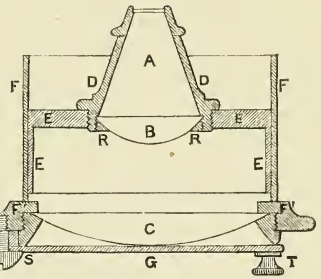
Lord S. G. Osborne replies ‡ to Mr. Nelson's criticism, and "still confidently recommends the instrument to the very many observers who have no substages, not for hypercritical study of diatoms, but as giving most lovely pictures of some of Nature's most beautiful work."

Wallich's Condenser.—Dr. G. C. Wallich has patented an improved condenser intended to obviate the difficulty which has hitherto been experienced in adequately illuminating objects having considerable depth, and more especially when examined in the binocular Microscope and with high-power objectives. It extends the range in depth through which more or less transparent objects may be distinctly seen; and, when used with the binocular, facilitates the production and increase of true stereoscopic effect. The speciality

* Eng. Mech., xl. (1884) p. 157. See also further remarks, p. 242.
† Ibid., p. 199, and see pp. 263–4 (1 fig.).
‡ Ibid., pp. 180–1.

of the improvement consists in the employment of a truncated cone of glass, in combination with one or more lenses capable of being adjusted with respect to one another. The conical surface is highly polished, so as to constitute an internally reflecting surface, the cone having such an angle as to produce total reflection.

Fig. 159.



In fig. 159 A is the cone mounted in a cell D and having a lens B attached to its larger end by transparent cement. C is a second larger lens, and mounted in suitable fittings E and F, by which its distance from B can be adjusted so as to produce various effects. As improved effects may in many instances be produced by preventing the admission of light into the condenser from one or other side of the lens C, a shutter G is added, pivoted at the circumference of the cylindrical fitting F^1 by a screw S, which shutter can be set in any required position by moving the knob T, or by rotating the entire condenser in or by its fittings.

For the purpose of producing various effects of illumination diaphragms are also used furnished with openings of various shapes and sizes, placed either between the lenses B and C, or in front of the smaller polished transmitting end of the catadioptric cone A.

Cells for Minute Organisms.*—In breeding Oribatidæ, Mr. A. D. Michael used glass cells each composed of an ordinary microscopical glass slip 3 × 1 in., having in the centre, fastened by marine glue or Canada balsam, a glass ring made of a transverse slice of glass tubing about 3/4 or 7/8 in. in diameter, the length of the tube, and consequently the depth of the cells, being usually about 3/8 in. The tubing should be of tolerably thin glass, if very thick it is opaque, and leaves little room inside the cell. Over this a thin glass cover, rather larger than the diameter of the tubing, was laid, either a circle or a square; the latter is often handy, as the projecting corners are convenient to take it on or off by, or sometimes a second slide or a broken piece of one is more serviceable. This cover was always quite loose, and simply held on by an ordinary brass-wire microscopical spring-clip; of course the upper edge of the slice of glass tube required to be smooth, so that the cover would lie flat upon it, and not allow the minute animals to escape.

A cell so prepared was carefully cleaned out, and examined under the Microscope, to see that it did not contain Acarina or ova. A small piece of thick white blotting-paper, not large enough to cover the whole bottom of the cell, was then placed in it and damped; a piece

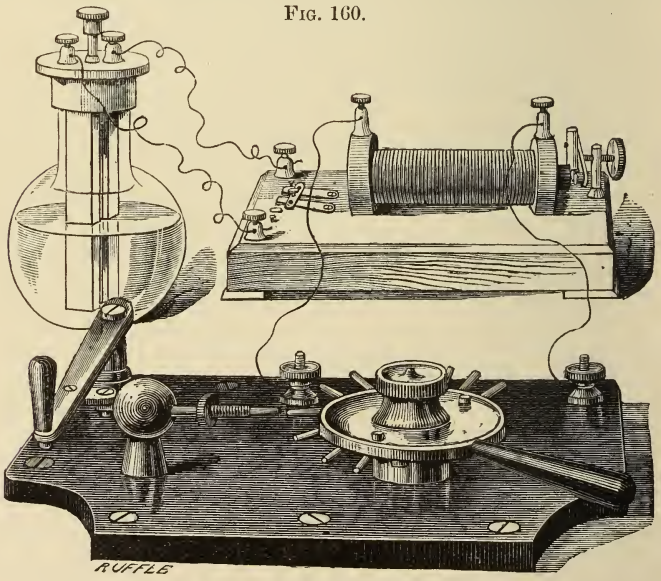
* British Oribatidæ, i. pp. 68–70.

or two of growing moss or fungus was then placed in the cell, having first been carefully examined under the Microscope to see that it also was free from Acarina and ova, and the cell was then ready for use. One or two specimens of the larva, nymph, or species to be observed, were placed in the cells; the cover was put on and fixed with the clip. By carefully attending to the hygrometric condition of the cell, damping the blotting-paper or removing the cover to give air as required, the animals throve well and got quite accustomed to the cells. When it was desired to observe the inmates, which was done at frequent intervals, the clip was removed and the cell transferred to the stage. If low powers were sufficient, the cover did not require to be removed if kept clean and if free from condensed moisture; if, however, higher powers were used it was found that usually the cover could be safely removed.

Mr. Michael found these simple cells answer better than any of the more elaborate apparatus. In particular he tried Mr. Macintyre's ingenious cork cells, but did not find them answer for Oribatidæ. In the first place, many species, being wood-borers, simply ate their way out or into the cork; in the next place, the very minute ones got lost in the interspaces of the cork and never reappeared; in the third place, the cells got dry too easily, and were apt to be too wet or too dry; the former of which was injurious, and the latter always fatal.

Stokes's Spark Apparatus.—Mr. A. W. Stokes has shown at the

Fig. 160.



conversazioni of this Society and of the Quekett Club the sparks of various metals under the Microscope, an exhibition which has proved

of great interest, and has always attracted much attention. The ingenious apparatus which he uses is shown in fig. 160 (drawn from an improved model made by Messrs. Watson and Sons.

The base-plate is of ebonite, and has at one end a small pillar, through which passes an arm carrying a piece of platinum. A similar support at the other end carries a double disk, between the plates of which are inserted the pieces of metal to be experimented on, viz. magnesium, tin, brass, steel, carbon, lead, iron, copper, platinum, and aluminium. The disk can be rotated by an ebonite arm so as to bring each metal successively in line with the platinum. The distance of the latter from the pieces of metal can be increased or reduced by moving the lever-arm with which the platinum holder is connected. A pint bichromate cell in connection with a small induction coil is sufficient to actuate the apparatus. A 1 in., 1/2 in., or 2/3 in. objective shows best. With a higher power than the 1/2 in. the spark is likely to pass to the brass of the objective.

The apparatus is adapted for use with the micro-spectroscope.

Bertrand's Polarizing Prism.*—E. Bertrand proposes a new form of polarizing prism as follows:—"The Nicol prism, the polarizing apparatus most generally employed, is attended with certain disadvantages: (1) the obliquity of the end-faces in relation to the axis of the prism; (2) the length of the prism, which is about four times its breadth; (3) the extent of the field, which is less than 30°; (4) the necessity of employing a very clear and somewhat large piece of Iceland spar, which is becoming more and more scarce and expensive.

Hartnack and Prazmowski† have improved this apparatus; the end-faces of their form of prism being perpendicular to the axis, the prism is shortened, and the field increased to 35°.

In the Nicol prism, and in that of Hartnack and Prazmowski, a luminous ray passing through the spar is divided in two: the ordinary ray undergoes total reflection at the film of Canada balsam or linseed oil, whilst the extraordinary ray is transmitted. By computation the field, within the spar, cannot exceed 26° 33′ 45″; on emerging into air the rays expand and the field attains 35°. It is impossible to exceed this exterior angle by utilizing the extraordinary ray; but if the ordinary ray were utilized, in consequence of its higher refractive index, the field would be increased to 44° 46′ 20″ in air.

To attain this result, I use a prism of flint glass of index 1·658 which I cut through a plane at an angle of 76° 43′ 8″ to the end-faces; the two section-faces thus produced are polished and between them is placed a cleavage plate of spar suitably oriented, the whole cemented together with a substance of refractive index equal to, or greater than 1·658.

A ray of light entering the prism normally cannot traverse the plate of spar without being divided into two rays, which are polarized at right angles. The ordinary ray, whose index is 1·658, will

* Comptes Rendus, xcix. (1884) pp. 538–40.
† See this Journal, iii. (1883) p. 428.

proceed without deviation, but the extraordinary ray, whose index is between 1·483 and 1·658, according to the direction of the ray, will not enter the spar if the angle of incidence is suitably regulated. My prism is devised to fulfil these conditions.

A polarizing prism is thus obtained about equal in length to that of Hartnack and Prazmowski, but the exterior field of view is 44° 46′ 20″. A large piece of spar is not required, a simple cleavage plate suffices; moreover, as the end-faces are of flint glass, they may be cleaned without injury.

This form of construction may be still further improved: the flint-glass prism may be cut in a plane forming an angle of 63° 26′ 15″ with the end-faces, and a cleavage plate of spar inserted between the section-faces as before. This prism is again cut in a plane symmetrical with the former in relation to the axis, and the two parts are cemented together, having between them another cleavage plate of spar placed symmetrically in relation to that in the first section. We thus obtain a polarizing prism half the length of Nicol's, with a field of view of 98° 41′ 30″."

Electric Illumination for Anatomical, Microscopical, and Spectroscopical Work.*—Dr. C. von Voit describes the result of some experiments as to the electric light, conducted by himself and Drs. Kühne, Kupffer, Rüdinger, and Bollinger.

The lamps used were an Edison incandescent lamp, of about 16 candle-power, a Müller, of about 24, and a Maxim of from 36 to 60, respectively.

In every instance the light was sufficient for the finest microscopical observations, and for the highest magnifying powers, free from the well-known disadvantages of other artificial illumination, such as the preponderance of the yellow-rays, and the heat with close approximation. When the light of the Maxim lamp was raised to about 60 candles, so that the M-form of the carbon filament was unrecognizable in consequence of the irradiation, the heat was scarcely perceptible, when the face was within 25 cm. of it.

The 16-candle lamp was effective at a distance of 1 m. For the arrangement of many Microscopes in a circle at a convenient distance round the source of light, the Müller lamp is most to be recommended, because the spiral form of the carbon produces equal effects in all directions.

The greatest intensity—of 60 candles—was equivalent to the best available diffused daylight, when the rays were made parallel by a condenser before falling upon the mirror.

In all the observations it was necessary for obtaining homogeneous images, unaffected by any reflex and interference phenomena, to insert immediately under the object a plate of ground-glass, or to place the preparation upon the polished side of a ground-glass slide.

* Central-Ztg. f. Optik u. Mechanik, iv. (1883) p. 206. Aus Die Elektro-Medicin in der Internat. Elektr.-Ausst. zu München im Jahre 1882 von Dr. R. Stintzing.

The objects examined were: fresh human blood, epithelium from the mouth, and saliva-corpuscles, numerous preparations (stained with colouring matters of all kinds) of muscle, nerves, epithelium, bones, skin, embryos, bacteria, "test objects" (*Pleurosigma angulatum*). Especially surprising was the faultless image of the red blood-corpuscles, an object which has hitherto for the most part withstood artificial illumination. Even with the weaker incandescent lamps, the faint hæmoglobin colour of the corpuscles showed a clearness beyond expectation.

A few more intense pigments, on the other hand, were considerably altered: in daylight saturated blue imbibitions, prepared with indigo-carmine, borax, and oxalic acid, were a dingy reddish-violet, with every kind of electric illumination, whilst objects coloured with anilin-blue were a more intense blue, and, when in thick sections, blackish blue. All coloured green with indigo and picric acid were of a decided saturated green.

A Crompton arc-lamp, of about 3000 candle-power, was found quite as advantageous as the incandescent lamps. The light, diminished (by about 15 per cent.) by an opal glass shade, and placed at a distance of 2·1 m. (in a horizontal direction) from the mirror of the Microscope, and raised 1·1 m. above it, was found the most convenient, whilst the plane mirror of Abbe's illuminating apparatus was adjusted, not on the brightest point, but on an adjoining portion of the globe. In this case the ground glass under the object was indispensable, and may always be reckoned an advantage. Where exceptionally such great brightness is requisite this illumination is to be recommended.

In order to see how far the excess of light promised advantage, the shade was removed, and the mirror adjusted on the carbons. Instead of the ground glass, which produced a field of view full of spots, a small piece of oiled tissue-paper was placed over the upper surface of the Abbe illuminating lens, and the smaller diaphragm inserted. An object, consisting of mouth-epithelium and saliva-corpuscles, observed with this illumination and Zeiss's oil-immersion 1/18 and a strong eye-piece, has perhaps given the most perfect microscopic image that has yet been seen. It was, indeed, attempted to obtain the same with direct sunlight, but with only partial success, as it was necessary to dim the sunlight by ammonio-oxide of copper.

Further to increase the illumination by a parabolic reflector appears impracticable, as the heat, which had never before been troublesome, became unbearable, even at a distance of several metres.

The whiteness of the electric light, resembling in this respect daylight, especially adapts it to the observation of such objects as are recognizable essentially by differences of colour. Fresh preparations of pathologically changed organs (cancerous and cirrhous liver), and fine shades of skin pigments of animals, were perfectly demonstrated by the incandescent lamps, and whilst enjoying the advantage of these almost non-heating lamps, by which the observer may be surrounded on all sides, there is no difficulty in undertaking the finest zootomical

preparations by its peaceful light, undisturbed by troublesome shadows of the hand and instrument.

As the spectrum of the incandescent lamp is not only continuous but incomparably more intense in the blue and violet than that of any other artificial light, the suitability of the light was tested for spectral absorption analysis. Complete success was obtained in recognizing in the blue and violet the absorption-bands of such colouring matters as had hitherto only been capable of investigation with sunlight; for instance, the three between F and H of the yellow colouring matter of the yolks of eggs, the alcoholic-ether extract being placed between the slit of the spectroscope and an Edison lamp.

Dr. M. Flesch also considers * the advantages of the electric light for microscopy.

The value of a light for microscopical purposes can be judged of by considering the causes which determine the maximum capacity of the Microscope. "The limit of resolution of the Microscope, which under present conditions cannot be extended, depends upon the illumination, and under the most favourable conditions it does not exceed with the most oblique light 3/8, or with perfectly central light 3/4, of a wave-length (about 0·55 μ) of white light. With homogeneous blue light of about 0·43 μ wave-length (Fraunhofer's line G), under the same circumstances, the above limits become reduced to about 3/10 and 6/10 respectively; that is, to about 0·15 μ and 30 μ." † The possibility of thus increasing the resolving power of the Microscope by the use of blue instead of white light, makes it desirable to introduce illuminating apparatus which will permit of the ready application of monochromatic light. It follows from the preceding that a good microscopic lamp must be rich in blue rays. This in the case of incandescent bodies is dependent upon the temperature. At 1500° C. bright blue rays are emitted, at 2000° violet rays. In the case of the electric light, the proportion of short-wave rays will vary with the strength of the current. O. E. Meyer ‡ gives the following table showing the brightness of the different lights, compared with that of the sun, the latter being reduced in intensity, through polarization, until the brightness of the yellow light was the same in each case.

	Arc Light.	Incandescent Light. (Edison's).	Gaslight.
Red	2·09	1·48	4·07
Yellow	1·00	1·00	1·00
Green	0·99	0·62	0·43
Blue-green ..	—	0·29	—
Blue	0·87	0·21	0·23
Violet	1·03	0·17	0·15
Extreme violet ..	1·21	—	—

The incandescent light contains, it will be seen, relatively, more of the blue rays than gaslight; and it will, therefore, much facilitate

* Zeitschr. f. Wiss. Mikr., i. (1884) pp. 175–81.
† Dippel's 'Das Mikroskop,' i. (1882) p. 324.
‡ Centralbl. f. Elektrotechnik, v. p. 457.

work with monochromatic light where the greater intensity compensates for the light absorbed. It also possesses the advantage of comparatively lower heat, as it can be brought very close to the object. It is also very pure, which proves useful with complicated stains, and it is very uniform.

Dr. Van Heurck, it will be remembered, has already published * the opinion that "the incandescent electric light supplies the illumination *par excellence* which the microscopist requires."

Clayton and Attout-Tailfer's Isochromatic Plates for Photomicrography.†—The different colours of the spectrum are, as is known, far from having the same reducing action on silver salts; there exists, in fact, an antagonism between their luminous intensity and photo-chemical action. It is thus that objects coloured yellow or orange (which are luminous colours) produce almost black images, whilst objects coloured blue or violet (which are dark colours) give pale and almost white tones.

Dr. E. Van Ermengem has obtained some excellent photo-micrographs by using the isochromatic plates of Clayton and Attout-Tailfer, of Paris, which in the reproduction of the Bacteria for instance do not necessitate any special device for illumination, or the use of coloured glass even when the objects are stained red with fuchsin.

According to Dr. Van Ermengem the scientific application of photography is likely to derive the best results from these plates. The methods of staining so much used at present in micrographic research have undoubtedly contributed to restrict the use of photography even where it would have been most useful. In bacterioscopical researches especially, it has been very difficult hitherto to get suitable images of certain bacteria, such as *B. tuberculosis*, which cannot be coloured with brown stains. The same was the case with preparations treated with methyl-blue or fuchsin, the most usual staining reagents. The isochromatic plates, however, enable excellent photographs of these different preparations to be obtained with equal facility. Their manipulation does not differ from that of the ordinary plates, and their sensitiveness is very great, though possibly less than that of the bromo-gelatin plates of Van Monckhoven. The sensitiveness of the plates to coloured light is due to the impregnation of the sensitized layer by a very weak solution of eosin. All the compounds do not, however, give good results, and what kind of eosin ought to be used is not yet decided.

Error in Photographing Blood-corpuscles.‡—A note on a possible source of error in photographing blood-corpuscles, by G. St. Clair, communicated to the Birmingham Philosophical Society, is a fruitless attempt to explain as an optical illusion Dr. Norris's asserted discovery by the aid of photography of a third kind of corpuscle in mammalian blood. The author invokes the principle of the forma-

* See this Journal, ii. (1882) p. 418.
† Bull. Soc. Belg. Micr., x. (1884) pp. 170–2.
‡ Nature, xxx. (1884) pp. 495 and 547.

tion of images by the passage of light through small apertures, and conceives that Dr. Norris's "colourless disks" are merely images at the end of the microscope-tube or the aperture of the eye-piece, and he seems to have taken some pains to obtain such images by placing under the Microscope a slide thickly strewn with small steel disks, and receiving the light on a screen beyond the eye-piece. Had he attempted to focus these ghosts and the real images of the disks *at the same time*, or considered a little more closely the elementary optical principles involved, we venture to say the note would never have been written.

The Tolles-Wenham Aperture Controversy.—The address * of Dr. J. D. Cox, the President of the American Society of Microscopists, is exclusively occupied with a review of the controversy between Mr. Wenham and Mr. Tolles on the aperture question, with extracts from the various papers published by them and others. Mr. Wenham was so fundamentally in the wrong throughout that controversy, not only on the merits of the question, but also in the manner in which his part of the controversy was conducted, that Dr. Cox may be, in part at least, forgiven for the relentless manner in which he recapitulates the strange optical errors which Mr. Wenham from time to time enunciated, not omitting the mishap by which—though in fact he had discovered, in 1855,† the great increase of distinctness of the more difficult diatoms when mounted in balsam and with a small hemisphere cemented over them with balsam—he after all missed the keystone of the aperture question and the important property of immersion objectives in consequence of having in some inexplicable way supposed that a glass hemisphere did not magnify the object at its centre because there was no refraction.‡

If, however, Dr. Cox, in demonstrating the correctness of the views of the American optician, felt himself obliged to deal so fully with the mistakes of his opponent, he does not shrink from paying a well-deserved tribute to Mr. Wenham in the following words:—"His authority was deservedly great. His improvements of the Microscope

* Proc. 7th Ann. Meeting Amer. Soc. Micr., 1884, pp. 5–39 (4 figs.).

† Quart. Journ. Micr. Sci., iii. (1855) p. 302.

‡ Ibid., and Mon. Micr. Journ., x. (1873) pp. 11–12. The text of Mr. Wenham's paper is as follows:—

"Now arose the question of a means of obtaining the full aperture on objects in balsam or fluid. It at once appeared that if the object was set in the centre of a sphere (or hemisphere) all rays from the central point must continue their course without deviation, and that in such a case neither the length of radius of the glass hemisphere or the refractive power of the material would influence the results. I therefore made a number of minute plano-convex lenses of various radii, some less than the 1/100th part of an inch. Such of these as turned out to be hemispheres were set exactly over a single selected diatom and balsam let in. *Before* the balsam was admitted for a well-known optical law, the object could not be seen. When a 1/5th or other object-glass was brought over this lens, the arrangement might be termed a four-system one, though the optical effect of the hemisphere as a lens was *nil*, simply because there was no refraction. The balsam object was not magnified. It occupied a like focal distance to the *dry* ones outside and the same adjustment served for either." Cf. also Mon. Micr. Journ., ix. (1873) p. 31.

and its accessories were so numerous, so beautiful, and so useful as to excite the enthusiasm of all who used the instrument. He had made himself an expert in the construction of object-glasses, and in every department of his activity he had with a noble disinterestedness made the world a free gift of his inventions."

We must take exception to one remark of Mr. Cox. It is not correct to say that Mr. Tolles "practically had to contend with the organized authority of the Royal Microscopical Society." The authority of the Society was never involved in the controversy, and the Fellows who saw the absurdity of the denial of the existence of an aperture in excess of that of 180° angular in air were at all times as numerous and influential, to say the least, as those who maintained the contrary view.

The only satisfactory point about this aperture question is that it is at last at rest, and that it is now no more incumbent upon microscopists to debate the question with objectors than it is for physicists to debate the rotundity of the earth or its rotation upon its axis.

Amphipleura pellucida resolved into "Beads." Nature of the Striæ of Diatoms.—Dr. H. Van Heurck writes to us as follows:—

The *A. pellucida* has a double system of striation, transverse and longitudinal, which has been known for some time, although the number of observers who have seen the longitudinal striæ is very limited.

Hitherto the "beads" on this diatom have not been clearly resolved, and the possibility of exhibiting them has been doubted. The matter is no longer doubtful, for I now adduce unmistakable proof—a photograph of the "beads."

In October 1883 I succeeded in producing a print on which the beads were fairly indicated, but the matter was not ripe for publication; I was proceeding with further experiments, when I was attacked by severe illness which prevented me from resuming my work during the whole of the winter.

I have recently taken up the subject again, and have succeeded in obtaining photographs, both by transmitted light and by the vertical illuminator, which suffice to clearly prove the existence of the beads, although as photographs they leave much to be desired.

If these beads are difficult to observe distinctly, they are far more difficult to photograph, so that I had almost despaired of obtaining a satisfactory print. We may, it is true, succeed in viewing the beads on the focusing screen of the photographic apparatus, and may see them distinctly, and yet on developing the image on the sensitized plate the whole appears foggy, indistinct, and valueless. Out of some fifty trials I hardly obtained one with tolerable success. I used some of the best known objectives, such as the 1/12 and 1/18 of Zeiss, the 1/10 of Tolles, and the 1/8 (1·47 N.A.) of Powell and Lealand, all homogeneous immersions, and, notwithstanding, the results were nearly always worthless. I attributed these failures to the "chemical" focus of the objectives, but I have since found that the real explanation was in the fact that the objectives were not equal to the task.

My success in photographing the beads has been due to the use

of the incandescent electric lamp; still, I hope to improve upon these results. Drummond's light in my hands was not satisfactory.

I send for comparison a print of *A. Lindheimeri* Grun., a species intimately allied to *A. pellucida*, differing only in being larger and in having bolder striation. The details shown on *A. Lindheimeri* will assist the interpretation of the print of *A. pellucida.*

It will be observed that in both species the longitudinal lines are not straight but wavy, which is due to the fact that the beads or alveoli are not opposite each other, but alternate irregularly. This is also observed in the photographs (*vide* photo. E, negative No. 789) produced by Dr. Woodward, of the *Rhomboides Van Heurckia* Bréb. This arrangement of the striation combined with the presence of the rudiment of the median nodule, which on my prints is well seen, confirms the opinion given by Mr. Kitton in a note on the text of my Synopsis, which he has been good enough to read, that the genus *Amphipleura* presents no essential generic character which would differentiate it from the genus *Van Heurckia* (the existence of the keels not being demonstrable and their notification appearing to him due to an error of observation), the species of the genus *Amphipleura* should therefore be comprised in the genus *Van Heurckia.*

I take advantage of this opportunity to explain my opinion on the nature of the striæ of diatoms, striæ which in many cases are only seen by the help of oblique condensers.

I cannot admit that these striæ are illusory.

The beads of the diatoms are really alveoli or cavities in the thickness of the valves; between the cavities are thickened parts, and it is these thickenings which appear as striæ. These striæ are stronger or weaker according to the separation of the alveoli, and also according as the siliceous bands between them are more or less thick.

I have explained this point in detail, as well as my other views on the structure of the valves, on pages 35–7 of the text of my Synopsis, which were printed early this summer and of which a copy is deposited with the Secretary of the Belgian Microscopical Society.

By way of summary of this note, I state: (1) that the *A. pellucida* as well as the *A. Lindheimeri* consist of alveoli arranged in series at right angles; the alveoli are arranged in regular transverse series and in wavy longitudinal series. (2) Our present objectives suffice to elucidate the structure of the diatom valves, provided we employ media of sufficiently high refraction, and suitable illumination. (3) The striæ exhibited by an improper illumination or by an objective whose aperture is too low to resolve the alveoli or the "beads" of *A. pellucida*, are due to the thickened parts of the valve, that is, to the parts situated between the beads and the alveoli.

The photographs I send herewith are:

(1) *A. pellucida* produced with Powell and Lealand's oil-imm. 1/8, illuminated by incandescent electric lamp,* and the vertical

* The illumination was obtained by means of the Nelson-Mayall-Van Heurck lamp,—thus I name the Nelson-Mayall lamp, in which I have replaced the lamp-wick by a Swan lamp of 6 volts. The great facility of movement provided in this lamp renders it of much service in these extremely delicate researches.

illuminator. The preparation silvered by Dr. A. Y. Moore's process.

A. Print from the original negative, 800 diam.

B. Print from negative enlarged to about 2850 diam.

C. Print magnified to 7000 diam., with Ross's Rapid Symmetrical, without diaphragm, by oxyhydrogen light.

(2) *A. Lindheimeri* Grun., medium of index 2·4, Zeiss's 1/18, incandescent electric light nearly axial, full aperture of Powell and Lealand's achromatic condenser.

A. Print from original negative.

B. An enlargement of the same.

American Association for the Advancement of Science.
[Report of the Philadelphia Meeting (probable abolition of the Section of Histology and Microscopy).]
Science Record, II. (1884) pp. 235–48.
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[Report of Rochester Meeting—Remarks of Dr. Dallinger.]
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Atwood, F.—New Apparatus for Photo-micrography. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) p. 170.

Bausch, E.—Binocular Microscope. [*Ante*, p. 607.]
Specification of U.S.A. Patent, No. 293,217, 12th February, 1884.
„ „ The Society Screw. [*Post.*]
Micr. Bulletin, I. (1884) p. 40.

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Proc. 7th Ann. Meeting Amer. Soc. Micr., 1884, pp. 41–6.
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[In contradiction of the statement that there was no such Society.]
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Cox, J. D.—Annual Address of the President to the Rochester Meeting of the American Society of Microscopists. Robert B. Tolles and the Angular Aperture question. [*Supra*, p. 970.]
Proc. 7th Ann. Meeting Amer. Soc. Micr., 1884, pp. 5–39 (4 figs.).

D., E. T.—Graphic Microscopy. X. Eggs of House-fly. XI. Sori of Fern: *Marattia alata*. *Sci.-Gossip*, 1884, pp. 217–8 (1 pl.), 241–2 (1 pl.).

Dallinger, W. H.—Researches on the Origin and Life-histories of the least and lowest living things.
[The full lecture—abstract, *ante*, p. 721.]
Nature, XXX. (1884) pp. 619–22 (1 fig.), 645–8.
„ „ See American Society of Microscopists.

Davis, G. E.—To our Readers.
[Announcing the suspension of the 'Microscopical News.']
Micr. News, IV. (1884) pp. 267–8.

Engelmann, T. W.—Recherches sur les relations quantitatives entre l'absorption de la lumière et l'assimilation dans les cellules végétales. (Researches on the quantitative relations between the absorption of light and assimilation in plant cells.)
[Version in French of German paper noted *ante*, p. 301. Describes the "microspectral photometer, an apparatus for quantitative microspectral analysis."] [*Post.*]
Arch. Néerl. Sci. Exact. and Nat., XIX. (1884) pp. 186–206.

F. R. M. S.—The Diatomescope and Mr. E. M. Nelson—An oblique illuminator for the Microscope wanted. [*Supra*, p. 961.]
Engl. Mech., XL. (1884) pp. 198–9, 263–4 (1 fig.).

Findon, C. J. B.—The Diatomescope. *Engl. Mech.*, XL. (1884) p. 264.

Fischer, G.—See Guébhard, A.

"Grey Beard."—The Annual Proceedings [of the American Society of Microscopists].
[Deprecating complaints of delay in publication.]
The Microscope, IV. (1884) p. 223.

Guébhard's (A.) Artikel Ueber das Vergrösserungs-vermögen der optischen Instrumente, Anhang zu, aus französischen Quellen zuzammengestellt von G. Fischer. (Appendix to Guébhard's article, *ante*, p. 810, on the magnifying power of Optical Instruments. Compiled from French sources by G. Fischer.) [*Post.*]
Central-Ztg. f. Optik u. Mech., V. (1884) pp. 217–20 (3 figs.).

Gundlach, E.—Improvement in Objectives. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) pp. 168–70.

Haycraft, J. B.—A Model Lens for use in Class Demonstrations.
Nature, XXX. (1884) p. 543 (1 fig.).

Hitchcock, R.—Recent Studies on the theory of the Microscope, and their practical results as regards the use of the Microscope in scientific investigations.
Amer. Mon. Micr. Journ., V. (1884) pp. 191–6.
„ „ The Electric Light for the Microscope.
[Mr. Walmsley's exhibit at the Philadelphia Meeting of the Amer. Assoc. Adv. Sci., &c.]
Amer. Mon. Micr. Journ., V. (1884) p. 199.

Hofmeister, V.—See Siedamgrotzky, O.

James, F. L.—Instructions for making a neutral-tint Camera lucida.
[Round cover-glass and pill-box.]
Amer. Mon. Micr. Journ., V. (1884) p. 179, from 'National Druggist.'

Julien, A. A.—An Immersion Apparatus for the determination of the temperature of the critical point in the fluid cavities of minerals. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) pp. 189–90.
Science, IV. (1884) pp. 342–3.

Kingsley, J. S.—Journal of R. Microscopical Society.
Science Record, II. (1884) p. 187.
„ „ [Answer to question "Which is the best Microscope?"—the answer being Hartnack or Zeiss if price is taken into consideration. "Almost every American student who goes to Europe to study biology gets rid of his American stand, and comes back armed with instruments of one of the two makers named."]
Science Record, II. (1884) p. 210.

KINGSLEY, J. S.—Workers and their Instruments.
[List of 31 United States and Canadian working microscopists with the Microscopes they use, being German 24, American 11, and English 2. "It may be that these men who have chosen the despised instruments of Europe are fools, and that they are not capable of appreciating a good article when they see it; but if we are to judge by their published works, we have no evidence of any dementia or idiocy."
Science Record, II. (1884) pp. 261–2.

" " [Suspension of publication of the 'Science Record.']
Science Record, II. (1884) pp. 272–5.

'Lens,' proposed resuscitation of, by Illinois State Microscopical Society.
Science Record, II. (1884) p. 207.

MARTIUS.—Eine Methode zur absoluten Frequenzbestimmung der Flimmerbewegung auf stroboskopischem Wege. (A method for determining the absolute frequency of the movement of the cilia by means of the stroboscope.) [*Post.*]
Arch. f. Anat. u. Physiol., 1884, *Physiol. Abtheil.*, pp. 456–60.

MILLER, M. N.—Photographing Diatoms and diffraction gratings.
[Reply to query as to "how to successfully photograph a diatom its natural size, preserving if possible the detailed structure in the photo." Suggests first making a photomicrographic negative × 200–500, and then making a microphotographic positive from the negative, which with a lens would show the detail of the larger picture.]
Engl. Mech., XL. (1884) p. 158.

NELSON, E. M.—Illumination for the Microscope. II., III. [*Post.*]
Engl. Mech., XL. (1884) pp. 157–8 (3 figs.), 263 (6 figs.), (in part).

" " On a Hydrostatic Fine Adjustment. [*Ante*, p. 800.]
Journ. Quek. Micr. Club, II. (1884) pp. 57–8 (3 figs.), 84–5.

" " The Diatomescope. [*Supra*, p. 962.]
Engl. Mech., XL. (1884) pp. 157 and 242.

" " " " [Rejoinder to F. R. M. S. Also remarks on oblique illuminators, which he thinks should "be consigned to the dust-bin."]
Engl. Mech., XL. (1884) p. 242.

OSBORNE, S. G.—The Diatomescope. [*Supra*, p. 961.]
Engl. Mech., XL. (1884) pp. 180–1.

" " " " [Comment on "F. R. M. S.'s" letter, and that there is no difficulty in fitting the apparatus to a substage.]
Engl. Mech., XL. (1884) p. 221.

QUEEN, J. W.—Some recent devices for quickly changing objectives.
[All have appeared *ante*, except Fasoldt, *supra*, p. 959.]
Micr. Bulletin, I. (1884) pp. 34–6 (6 figs.), 42–3 (5 figs.).

Queen's (J. W. & Co.) New Dissecting Stand. [*Post.*]
Micr. Bulletin, I. (1884) p. 38 (1 fig.).

" " New Class Microscope.
[Described II. (1882) p. 398.]
Micr. Bulletin, I. (1884) p. 47 (1 fig.).

[REDDING, T. B.].—The Microscope. II.
Indianopolis Journ., 12th October, 1884, p. 7.

ROYSTON-PIGOTT, G. W.—Diatomescope experiments.
[Examples showing the capabilities of the instrument, with drawings of the appearance of *P. angulatum*.]
Engl. Mech., XL. (1884) p. 239 (2 figs.).

SIEDAMGROTZKY, O., and V. HOFMEISTER.—Anleitung zur mikroskopischen und chemischen Diagnostik der Krankheiten der Hausthiere für Thierärzte und Landwirthe. (Guide to the microscopical and chemical diagnosis of the diseases of domestic animals, for veterinary surgeons and farmers.) 2nd ed.
[Contains general remarks on the use of the Microscope, pp. 4–16, and the principal impurities of microscopical preparations.]
iv. and 227 pp. (56 figs.), 8vo, Dresden, 1884.

SMITH, J. LAWRENCE, Memoir of.
[Inventor of the Inverted Microscope.]
Proc. Amer. Acad. Arts and Sci., XIX. (1884) pp. 535–9.

Society Screw, Committee appointed by American Society of Microscopists as to. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) p. 172.

Spencer, C. A., and Tolles, R. B., Proposed Memorials to.
Amer. Mon. Micr. Journ., V. (1884) p. 171.

Spencer's (H. R. & Co.) Objective Protector. [*Supra*, p. 959.]
Amer. Mon. Micr. Journ., V. (1884) p. 200.

STRICKER, S.—Ueber das elektrische Licht als Hülfsmittel für den mikroskopischen Unterricht. (On the electric light as an aid for microscopical instruction.)
Wiener Med. Jahrbücher, 1883, pp. 463–75.

Swift & Son's New 1-in. Objective, 40° Angle of Aperture, "constructed on an "entirely new optical principle, whereby extraordinary depth of focus and "flatness of field combined with resolving power is obtained. This objective "works beautifully with the Binocular Microscope, and owing to its large "angular aperture is rendered the best objective extant for use with the Lan-"tern-projecting Microscope." *Sci.-Gossip*, 1884, p. cxvi. (Advt.).

TAYLOR, J. E.—The Aquarium: its Inhabitants, Structure, and Management. New ed.
[Contains "The Aquarium as a Nursery for the Microscope," pp. 113–38.]
xvi. and 316 pp. (239 figs.), 8vo, London, 1884.

Tolles, R. B.—See Spencer, C. A.

WALLICH, G. C.—An improved form of "Condenser" for the Microscope. [*Supra*, p. 962.] *Specification of Patent*, No. 7639, 13th May, 1884.

WATTS, H.—[Postal Microscopical Society formed in Australia.]
Journ. of Micr., III. (1884) pp. 261–2.

WEST, T.—Blackground illumination [is a poor way of getting at the facts which a specimen may disclose; so also is polarizing . . . .]
Journ. of Microscopy, III. (1884) p. 247.

WILSON, W. L.—A cheap Microscope holder.
["It costs about a penny, and works as well as a guinea one with universal brass hinge. It consists of a turned American clothes-peg, held between two upright strips of wood, and these are bound at the top with an elastic band, which is passed three times round them. The bottom end of the strip is held by one screw to a block of wood. The clothes-peg thus has every motion, up and down between the strips of wood, round upon its own axis, and sideways on a hinge."]
Sci.-Gossip, 1884, p. 260.

WOODWARD, B. B.—The Microscope: how to make and how to use one.
Young England, 1884, pp. 213–5 (3 figs.).

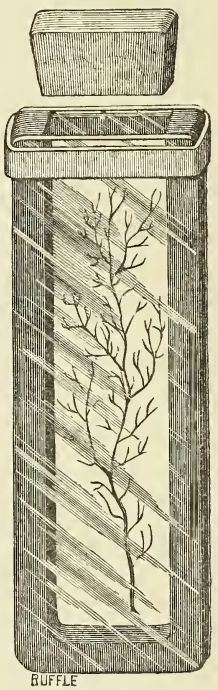
Woodward, J. J., death of. *Amer. Mon. Micr. Journ.*, V. (1884) pp. 173–4.
Cinc. Med. News, XVII. (1884) pp. 571–5.

WRAY, L., Jun.—An Improved Microscope Screen. [*Supra*, p. 956.]
Engl. Mech., XL. (1884) p. 180 (1 fig.).

β. Collecting, Mounting and Examining Objects, &c.

Hardy's Collecting Bottle.—We are now able to give a woodcut (fig. 161) of one of Mr. J. D. Hardy's bottles for collecting and examining aquatic specimens (6 in. × 2 in. × 3/8 in.) described *ante*, p. 803. At the October meeting of the Society, at which it was exhibited, the opinion was very generally expressed that the bottle was a most useful contrivance, and one that it was somewhat surprising had not been adopted long ago.

Fig. 161.



Collecting Desmids.*—The Rev. F. Wolle gives the following directions for collecting desmids:—

"The outfit need not consist of more than a nest of four or five tin cans (tomato or fruit), one within the other for convenience of carriage; ten or a dozen wide-mouthed vials, and a small ring-net made of fine muslin at the end of a rod about four feet in length. Should a boat be needed, it can usually be hired on the spot. After selecting what seems to be a good locality, drag the net a few feet among the grass and mosses, allow the bulk of the water to drain through the muslin, and then empty the residue into one of the cans; repeat this process as often as may be desirable. Ten or fifteen minutes after the cans have been filled, most of the surface-water may be poured off, and the remainder transferred to a glass vial, when the solid contents will gradually sink, and the superfluous water can be again poured off and the vessel filled up with deposits from other vials. In shallow places what is known as swamp-moss (*Sphagnum*), bladder-wort (*Utricularia*), water milfoil (*Myriophyllum*), or other finely cut-leaf water-plants are likely to abound; these should be lifted in the hand, and the water drained or squeezed from them into a tin can to be subsequently treated as already stated.

A few drops of carbolic acid in each vial, just enough to make its presence perceptible, will preserve the contents for months, and even years, from deterioration: the green colouring matter (chlorophyll) may fade, but this, in the case of desmids, is of little importance; nevertheless, when practicable, always examine the materials when fresh. When dried on paper for the herbarium, the specimens can still, after being moistened with water, be microscopically examined, but not with the best results, since the drying up is apt to collapse or otherwise distort the cells."

* Wolle, F., 'Desmids of the United States.' See this Journal, *ante*, p. 791.

Preparing Embryos.*—J. A. Ryder points out that in working with vertebrate materials, hardening and killing should be done in such a way as not to distort the axis of the embryos, in order that the knife may be adjusted so as to cut in any desired plane with accuracy. The imbedding must be as homogeneous as possible; for this purpose saturating the object with paraffin has been found to be the best, so that evenly thin sections may be produced. The methods of Bütschli, Plateau, Calberla, Duval, all serve this purpose, and their relative values are probably expressed in about the order in which they stand. Staining is best accomplished by dyeing the object as a whole; mounting should be done serially and with the ribbon method.

Method of Studying the Amphibian Brain.†—Prof. H. F. Osborn hardens the brain in Müller's fluid (bichromate of potash), the ventricles being fully injected. After the usual alcoholic treatment, the brain is placed for one week in a carmine solution, then for twenty-four hours in acetic acid.

The imbedding mass is prepared by shaking the contents of an egg with three drops of glycerin. After soaking in this mass, the brain is placed in position, and hardened in the vapour of boiling 80 per cent. alcohol. The mass is then placed for one week in absolute alcohol.

Sections are made under alcohol with a Jung's microtome, fifty or sixty sections collecting on the razor in alcohol are then floated at once, in order, upon the slide. To keep them in place, they are covered with old-fashioned blotting-paper (cigarette-paper was suggested as better by Dr. C. S. Minot) and treated with alcohol and oil of cloves through the papers, a device which may prove convenient in many cases.

Preparing Planarians and their Eggs.‡—In the preparation of Planarians for histological study, J. Jijima recommends corrosive sublimate as the only good preservative agent. The worms are placed in a shallow plate, *without water*, and a saturated solution of corrosive sublimate, heated almost to boiling, is poured over them. In this way they are killed so quickly that they do not have time to contract. They are left thirty minutes or less in the sublimate, then placed in water for an hour or more. The water should be changed several times, in order to remove all the sublimate; otherwise it forms needle-like crystals, which impair or ruin the preparation. Three grades of alcohol ("weak, strong, and absolute") are used in hardening, in each of which the object should be left at least forty-eight hours before staining. Borax-carmine (probably the alcoholic solution) is recommended as a staining agent; a dilute solution is used in preference to the full strength, and allowed to act from three

* Amer. Mon. Micr. Journ., v. (1884) pp. 190–1.

† Science, iv. (1884) p. 343. Abstract of paper read before the Philadelphia Meeting of the Amer. Assoc. Adv. Sci. Also Amer. Mon. Micr. Journ., v. (1884) p. 188.

‡ Zeitschr. f. Wiss. Zool., xl. (1884) pp. 359–464 (4 pls.). Amer. Natural., xviii. (1884) pp. 1068–9.

to four days. For preservation as museum specimens, they are killed with strong nitric acid (about 50 per cent.), in which they die fully extended.

Preparation of the Ova.—The egg-capsules of fresh-water Planarians are generally attached to water-plants by means of a white secretion. The ova are very small and few in number, and are scattered among an immense number of yolk-cells. The ova are completely naked, and a little smaller than the yolk-cells, and are not easily isolated. When cleavage begins, a large number of yolk-cells surround the ovum, and form with it a mass large enough to be seen with the naked eye. Jijima adopts the following mode of isolation and preparation:—By the aid of two sharp dissecting needles, the egg-capsule is opened on a slide in dilute acetic acid (2 per cent.). The contents flow out, and the empty capsule is then removed. The slide is next shaken, in order to isolate the ova so far as possible from the yolk-cells. This process detaches many of the yolk-cells, but not all; each ovum will still have yolk-cells adhering to it, and will now appear to the naked eye as a minute white mass. A cover-glass supported by wax feet or by slips of paper is now placed over them. After about thirty minutes the acetic acid is carefully removed by the aid of small pieces of blotting-paper placed at one side of the cover, and replaced by alcohol (70 per cent.). The withdrawal of the acetic acid must be as slow as possible, otherwise the ova will be lost. After an hour the alcohol is replaced by a stronger grade (90 per cent.), in which the ova should remain two hours. Finally, the alcohol is replaced by a mixture of glycerin and water in equal parts, and this in turn by pure glycerin. The preparation is now complete, and the cover-glass may be fixed in the usual way by means of lac.

In order to obtain sections of embryos which are too small to be treated individually, the contents of the capsule may be hardened *in toto* in chromic acid (1 per cent.), which renders them less brittle than corrosive sublimate.

The changes which take place in the ovum initiatory to cleavage are very difficult to trace, as they are generally completed before the cocoon is laid. In some cases ova were found in fresh laid capsules, which showed the germinal vesicle still unchanged; others were found to have two nuclei, supposed to be derivatives from the first cleavage nucleus. This stage of two nuclei was also found in some cocoons taken directly from the penial sheath, in which the cocoon formation takes place. It is therefore not quite certain when fecundation takes place, whether in the cocoon or before its formation.

Starch Injection Mass.*—Prof. S. H. Gage considers that a coarse injection mass which is cold-flowing, which may be forced nearly to the capillaries, rapidly hardening after injection and leaving the vessels flexible, which does not dull dissecting instruments, and is suitable for permanent dry or alcoholic preparations, being at the same time simple in its manipulation, cleanly and economical, is fully

* Amer. Natural., xviii. (1884) pp. 958–60, from 'New York Medical Journal,' 7th June, 1884.

realized in the starch mass introduced by A. Pansch, and since recommended, with various modifications, by Wikszemski, Dalla Rossa, Meyer, and Browning.*

As starch is insoluble in alcohol and cold water, it becomes hard when injected into the blood-vessels simply by the exudation of the liquid with which it is mixed. (That the starch-grains forming the mass remain entirely unchanged may be easily demonstrated by making a microscopic examination of the contents of an injected vessel.)

The mass originally recommended by Pansch consisted of wheat-flour and cold water, to which was added a sufficient quantity of the desired colouring matter. Later experiments have shown that pure starch is better than flour.

Mass for Ordinary Injections.—Dry starch ("laundry" is good), 1 vol.; 2½ per cent. aqueous solution of chloral hydrate, 1 vol.; 95 per cent. alcohol,† 1/4 vol.; colour, 1/4 vol. Since almost any animal injected may afford some organ worth preserving, it seems better to employ permanent colours for tinging the mass. Among those which are available, probably vermilion, red lead, ultramarine, chrome, orange, yellow or green are preferable.

Preparation of the Colour.—Dry colour, 1 vol.; glycerin, 1 vol.; 95 per cent. alcohol, 1 vol. To avoid lumps, which would clog the cannulæ, or small vessels, the colour is thoroughly ground with the liquid in a mortar. It is stored in a well-stoppered bottle, and is prepared for use simply by shaking.

Special Mass.—For the injection of brains, and, perhaps, for other rapidly perishing specimens, it seems best, as suggested by Wilder, to use strong preservatives in preparing the mass. Corn starch (that used for food), 1 vol.; 5 per cent. aqueous solution of chloral hydrate, 1/2 vol.; 95 per cent. alcohol, 3/4 vol.; colour, 1/4 vol. For convenience and economy, a considerable quantity of either of the masses described above may be prepared at once, and kept in a wide-mouthed specimen or fruit jar. A smooth stick in each jar is convenient for stirring the mass, which should always be done just before using. The syringe may be filled directly from the jar, and any mass remaining in the syringe after the injection is finished may be returned to the jar.

If it is desired to have the mass enter very fine vessels, some of the stock mass, as given above, diluted with an equal volume of water or chloral solution, may be injected first, and immediately followed by the undiluted mass, or for large animals, a mass containing twice the usual amount of starch. In whatever form the starch is used, it is necessary to work somewhat expeditiously, because the

* See A. Pansch, Arch. f. Anat. und Entwickl., 1877, pp. 480–2, and 1881, pp. 76–8; Wikszemski, ibid., 1880, pp. 232–4; Dalla Rossa, ibid., pp. 371–7; H. v. Meyer, ibid., 1882, pp. 60–1, and 1883, pp. 265–6; Browning, 'Annals of Anatomy and Surgery,' 1884, pp. 24–5.

† The chloral and alcohol prevent fermentation in the mass when it is kept in stock; the alcohol also increases the fluidity and likewise the more rapid hardening in the vessels; both, of course, act as a preservative upon the animal injected.

exudation of the liquid in the smaller vessels takes place so rapidly that the mass hardens very quickly in them. The larger the vessel the more slowly, of course, do the exudation and consequently the hardening take place. It sometimes happens that large vessels, like the aorta, are not fully distended after the exudation of the liquid. In this case some mass containing double the ordinary amount of starch can be advantageously injected in two hours or longer after the first injection.

Dry Preparations.—Finally, if vessels injected with the starch mass are dissected free, soaked a day or two in Wickersheimer's preservative, and then dried, they retain their form, and to a great degree their flexibility.

Imbedding in Sticks of Paraffin.*—J. S. Kingsley describes a convenient method of imbedding. Small sticks of paraffin, fitting the holder of the microtome, are cast in quantity in suitable paper moulds and are laid aside until wanted. When it is desired to imbed an object it is treated as for any paraffin imbedding. When thoroughly impregnated with paraffin, a bit of wire is heated and with it a hole is bored in one of the sticks of paraffin and the object is quickly inserted.

This method is especially adapted for cutting transverse sections of elongated objects such as tadpoles, and furthermore it obviates all danger of overheating the specimen. With objects of spherical shape, of which sections are desired in any particular plane, it affords no especial advantage.

"Microtomy."†—J. A. Ryder suggests the word "microtomy" for the "new art" which has within a very recent period been developed, including both the processes preliminary to the actual cutting of sections, and also those necessary for mounting.

Gray's Ether Freezing Microtome.—The improvements in this microtome, the design of the Rev. Metcalfe Gray, consist in the holder for the knife, and in the addition of guides, that the direction of the cuts may be uniform, while steadiness is secured.

All workers with tools know how important it is that they should be held at the proper angle to the work, in order to secure the best results, and the fault of many if not all section-cutters in which plane-irons or chisels are used is that there are no means whereby this object may be attained, the results in consequence depending upon knowledge and skill, which many to whom sections would be most valuable have no time to acquire.

To meet this difficulty an iron duplex plane has been altered by cutting away the connecting bar in front of the end slot, so that the iron is fixed firmly at the proper angle, and has the greater part of its front surface clear, up which the sections as they are cut may slide without obstruction. The cutting edge of the iron is ground level on a piece of plate glass with emery powder, and afterwards sharpened.

* Science Record, ii. (1884) p. 175.
† Amer. Mon. Micr. Journ., v. (1884) pp. 190–1.

The plane thus altered works upon two strips of plate glass, which can be adjusted to the width of the iron, and easily renewed if broken, being kept in position by wooden bars which act as guides to the plane.

The inside edges of the guides just allow the plane to work freely upon the glass, and the edges of the glass are adjusted carefully so as to allow the plane-iron to pass between without touching them.

The top of the table is roughened with a file, and not grooved, in order to secure more evenly and firmly the substance to be cut, and in the spray small brass nozzles are used which can be renewed when desired.

In use, the whole instrument is clamped to the left-hand corner of a table, with the side towards the operator. The cutting edge of the plane-iron being fixed about 3/16 in. above the top of the table, and the substance to be cut being frozen, the operator firmly grasps the plane with his right hand, and causes it to travel backwards and forwards between the guides, while he leans over the instrument, and with his left hand, before each cut, turns the large screw-head through one or more divisions, according to the thickness of the section desired. In turning the screw-head, the worker will be guided by the nick in the little brass screw in the end of the wooden base of the instrument.

Any advantages of a diagonal cut may be secured by placing the substance to be operated upon in a diagonal position upon the table.

Preparing Picrocarmine and Indigo-Carmine.*—Dr. F. L. James writes that whilst picrocarmine is one of the most valuable staining agents, the formula for preparing it, "for some unaccountable reason, is not given in any of the standard works on the subject, and microscopists are forced to purchase it from dealers at exorbitant prices," and he therefore gives the following as the process used in his laboratory for preparing a very satisfactory article.

"Dissolve 15 grains of the best carmine in the smallest quantity possible of strong water of ammonia, and add distilled water enough to make one ounce of the solution. In a separate vessel dissolve 75 grains of picric acid in the smallest amount of boiling distilled water, making a saturated solution. When cold pour the two solutions together, and let stand in a closely stoppered bottle for several days, giving it an occasional shake. At the expiration of four or five days filter the solution, and pour the filtrate into flat dishes; saucers or soup-plates will do. Cover with a plate of glass close enough to keep out dust, but not so closely as to prevent evaporation. Put in a moderately warm place, and let stand until the fluid has entirely evaporated, leaving a crop of fine brickdust-red crystals. These should be collected, thoroughly dried, and preserved. When required for use, dissolve in about fifty times their weight of distilled water, filter the solution, and keep in glass-stoppered vials. Do not make more than an ounce of the solution at once, as a little of it goes a long way."

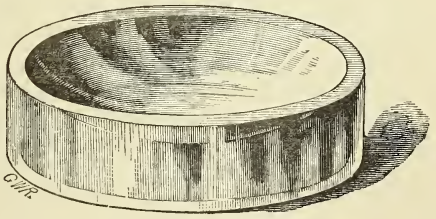
* Amer. Mon. Micr. Journ., v. (1884) pp. 178-9 and 199, from 'National Druggist.'

"Another stain that the histologist, and especially the student of micro-botany, frequently has occasion to use, is the so-called indigo-carmine, or sulph-indigotate of potash solution. Like the foregoing (picrocarmine) the text-books content themselves with recommending it, but giving no working formula for preparing it.

The following process gives a brilliant beautiful blue that works well with almost any kind of preparation, and is most useful in double staining of vegetable sections. Take of the best indigo, in lump, 30 grains. Powder in a capsule, and dry thoroughly in a water bath. When perfectly dry, add 2 drachms (by weight) of fuming (Nordhausen) sulphuric acid, adding it drop by drop, and stirring with a glass rod. As the indigo swells under this treatment, a large capsule is necessary. The whole of the acid having been added, stir well, cover, and let stand for twenty-four hours. Transfer to a tall flask, and add 3 ounces of distilled water. Let stand for four days, giving the flask an occasional shake. A magnificent blue colour is now obtained, but its acidity prevents its being used in this condition. The solution must now be neutralized by the addition of carbonate of potash (or soda) added cautiously, with frequent testings, as an excess of the alkali causes the separation of the indigo in a doughy mass (which can be redissolved, however). Filter the neutralized solution, and evaporate to dryness. For use, dissolve in fifty times its weight of distilled water."

Mercer's Solid Watch-glass.*—Dr. A. C. Mercer uses the "Syracuse Solid Watch-glass" (fig. 162) as a bath, or staining or dissecting dish for the histological laboratory. It rests solidly upon the table or stage, and is not liable to be overturned and its contents spilled. It is transparent and can be used over black, white, or coloured paper, enabling the student to use such backgrounds for his work as will permit him to watch its progress to the best advantage. Transparent tissues can be examined in it from time to time, or dissected and studied on the stage while in water, alcohol, oil of cloves, or other bath, enabling the student to reject unsatisfactory specimens at any step in the process of preparation.

Fig. 162.



When the top and bottom edges are cut, one watch-glass rests dust-tight upon another, and a piece of plate glass will fit accurately over it as a cover. In such a watch glass, covered, specimens may remain for long staining or soaking, without loss of fluid by evaporation. When the concave surfaces are polished, the watch-glass is as clear as a lens, and becomes a perfect receptacle for transparent dissecting material on the stage.

* The Microscope, iv. (1884) pp. 676-7.

Cheap method of making Absolute Alcohol.*—B. Sharp describes a cheap method of making absolute alcohol, from the strong (95 per cent.) spirit, used in Prof. Ranvier's laboratory in Paris.

A wide-mouthed bottle is taken, holding about a litre, and three-quarters filled with strong alcohol. A mass of pulverized cupric sulphate ($Cu\ SO_4 + 5\ Aq$) is heated to a red heat in order to drive off the water of crystallization. This is poured, when cool, into the alcohol, the mouth of the bottle quickly closed, and the whole shaken. The cupric sulphate is insoluble in alcohol, but has an affinity for the water contained in it, and the water is consequently taken up, and the cupric sulphate becomes bluish. When this has stood—with occasional shakings—for a day or so, decant, and repeat the operation, especially if there is very much of a bluish colour in the sediments. When finished a drop of alcohol can be mixed with a drop of turpentine on an object-glass, and if there be no particles of water to be seen under the Microscope, the alcohol is absolute enough for all practical purposes.

Arranging Sections and Diatoms in Series.†—P. Francotte has modified the method of Dr. Van Heurck ("to render it more practical") as follows:—

(1) Dissolve (warm) from 7–10 gr. of glue in 100 gr. of water (gelatin gives equally good results). A yellowish liquid is obtained which becomes perfectly clear on cooling; filter.

(2) Spread this solution on the slide, in the same way as with collodion or by means of a brush; arrange the sections on the glass while damp, and let it dry protected from the dust. To hasten evaporation the preparation may be placed in a water-bath, or better still, in an oven (at a temperature from 35° to 40° C.).

(3) When dry, warm gently over a lamp. The paraffin is removed by turpentine.

(4) Apply the cover-glass coated with liquid balsam.

The turpentine should be washed with absolute alcohol, and then the cover-glass coated with glycerin should be fixed if it is desired to preserve the preparation in the latter reagent. If the object has not been previously stained the sections can be very well stained by a reagent which is dissolved in alcohol (hæmatoxylin, eosin, anilin dyes, &c.), alcohol not dissolving either glue or gelatin. It would not be possible to use a staining agent in an aqueous solution unless the sections were previously washed with tannic acid, which would disadvantageously complicate the process.

The method recommends itself to the author by the ease with which the fixing liquid can be obtained; the sections always adhere perfectly; no displacement is to be feared; in washing, ether, chloroform, and oil of cloves can be used; the mounting can be in balsam, glycerin, or any other reagent. The wrinkles made in cutting are effaced without difficulty. Sections obtained by imbedding in gum, albumen, soap, or celloidin, can also be arranged by this method, but

* Proc. Acad. Nat. Sci. Philad., 1884, p. 27.
† Bull. Soc. Belg. Micr., x. (1884) pp. 137–41.

in this case they must be previously passed through distilled water, and placed on the glass while still wet with the solution of glue; to avoid distortion of the tissues, evaporation must only be allowed until desiccation begins; then treat with strong alcohol, which precipitating the glue, produces perfect adherence between the sections and the glass.

A very simple method described by Dr. Flögel also deserves to be known, as it may be useful for arranging sections of objects imbedded in paraffin. The process is as follows:—5 gr. of gum arabic are dissolved in 100 gr. of water; this solution is poured over the entire surface of a perfectly clean glass slide, and the excess of liquid run off by holding the slide vertically.

The operation may then be conducted in two ways.

(1) The sections are arranged upon a perfectly dry surface; then by breathing upon it, the thin layer of gum is dissolved and the sections sink into it; it is again allowed to dry, which takes place rapidly. The paraffin is removed by benzol, and the cover-glass coated with balsam is put on as previously described.

(2) The sections are arranged on the wet slide to which they adhere as the water evaporates; the desiccation being complete they are finished as in the previous case.

For thin and delicate sections the first method is preferable. For sections of considerable size and thickness, the second should be employed.

Balsam of Tolu for Mounting.*—C. H. Kain recommends balsam of tolu for mounting, as having a higher index than styrax. It has some colour, but for such purposes as mounting diatoms, where only a thin layer of the medium is required, the slight discoloration will not prove very objectionable. It is perhaps possible to bleach the solution somewhat. To prepare the tolu for use it should be dissolved in either alcohol or chloroform (the latter is preferable for many reasons) and then well filtered. It will not dissolve in benzole. By a gentle heat the solvent can then be evaporated so as to leave the solution in any desired state of concentration.

The ordinary gum benzoin (or benjamin) is quite as good as styrax, if not better, but neither is so good as tolu. The gum benzoin should be prepared as directed for tolu.

Biniodide of Mercury and Iodide of Potassium and Phosphorus for Mounting.†—Mr. Kain also drops "a word or two of caution in regard to the use of the solution of biniodide of mercury and iodide of potassium as a mounting medium. On account of its great density and high refractive index it is valuable for many purposes, but immersion objectives should be used on such mounts with great caution. Even after the glass cover has been apparently thoroughly washed, enough of the mercurial solution often adheres to cause quite a deposit of mercury to accumulate on the front brasswork of the

* Micr. Bulletin, i. (1884) p. 36.
† Ibid., pp. 36-7.

objective. The writer came near ruining a valuable objective in this way. The solution is also a violent poison, and if the slightest drop touches a tender portion of the skin, as the lips for instance, it burns like fire, and leaves a bad blister.

Phosphorus mounts, too, are fraught with considerable danger. The beautiful slides of Möller mounted in this medium are evidently prepared with great care, but after a time the medium either acts upon the asphalt ring or penetrates it, so that the smell of phosphorus is plainly discernible, and in the dark the ring is luminous. A correspondent states that he had a bad fire in his cabinet from the spontaneous combustion of one of these mounts. For those who possess valuable cabinets it will be at least a wise precaution to avoid placing phosphorus mounts with their other slides. They should be kept in a cool, dark place, and in such a locality that other property will not be jeopardized if spontaneous combustion should ensue. Notwithstanding its very high index of refraction, it is not likely that phosphorus will ever become a general favourite as a mounting medium, partly on account of the danger in manipulating it, and partly because the preparations lack permanence, for even when carefully kept away from the light they deteriorate in the course of time."*

The statement of the correspondent as to the "bad fire" in his cabinet through the combustion of a phosphorus-mounted slide is, we fear, a little imaginative, or at least exaggerated, having regard to the very small quantity of phosphorus in a mount.

Chapman's Slide Centerer.†—This is a device of Mr. A. B. Chapman for mounting objects accurately in the centre of the glass slip, and for applying the thin cover-glass concentrically with the object. It has two revolving backgrounds to contrast with the colour of the object, one being black with white circles, the other white with black circles, and so arranged that, by simply turning a little knob, either can be used or both removed as desired without touching the slip, which can be finished entirely (except the ringing) before it is taken off the instrument. It is so simple that there is nothing to prevent any manipulation required in mounting the object.

Indian Ink for examining Microscopic Organisms.‡—L. Errera, after some general remarks on the principles involved in mounting in media of different refractive indices and in staining,§ points out that living organisms do not absorb the various colouring solutions. The exception to this rule pointed out by Brandt ‖ and Certes ¶ are only apparent exceptions. According to Brandt, the nucleus of living Protozoa can be dyed pale violet by a dilute solution of hæmatoxylin, and the fatty granules can be dyed brown by Bismarck brown.

* As to this, see this Journal, *ante*, p. 475.

† Sci.-Gossip, 1884, p. 260.

‡ Bull. Soc. Belg. Micr., x. (1884) pp. 184–8.

§ "In visiting the laboratories of microscopists one might often believe oneself to be in a dyer's workshop."

‖ See this Journal, i. (1881) p. 956.

¶ Ibid., pp. 527 and 694.

Certes found this last action also with cyanin or quinolein blue. But in all these experiments the protoplasm, properly so called, remains colourless, and the coloured solution always exercises an injurious action on the vitality of the organisms; so that it can only be used in an extremely dilute condition and for a very short time.

If, on the contrary, we try the converse method and place the living organisms in a somewhat strong coloured solution they are likely to die, either by exosmosis or more often by actual poisoning.

It will therefore be useful to have a deeply coloured liquid which is not poisonous, and which does not exercise any sensible osmotic action on microscopic beings placed in it. To satisfy these conditions it is sufficient to substitute for the coloured solutions water holding in suspension coloured insoluble powder. Indian ink, on account of its harmless nature and its deep colour, is very fit for this purpose. It consists, as is well known, of lampblack and a gummy substance, very slightly perfumed with musk or camphor. On powdering it into water a very black liquid is obtained, owing to the fine particles of carbon held in suspension; it does not cause the plasmolysis of the cells, and the organisms continue to live perfectly in it.

The process of using it is as follows:—A little indian ink, not too much perfumed, is rubbed up in a porcelain saucer. It is important to triturate it carefully. The liquid should show, under the Microscope, excessively small granules of equal size, having a lively Brownian movement; it ought to have, when in very thin layers, a dark grey, but not an opaque black tint. A drop of this liquid is placed on a slide, the organisms to be examined are placed upon a cover-glass, and this is applied to the drop. In this way black particles between the cover-glass and the objects are avoided. The objects appear remarkably illuminated on the grey-black ground, so that their details can be seen distinctly. The carbonaceous matter does not seem to affect the organisms; they bear it very well, and the author has been able thus to preserve *Spirogyra*, *Vaucheria*, Infusoria, &c., for several days alive.

For prolonged observations it is of course advisable to use a moist chamber, or to prevent evaporation by placing the preparation in an atmosphere saturated with aqueous vapour.

Permanent preparations can also be made. To do this, the indian ink, in water, is gradually replaced under the cover-glass by indian ink in glycerin. Care must be taken that the black liquid does not pass the edges of the cover, otherwise currents will be produced in consequence of the evaporation, and the black particles will no longer be uniformly distributed.

Indian ink will, it seems to the author, render great service in showing the gelatinous envelopes of the lower organisms, and the gelatinized layers of the membranes of the higher plants. The gelatinous envelopes of many filamentous algæ, of *Glœocapsa*, of the colonies of zooglœa, &c., are with difficulty distinguishable in water, but nothing, on the contrary, is so easy when the observation is made in water charged with indian ink. The method might probably also,

it is suggested, be applied advantageously in the study of the digestion of the Infusoria, of the movement of diatoms and ciliated organisms, &c.

Apparatus for Aerating Aquaria.*—Different forms of apparatus are used in laboratories for supplying air to plants and animals kept for observation in aquaria. These, P. Francotte thinks, are all rather complicated, and he has therefore constructed two very simple models, which he has successfully employed.

Make a loop at 30 cm. from one of the extremities of a glass tube of from 5 to 7 cm. diameter and 1 m. long. To do this heat the tube and bend it on itself, the tube thus being divided into two unequal portions.

At 7 or 8 cm. from the loop, and in the shorter part of the tube, heat a small point by the blow-pipe. The heated glass forms a little bead, and whilst this is very hot draw it out (by a piece of tubing) into a little capillary tube, and bend it if possible at a right angle at a distance of 1 cm. from its point of origin, at the same time breaking off the end. The tube, thus prepared, is put in communication with a vessel of some litres' capacity, placed at a height of from 1 m. to 1·50 m. This can be done by a piece of indiarubber tubing and a siphon, the short arm of which is immersed in the vessel. By sucking the lower end of the tube, the latter will be filled with water. The liquid column will play the part of a piston in a pump; the air will be drawn through the opening of the capillary tube, and a number of little columns of water will be produced containing between them bubbles of air.

To regulate the flow of water and insure the air being supplied in proportion to the liquid used, the indiarubber tube should be compressed by a clip, and the apparatus made to work as slowly as possible, so that the air-bubbles drawn in can be easily counted. The lower extremity of the tube is plunged in the aquarium, where the air causes a bubbling and movement in the water.

Dr. Fol recently suggested † saturating with carbonic acid the sea-water containing Medusæ, star-fishes, &c., in order to render them motionless. This can be best accomplished by a modification of the above apparatus. In place of drawing out a capillary tube, a tube of the same diameter as the principal tube is soldered at right angles to it and slightly bent. The branch tube is then by an indiarubber tube placed in communication with the apparatus containing the gas, ether, &c.

Detection of Sewage Contamination by the use of the Microscope, and on the Purifying Action of minute Animals and Plants.‡—Dr. H. C. Sorby writes: "By studying with the Microscope the solid matters deposited from the waters of a river, the previous contamination with sewage can usually be detected without any considerable difficulty. If the amount be serious, the characteristic particles of

* Bull Soc. Belg. Micr., x. (1884) pp. 141–3.
† See this Journal, iii. (1883) p. 137.
‡ Journ. Soc. Arts, xxxii. (1884) pp. 929–30.

human excrement can easily be seen; and if it is small, and has been carried a long way by the current, it can usually be recognized by means of the hairs of oats derived mainly from the droppings of horses, which resist decomposition for a long time, and are not consumed as food by minute animals. I, however, do not propose to enter into detail in connection with this part of my subject, but specially desire to call attention to the connection between the number of minute animals and plants, and the character of the water in which they live, and also to their influence in removing organic impurities.

For some time past I have been carefully ascertaining the number per gallon, of different samples of river and sea water, of the various small animals which are large enough not to pass through a sieve, the meshes of which are about 1/200 part of an inch in diameter. The amount of water used varies from ten gallons downwards, according to the number present. By the arrangements used there is no important difficulty in carrying out the whole method in a satisfactory manner. I confine my remarks entirely to general mean results.

The chief animals met with in fresh water are various entomostraca, rotifera, and the worm-like larvæ of insects. I find that the number per gallon and percentage relationships of these mark, in a most clear manner, changed conditions in the water, the discharge of a certain amount of sewage being indicated by an increase in the total number per gallon, or by an alteration in the relative numbers of the different kinds, or by both. All my remarks apply to the warm part of the year, and not to winter.

It is known that entomostraca will eat dead animal matter, though probably not entirely dependent on it. I have myself proved that they may be kept alive for many months by feeding them on human excrement, though they soon died without it. If the amount of food in any water is small, not many of such animals can obtain sufficient; but if it be abundant, they may multiply rapidly, since it is asserted that in one season a single female *Cyclops* may give rise to no less than four thousand millions of young. In stagnant muddy ponds, where food abounds, I have found an average of 200 per gallon. In the case of fairly pure rivers the total number of free-swimming animals is not more than one per gallon. I, however, found that where what may be called sewage was discharged into such water the number per gallon rose to twenty-seven, and the percentage relationships between the different groups of entomostraca were greatly changed. In the Thames at Crossness, at low water, the number was about six per gallon, which fell to three or four at Erith, and was reduced to less than one at Greenhithe.

There is, however, a very decided limit to the increase of entomostraca when the water of a river is rendered very impure by the discharge of too much sewage, probably because oxygen is deficient, and free sulphide of hydrogen present. Such water is often characterized by the great number of worm-like larvæ of insects. Thus, in the Don, below Sheffield, in summer, I found the number per gallon, of entomostraca only about one-third of what it is in pure waters;

whilst, on the contrary, the number of worm-like larvæ were more than one per gallon.

Now if the minute free-swimming animals thus increase when a certain amount of sewage supplies them with ample food, it is quite obvious that they must have a most important influence in removing objectionable impurities. The number of excrements of entomostraca in the recent mud of such rivers as the Thames is most surprising. In one specimen from Hammersmith, I found that there were more than 20,000 per grain; and the average number at Erith in August, 1882, was above 7000, which is equivalent to about 200,000 per gallon of water at half-ebb, from the surface to the bottom. This enormous number must represent a very large amount of sewage material consumed as food; and though, as in the case of larger animals, a considerable part of their excrements no doubt consists of organic matter capable of putrefaction, yet there can be no less doubt that the amount entirely consumed in the life-processes of the animals is also great.

As named above, I kept *Cyclops* alive for many months by feeding them on human excrement. It is thus easy to understand why, when they abound in the Thames, the relative amount of human excrement is very considerably less than in the winter, when their number must be much smaller.

We thus appear to be led to the conclusion that when the amount of sewage discharged into a river is not too great, it furnishes food for a vast number of animals, which perform a most important part in removing it. On the contrary, if the discharge be too great, it may be injurious to them, and this process of purification may cease. Possibly this explains why in certain cases a river which is usually unobjectionable may occasionally become offensive. It also seems to make it clear that the discharge of rather too much sewage may produce relatively very great and objectionable results.

Though such comparatively large animals as entomostraca may remove much putrefiable matter from a river, we cannot suppose that, except incidentally, they remove such very minute objects as disease germs, but it would be a subject well worthy of investigation to ascertain whether the more minute infusoria can, and do consume such germs as a portion of their food. If so, we should be able to understand how living bodies, which could resist any purely chemical action likely to be met with in a river, could be destroyed by the digestive process of minute animals. Hitherto I have had no opportunity for examining this question critically, but have been able to learn certain facts which, at all events, show that it is well worthy of further examination. It is only during the last month that I have paid special attention to the number of the larger infusoria, and various other animals of similar type, met with per gallon in the waters of rivers and the sea, which can be seen and counted by means of a low magnifying power. At low water in the Medway above Chatham, in the first half of June, the average number per gallon has been about 7000, but sometimes as many as 16,000. Their average size was about 1/1000 in. Possibly the number of still more

minute forms may be equally great; but, even if we confine our attention to those observed, we cannot but conclude that their effect in removing organic matter must be very considerable; and judging from what occurs in the case of larger animals, those 1/1000 of an inch in diameter may well be supposed to consume as food, particles of the size of germs. Up to the present time, I have, however, collected so few facts bearing on this question, that it must be regarded merely as a suggestion for future inquiry.

So far, I have referred exclusively to the effect of animal life. Minute plants play an important part in another way. The number per gallon of suspended diatoms, desmids, and confervoid algæ is, in some cases, most astonishing, and they must often produce much more effect than the larger plants. As far as I have been able to ascertain, their number is to some extent related to the amount of material in the water suitable for their assimilation and growth. In the mud deposited from pure rivers their number is relatively small, but in the district of the Thames, where the sewage is discharged, I found that in summer their number per grain of mud at half-ebb tide was about 400,000, which is equivalent to above 5,000,000 per gallon of water. This is two or three times as many as higher up or lower down the river, and, out of all proportion, more than in the case of fairly pure rivers like the Medway. Their effect in oxygenating the water must be very important, since, when exposed to the light, they would decompose carbonic acid and give off oxygen, under circumstances most favourable for supplying the needs of animal life, and counteracting the putrefactive decomposition so soon set up by minute fungi when oxygen is absent.

Taking then, all the above facts into consideration, it appears to me that the removal of impurities from rivers is more a biological than a chemical question; and that in all discussions of the subject, it is most important to consider the action of minute animals and plants, which may be looked upon as being indirectly most powerful chemical reagents."

Examination of Handwriting.* — Dr. G. E. Fell records a curious case in which the Microscope was applied by himself and Prof. D. S. Kellicott to the detection of the manipulation of a written document.

At first sight the document looked as if it was all written with one kind of ink—a heavy black ink. Closer examination with a Microscope, however, showed that the original writing was in a pale yellow ink, and that this had afterwards been traced over with the black ink. Further examination showed that the last clause, "And Colby's bond is hereby cancelled," had been originally written with ink of a brownish tinge. The document was held by the judge, before whom the case came, to be spurious, the inference being that the words quoted above had been added after it was signed, and that then the whole was traced over in order to make the entire document appear to have been written at one time and with the same ink.

* Proc. Amer. Soc. Micr., 7th Ann. Meeting, 1884, pp. 47–58.

The Microscope in Palæontology.*—Dr. M. Poignand briefly sketches the use of the Microscope in palæontology generally, and notices a few well-known instances in more detail. These include bones, teeth, scales and carapaces, shells, corals, sponges, plants, &c. The paper is accompanied by a plate illustrating the structure of the teeth of *Megatherium* and the sloth.

Adams, J. M.—Easy Method of staining Bacteria.

["Dissolve anilin violet, blue, or brown in glycerin, with or without alcohol or carbolic acid. Prepare thin covers by dropping with pipette a drop of bacterial fluid on each, and allowing it to dry thoroughly. Cover the dry bacterial film with a drop of the staining, and let it remain an hour, or long enough to stain deeply. Put a drop of water on centre of slide, and invert the cover on it ready for mounting, letting it sway slightly to and fro to wash away a part of the surplus staining and glycerin, but not to remove the film. Press down the cover with a blotter, which will absorb the surplus, and ring quickly. The glycerin being washed away in part does not materially dim the bacteria or affect the anilin, and it is surprising how distinctly visible all kinds of bacilli, spirilla, and some of the bacteria and micrococci appear by this process.

One pleasant advantage is the freedom from sediment, as is apt to occur with other methods of staining, and the ease with which the depth of colouring may be regulated, as well as the reliable work for time being."]

The Microscope, IV. (1884) pp. 224–5.

Analysis, the Microscope in. [*Post.*]

Sci. Monthly, II. (1884) p. 187, from *New York Independent Record.*

Aylward's (H. P.) Telescope Walking-stick to use with his Pond-life Apparatus.

Journ. of Microscopy, III. (1884).

Barrett, J. W.—New method of cutting sections for microscopical examination. [*Post.*] *Journ. Anat. and Physiol.*, XIX. (1884).

Caldwell's Automatic Microtome. [*Post.*]

Quart. Journ. Micr. Sci., XXIV. (1884) pp. 648–54 (1 pl.).

Chapman's (A. B.) Microscopic Slide Centerer. [*Supra*, p. 986.]

Sci.-Gossip, 1884, p. 260.

Dimmock's (G.) Method of cataloguing and arranging slides. [*Post.*]

Sci. Record, II. (1884) pp. 185–6.

Doherty, A. J.—On Injecting.

[Methods. Formulæ. The Syringe. Killing the animal. Injecting a whole animal. Hardening injected tissues. Injecting separate parts.]

Micr. News, IV. (1884) pp. 268–75.

Elsner, F.—Mikroskopischer Atlas (Microscopical Atlas). Part II., 8 pp. and 2 pls. of 29 photo-micrographs; Part III., 9 pp. and 2 pls. of 33 photo-micrographs; Part IV., 8 pp. and 2 pls. of 30 photo-micrographs.

[Contains Cocoa, Cinnamon, Cloves, All-spice, Capsicum, Nutmeg, Mace, Pepper, Saffron, Cardamom, and Adulterants.]

4to, Halle a. S., 1884.

English's (H.) Typical Series of Vegetable Fibres.

[Mounted in a mixture of glycerin and water, which is thought to be the best medium for the purpose.]

Amer. Mon. Micr. Journ., V. (1884) p. 200.

Fell, G. E.—Examination of Agreement, Exhibit "B." The People v. Colby. [*Supra*, p. 991.] *Proc. 7th Ann. Meeting Amer. Soc. Micr.*, 1884, pp. 47–58.

The Microscope, IV. (1884) pp. 207–8.

Freud, S.—Eine neue Methode zum Studium des Faserverlaufs im Centralnervensystem. (A new method of studying the central nerve-system.) [*Post.*]

Arch. f. Anat. u. Physiol., 1884 (*Anat. Abtheil.*) pp. 453–60.

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* Journ. of Microscopy, iii. (1884) pp. 163–70 (1 pl.).

Garbini, A.—Manuale per la Tecnica moderna del Microscopio nelle Osservazioni zoologiche, istologiche ed anatomiche. (Manual of the modern technic of the Microscope in zoological, histological and anatomical observations.)
16mo, Verona, 1884.

Gravis, A.—Microscopical Technique at Naples in 1883.
[Translated and adapted by J. S. Kingsley from the French in Bull. Soc. Belg. Micr., *ante*, p. 483.]
Sci. Record, II. (1884) pp. 198–203, 227–31.

Griffin, A. W.—On the collection and preparation of the Diatomaceæ. II. Preparation. *Journ. of Microscopy*, III. (1884) pp. 229–36.

Hofmeister, V.—See Bibliography *a*.

James, F. L.—Method of preparing picro-carmine and indigo-carmine. [*Supra*, p. 982.]
Amer. Mon. Micr. Journ., V. (1884) pp. 178–9, 199, from *National Druggist*.

Jijima, J.—Entwickelungsgeschichte der Süsswasser-Dendrocœlen. (Development of Fresh-water Dendrocœla.)
[Contains methods of preparing Planarians and their Eggs. Abstr. in Amer. Natural., xviii. (1884) pp. 1068–9, *ante*, p. 746, and *supra*, p. 978.]
Zeitschr. f. Wiss. Zool., XL. (1884) pp. 359–464 (4 pls.).

Kain, C. H.—Mounting Media. [*Supra*, p. 985.]
Micr. Bulletin, I. (1884) pp. 36–7.
Journ. of Microscopy, III. (1884) p. 259.

Kingsley, J. S.—Microscopical Methods. IV. Imbedding.
Sci. Record, II. (1884) pp. 172–6 (1 fig.).
„ „ Rapid Imbedding. [*Post.*] *Sci. Record*, II. (1884) p. 269.
„ „ Glycerine Mounts. [*Post.*] „ „ pp. 269–70.

Lendenfeld, R. v.—On the Preservation of tender Marine Animals.
[Summary of the methods usually employed.]
Proc. Linn. Soc. N. S. Wales, IX. (1884) pp. 256–8.

Lewis, W. J.—Hair, microscopically examined and medico-legally considered. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) pp. 162–6.
The Microscope, IV. (1884) pp. 197–201.
Also under the title of "The Microscope in Forensic Medicine."
Sci. Monthly, II. (1884) pp. 227–8.

Libbey, W., jun.—Celloidine as an Embedding Mass.
[Similar directions to those given *ante*, p. 822.]
Amer. Mon. Micr. Journ., V. (1884) p. 183.

M'Murrich, J. P.—Killing Infusoria. [*Ante*, p. 813.]
Amer. Natural., XVIII. (1884) p. 832.

Osborne, H. F.—Upon a Microscopical method of studying the Amphibian Brain. [*Supra*, p. 978.] *Amer. Mon. Micr. Journ.*, V. (1884) p. 188.
Science, IV. (1884) p. 343.

Peyer, A.—Die Microscopie am Krankenbette. (Microscopy at the sick-bed.)
[Contains coloured plates of the appearance, under the Microscope, of urine (63), sputum (14), and fæces (2) in disease.]
8vo, Basel, 1884, xii. and 19 pp. and 79 pls. with explanations.

Piper, R. U.—Identification of Blood-corpuscles.
[Table of the measurement of blood-corpuscles from 13 young dogs selected out of like tables of measurement of more than 400 dogs.]
The Microscope, IV. (1884) pp. 219–22.

Plaut, H.—Färbungs-Methoden zum Nachweiss der fäulniss-erregenden und pathogenen Mikroorganismen. (Staining methods for demonstrating the putrefactive and pathogenic micro-organisms.) [*Post.*]
fol. Leipzig, 1884.

Pond Life, Collecting. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) p. 200.

Riebe, A.—Mikro-photographischer Atlas für Brennereien. (Micro-photographic atlas for distilleries.) Heft 1. fol. Halle, 1884, 1 p., 4 figs., and 2 pls.

Rogers, W. A.—A new form of Section-cutter. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) p. 171.
The Microscope, IV. [1884) p. 205.

Ryder, J. A.—On the preservation of embryonic materials and small organisms, together with hints upon embedding and mounting sections serially.
Ann. Rep. U. S. Fish Commission for 1882.
Sci. Rec., II. p. 253.

„ „ On some points in Microtomy. [*Supra*, p. 978.]
Amer. Mon. Micr. Journ., V. (1884) pp. 190–1.

Siedamgrotzky, O.—See Bibliography *a*.

Slack, H. J.—Pleasant Hours with the Microscope.
[Difficulties of interpretation. (Teasdale's test slides.)]
Knowledge, VI. (1884) pp. 270–1 (1 fig.).
„ „ [Mouth Organs of Diptera.] „ „ pp. 312–3 (5 figs.).
„ „ ["Daddy-Longlegs."] „ „ pp. 396–8 (4 figs.).

Smith, T.—Remarks on fluid and gelatinous media for cultivating micro-organisms, with description of Salmon's new culture-tube and demonstration of the process of using it. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) pp. 185–7.

„ „ Method of demonstrating the presence of the Tubercle Bacillus in Sputum.
[Summary of Koch's account of his original method, as modified by Ehrlich and Weigert, from MT. K. Gesundheitsamt, II., Berlin, 1884.]
Amer. Mon. Micr. Journ., V. (1884) pp. 196–9.
from *Medical Annals.*

Sternberg, G. M.—Methods of cultivating Micro-organisms.
[Practical demonstration of the advantages of his method—described in Rep. Amer. Assoc. Adv. Sci. for 1881—over others.]
Amer. Mon. Micr. Journ., V. (1884) pp. 183–5.

Taylor, T.—Microscopic Observations. Internal Parasites in Domestic Fowls, and Butter and Fats. [*Post.*] 8vo, Washington, 1884, 7 pp. and 1 pl.

Technique, Microscopic, recent advances in. *Science*, IV. (1884) pp. 350–1, 365.

Truan y Luard, A.—Ensayo sobra la Sinopsis de las Diatomeas de Asturias.
[Contains directions for collecting and mounting diatoms.]
An. Soc. Españ. Hist. Nat., XIII. (1884) pp. 307–52 (4 pls.) in part.

Tschirch.—Ueber mikroskopische Stärkemehluntersuchungen. (On the microscopical examination of Starch.) [*Post.*] *Bot. Centralbl.*, XX. (1884) p. 122.

Virchow, H.—Ueber die Einwirkung des Lichtes auf Gemische von Chromsauren Salzen (resp. Chromsäure), Alkohol und extrahirten organischen Substanzen. Technische Mittheilung. (On the action of light on mixtures of chromates (chromic acid), alcohol, and extracted organic substances. Technical communication.) [*Post.*]
Arch. f. Mikr. Anat., XXIV. (1884) pp. 117–9.

Voigt, W.
[Contains a method of isolating the jaws of *Branchiobdella*. [*Post.*]
Semper's Arbeit., VII. (1884) pp. 47 and 54–5.

Vries, H. de.—Handleiding bij het vervaardigen van microscopische Praeparaten uit het Plantenrijk, voor eerstbeginnenden. (Instruction in the making of microscopical preparations from the vegetable kingdom for beginners.)
[Part I. General rules for making and examining microscopical preparations. Part II. Cells. Part III. Tissues. Part IV. Reproductive organs of Phanerogams. Part V. Cryptogams.]
8vo, Zaltbommel, 1884, x. and 97 pp.

West, T.—*Bugula avicularia*.
[May be mounted with the polypus fully expanded by *dropping* gin carefully and slowly into a small vessel containing the specimen in sea water, observing to do so when they are *fully expanded*. This intoxicates them; they die in their extruded condition, and can be removed and mounted.]
Journ. of Microscopy, III. (1884) pp. 248–9.

Wythe, J. H.—Remarks on Microscopic Graphiology.
[Discussion on his paper published, I. (1881) p. 859.]
Journ. Quek. Micr. Club, II. (1884) pp. 86–90.

PROCEEDINGS OF THE SOCIETY.

Meeting of 8th October, 1884, at King's College, Strand, W.C., the President (the Rev. W. H. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 11th June last were read and confirmed, and were signed by the President.

Mr. Crisp said that the first matter upon the Agenda was the Report of the Deputation who were appointed to represent the Society at the meetings of the American Society of Microscopists and the American Association for the Advancement of Science. The President would present that Report, but before he did so, he (Mr. Crisp) would read the reference to the subject which had been printed by anticipation in the October number of the Journal (see p. 808).

The President said it now fell to him to report upon the visit which he had paid on their behalf since their last meeting, in company with Mr. Bennett (Mr. Glaisher being unfortunately prevented from attending), and he might say at the outset that the visit was of considerable interest. After some days spent in New York, during which he endeavoured to obtain as much information as was possible with regard to American microscopy generally, they made their way to Rochester, N.Y., where the annual meeting of the American Society of Microscopists was to be held. The inaugural address by Dr. J. D. Cox, the President of the Society, was chiefly devoted to an account of the work of Tolles, particularly as regarded the production of the lenses of large aperture for which his name was famous. At the subsequent meetings subjects of a very practical character were brought forward and discussed, and a great deal of enthusiasm was shown, especially by the younger men present, amongst whom he was glad to find there were many who were devoting themselves to the study of micro-organisms and pathogenic forms. The discussions also were carried on with great spirit. The factory of the Bausch & Lomb Optical Co. (situated in the town of Rochester) was thrown open to the inspection of all the visitors, and the firm spared no pains to make everything as interesting as possible. They were taken through all the departments, and shown all the processes of manufacture of Microscopes and apparatus by machinery which it was said produced the various parts with such accuracy that they would perfectly fit any instrument of the class to which they belonged. On the same evening a handsome repast was served in a tent, tastefully arranged and lighted by electricity. Great good feeling was displayed, healths were drunk, and prosperity to the Royal Microscopical Society was one of the toasts of the evening. At the conversazione there was a large display of Microscopes and objects, and though there was nothing specially new exhibited, the general arrangements were so well carried out that the gathering was

one of the best of its kind that he had ever attended. Generally, the meeting must be considered as a most successful one, and as regarded themselves (the Deputation), he could only say that were received not only with the greatest cordiality but even with the greatest deference, doubtless from the circumstance that they were there as the representatives of a Society whose position was considered to entitle it to every mark of respect. In addition to the great kindness everywhere experienced, the friends at Rochester took a further opportunity of showing their generosity, and of treating him not merely as a visitor but as their guest, for though he went to an hotel on his own account, he found on leaving that his bill had been paid. The feeling he left behind was one of a most pleasant description. He had formed some new friendships, and had made the acquaintance of much to be remembered with pleasure.

The President then referred to his visit to the meeting of the American Association for the Advancement of Science at Philadelphia, which he also attended in the character of a Deputation from the Society, and here also he experienced the utmost cordiality from all with whom he came in contact.

Dr. Anthony said that it gave him great pleasure after hearing the account which the President had given them, to propose on behalf of the Society that its warmest thanks be given to the American Society of Microscopists for the very cordial, generous, and hospitable reception which they had given to the representatives of the Society on the occasion of their recent visit to the Annual Meeting at Rochester. He had himself fully expected that a Deputation from this Society would meet with a hearty welcome, and he was sure that all would be glad to hear how thoroughly these anticipations had been realized. It had not unnaturally been regarded as an evidence of very friendly feeling that a Society like theirs should send its representatives to express an interest in what was being done across the water; long might it be the case that the people who formed that great nation would remember with affection the old country from which they sprang.

Dr. Braithwaite seconded the motion.

Mr. Beck said it was no matter of surprise to him that the Deputation should have so pleasant a report to give of their visit to the American microscopists, because he knew from personal experience, how pleased they were to receive even a humble microscopist like himself. He knew also that it could not but be pleasant to their friends to receive an acknowledgment of their welcome, and he was therefore very glad that Dr. Anthony had proposed the vote of thanks in the way he had done. He hoped that from year to year, any of their Fellows who crossed the Atlantic would bear with them some proofs of their connection with the Society which would be found to be an "open sesame" to the goodwill of their fellow workers over there. Though they were still young as a country, and though some of their researches were behind those of the old world, yet there was an earnest striving after scientific knowledge for its own sake which would before long make them an important factor in connection with

the progress of research into those numerous questions which were destined to engage attention in the future. It might not be out of place to mention that the American Government was so well aware of the value of the Microscope that one was included in the outfit of every officer appointed to a distant station, not for medical purposes, but so that, having a large amount of time upon his hands, he might be able to collect valuable information as to the objects by which he found himself to be surrounded.

Mr. A. W. Bennett said he should like to be allowed to say a few words also as to the very great kindness and hospitality with which they were received at Rochester. He could of course well understand that one so distinguished in scientific research as their President should be received with special marks of distinction; but when they found that a similar reception was also extended to a humble member of the Society like himself they might well consider it as a proof of the high regard in which their Society was held. He might add that after their President had been compelled to leave, he (Mr. Bennett) took an opportunity of publicly thanking the American Society for what they had done; and he should like to mention that he was assured that the visit of their President had had no little effect in stimulating the love of the advancement of science amongst the members.

The President having put the motion to the meeting declared it carried by acclamation.

Mr. J. Mayall, jun., thought that it would doubtless be agreeable to the meeting if their thanks were also extended to the American Association for the Advancement of Science, and he had great pleasure in moving accordingly.

Mr. Cheshire having seconded the motion,

The President put it to the meeting and declared it to be carried unanimously.

Mr. Crisp said that before they left this subject he might refer to the lustre which had been reflected upon the Society by their President during the meeting of the British Association at Montreal, more particularly in connection with the lecture which he delivered "On the lowest and smallest forms of life as revealed by the modern Microscope" (see p. 721). The public press, both here and on the other side, had been especially complimentary to the President in regard to this lecture.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Hon. Mrs. Ward.—The Microscope. vi. and 154 pp., 25 figs. and 8 pls. 3rd. ed. 8vo, London, 1869.	*Mr. Crisp.*

Mr. Crisp called the attention of the meeting to the fact of the death of one of their most distinguished Honorary Fellows, Dr. J. J. Woodward, and read an obituary notice of him from the 'Times.'

The President was sure that all would feel sincere regret that the

Microscope had lost so efficient and earnest a worker, one who had not only done excellent work himself, but who had set going a great many other workers in the same direction. Dr. Woodward had in addition to his microscopic studies worked very hard in his department until some time ago having met with a serious accident, he showed some signs of paralysis. Just about that time President Garfield required his services and the great strain and anxiety thus placed upon him proved too much for him in his state of health.

Dr. Maddox said perhaps he might be allowed to say a kindly word concerning one whose friendship he had valued highly, and with whom he had corresponded for many years upon those subjects which had rendered his name famous in the history of photo-micrography. He used to write so freely upon matters of mutual interest and explained his methods and processes of manipulation so fully, and always with so much courtesy, that he felt that he had indeed lost a friend, and he wished to take the opportunity of recording the respect in which he held the memory of one to whom he had so largely been indebted.

Mr. Beck did not like to let the opportunity pass of making the suggestion that steps should be taken to secure a good obituary notice of Dr. Woodward in their next annual report. The notice read by the Secretary was, he believed, the one which appeared in the 'Times' newspaper, which, though good as far as it went, yet could not, in that brief compass, give an idea of the genial character of the man, and his high personal qualities. He had known him for thirteen years, and whenever during that period he went to Washington there was always a warm welcome and every assistance which he required. Though Dr. Woodward's labours were very great at the Army and Navy Museum, he found time to carry out a large number of researches, the results of which they had so often seen. He had the advantage of working under a liberal Government, who provided him with apparatus suited to his requirements, and he thus possessed a magnificent collection of object-glasses which he knew well how to use, as the beauty of his photographs abundantly testified. These photographs he took a pleasure in showing and he had an ingenious contrivance at the museum for enabling the public to see them.*

* Since the meeting the following obituary notice of Dr. Woodward has been received.

"War Department, Surgeon-General's Office,
Washington, D.C., August 20, 1884.

In announcing to the Officers of the Medical Department the death of Joseph Janvier Woodward, Surgeon and Brevet Lieutenant-Colonel, U.S. Army, which occurred near Philadelphia, Pa., August 17, 1884, the Surgeon-General wishes to offer his tribute of respect to the memory of the deceased, whose distinguished career and valuable services, for a period of twenty-three years, have shed lustre on the corps, and for whose untimely loss feelings of profound regret will be shared alike by his comrades in arms and by the profession at large.

Dr. Woodward was born in Philadelphia, Pa., October 30, 1833, and was educated at the Central High School of that city, graduating with honour as Bachelor of Arts in 1850, and receiving the degree of Master of Arts from the same institution in 1855.

He graduated in medicine at the University of Pennsylvania, April 1853;

Mr. Conrad Beck exhibited and described a new form of portable Microscope in which the Jackson-Lister form of stand was retained.

Mr. J. Mayall, jun., exhibited a Microscope having a modified form of rack and pinion adjustment, in which what was known as the "stepped-rack" principle had been adopted (see p. 958). It consisted in making use of a triple rack with three pinions on one axis, which gave a remarkable degree of smoothness of motion without the slightest tendency to slip. This form of rack was used on a large scale in the beds of

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entered the army as assistant-surgeon, August 5, 1861; became captain and assistant-surgeon, July 28, 1866; major and surgeon, June 26, 1876. "For faithful and meritorious services during the war" he received the brevets of captain, major, and lieutenant-colonel, U.S. Army.

He was assigned to duty in this Office May 19, 1862, and from that date until the beginning of the illness which terminated in his death was intimately identified with its professional and scientific work.

While the valuable results of his life's labour are comprehended in a long list of miscellaneous publications, both professional and scientific, too familiar to the corps to require individual mention, his greatest triumphs were won in the field of microscopical investigation in normal and pathological histology, and in his happy application of photo-micrography to the purposes of science. In these pursuits he attained remarkable success, and achieved an enviable, world-wide reputation, leaving to science and medicine lessons of undoubted value and usefulness. Of his strictly professional work, the medical portion of the 'Medical and Surgical History of the War of the Rebellion' was the crowning achievement. In the second part of this work he developed the results of his careful investigations into the nature and pathology of the intestinal diseases which had proved so fatal in the late war. Here also he displayed his wonderful capacity for that minute and exhaustive research which forms so striking a feature of his writings.

As in the case of his co-labourer, Otis, he yields to other hands the honour of completing his labours.

In addition to his engrossing professional duties, his restless activity of mind led him to seek recreation in his favourite studies, physics, art, and philosophy.

Endowed with a retentive memory and of untiring industry, he acquired a vast store of information, which he held available for use at will; fluent of speech, he took delight in the expression of his views and opinions both in social converse and in the arena of scientific debate.

His fund of knowledge, his strong convictions, his tenacity of opinion, and his quick perception made him a controversialist of no low order.

With such a record, it is needless to speak of his zeal, his ambition, or his devotion to his profession, and especially to the reputation of the corps of which he was so bright an ornament.

Of a sensitive, highly strung, nervous organization, the confinement, anxiety, and labour to which he was subjected in his attendance upon the late President Garfield during his long illness, proved too much for a mind and body already overstrained by incessant labour, and precipitated the illness which finally terminated his life.

At the time of his death Dr. Woodward was a member and Ex-President of the American Medical Association, a member and Ex-President of the Washington Philosophical Society, a member of the National Academy of Science, of the Association for the Advancement of Science, of the Academy of Natural Sciences of Philadelphia, and of the College of Physicians and Surgeons of Philadelphia. He was an honorary member of several American and foreign scientific, medical, and microscopical societies, and the recipient of many distinguished honours from learned bodies in this country and abroad.

R. Murray,
Surgeon-General, U.S. Army."

powerful planing machines, to which a perfectly true motion combined with a powerful grip was an essential qualification. He also explained a new form of fine adjustment which Messrs. Swift had applied to the same instrument.

Mr. Crisp exhibited the Geneva Company's Microscope Callipers (*ante*, p. 796), an instrument for measuring very minute thicknesses up to 1/1200 mm.

Mr. J. Mayall, jun., said that Mr. A. Y. Moore had forwarded a slide of *Amphipleura pellucida* which was worth remark. It looked as if the diatoms had been burnt on the cover-glass in the usual way, and that then a coating of silver had been deposited upon them. The object gave the strongest and best image with the vertical illuminator that he had ever seen. He could not explain why it was so without further examination; but Mr. Powell had brought a Microscope for the purpose of showing it, so that the Fellows would have an opportunity of examining it for themselves.

Mr. Crisp said that the slide was no doubt mounted in the way recently published by Mr. Moore (*ante*, p. 829), viz. by coating one side with pure silver, increasing its visibility more than four times.

Mr. Mayall said he might venture to state that he had examined the slide with an objective of very large aperture and did not see the dots as described by Mr. Moore.

Prof. Bell exhibited specimens of Crustacea which had been sent by Mr. Bolton—*Leptodora* and *Argulus*—and made some remarks descriptive of the animals and their habits.

Mr. Crisp exhibited Mr. Griffith's ingenious turn-table, described (but not exhibited) at the June meeting (*ante*, p. 826).

Prof. Bell said he did not know whether it was the case that any of the Fellows of the Society had not yet been to one of the most interesting and instructive exhibitions which had been offered to their notice, but if so, he would strongly recommend them to repair the omission while the opportunity remained, and pay a visit to room No. 15 of the City and Guilds' Institute to see what Mr. Watson Cheyne had prepared in the way of Bacteria and their various modes of propagation in their proper media (see p. 808). He thought it desirable to mention the matter, because the time for the close of the exhibition was now getting short. Mr. Cheyne gave a demonstration on Thursdays at 4 o'clock. He hoped that the value of the exhibition would before long be more fully recognized, and that it might lead to the establishment of some such systematic experiments and researches as those carried on by Dr. Koch under the auspices of the German Government.

Mr. Cheshire said he was glad that Prof. Bell had drawn attention to this matter. He had recently found some specimens which were very peculiar, and which he had given to Mr. Cheyne, who was

now cultivating them. They grew in meat gelatin, and apparently commenced by constantly turning corners upon themselves so as to form nodules. When they had exhausted the gelatin surrounding them, they commenced to throw out threads in various directions, at the ends of which fresh nodules were formed. These in turn threw off other threads, but always in the direction of unexhausted gelatin, and how it was that these bacilli had this extraordinary faculty for finding out the best method of obtaining nutriment was a very curious question. The peculiarities described were drawn upon the blackboard by the speaker, who referred to the species as *Bacillus Alvii*.

Dr. Maddox thought that in speaking of the absence of this class of exhibits at the Health Exhibition, Prof. Bell had omitted to mention what was shown in the Foreign Sections, amongst which he might refer to Pasteur's and Miquel's tables, where a very complete series of objects was shown, particularly as illustrating the development of the silkworm disease. He had been in correspondence with Dr. Miquel and found that he was carrying out his experiments in a very extensive and complete manner, with as many as 500 bulbs at one time.

Prof. Bell said that his remarks referred only to the English exhibits. He did not at all intend to ignore what was shown by foreign exhibitors.

Mr. Beck said the greatest advantage of the display at the Exhibition was in the demonstrations which took place. Where such things were only shown in bottles, people passed by them and were no wiser.

The President said the subject was so extremely interesting that it was to be hoped that all who could do so would visit the laboratories. He was sorry that he had not himself yet had an opportunity of going, but he intended to do so.

Dr. Millar said he had been very much interested by what he had seen at the laboratory. Mr. Cheyne lectured before a very small audience, but those who attended could not fail to be much gratified.

Mr. J. D. Hardy exhibited and described his flat collecting bottle made of sheet glass, with thick indiarubber cemented between (see p. 977).

The President thought that all pond hunters would at once see the great advantage of having their collecting bottles of this shape, so that they would go easily into the coat pocket. The contents could also be readily examined under the Microscope. He considered it a most admirable contrivance for the purpose for which it was designed.

The following Instruments, Objects, &c., were exhibited:—

Mr. C. Beck:—Portable Microscope of Jackson-Lister form.

Prof. Bell:—*Leptodora* and *Argulus*.

Mr. T. Bolton:—*Brachionus urceolaris*.

Mr. Crisp:—(1) Geneva Co.'s Microscope Callipers; (2) Griffith's Turn-table.

Mr. J. D. Hardy:—Collecting bottle.

Mr. J. Mayall, jun.:—(1) Swift Microscope with triple "stepped-rack;" (2) Swift's patent fine adjustment; (3) *Amphipleura pellucida* coated with silver.

New Fellow:—Mr. George Thomas Bettany was elected an *Ordinary* Fellow of the Society.

Meeting of 12th November, 1884, at King's College, Strand, W.C., the President (the Rev. W. H. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 8th October last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Photo-portrait of the late F. A. Nobert, with his ruling machine, enlarged by Mr. J. Mayall, jun.	*Mr. J. Mayall, jun.*

Mr. J. Mayall, jun., said that at the last meeting he had called attention to a triple "stepped-rack" fitted to a Microscope which he then exhibited. It had since been found that this arrangement was rather difficult to fit with sufficient accuracy, so that a new form with a double rack had been substituted. This was found to have the required smoothness of motion (see p. 958). The Swift Microscope, which he exhibited thus fitted, had also a modified form of the Wale's inclining limb by which Mr. Swift was able to secure the complete rotation of an ordinary form of mechanical stage, which had been seldom obtained in combination with the "Jackson" form of stand. A polarizing prism, made after the formula of Dr. Bertrand, as described *supra*, p. 965, was applied to the Microscope. He also exhibited an unmounted prism made upon the same plan, showing the peculiarity of its construction, by which a field of about 44° was obtained.

Mr. Crisp exhibited and described Fasoldt's nose-piece (*supra*, p. 959).

Prof. Bell said that he had placed on the table for exhibition a cluster of branched *Vorticellæ*, which had been sent by Mr. Bolton in the hope that some Fellow of the Society might be able to name them. They were not mentioned in Kent's Infusoria.

Dr. Maddox exhibited one of Miquel's culture slides, described *ante*, p. 815. He also referred to Dr. Miquel's method of propagating bacilli by the use of sterilized gelatinized paper, some of which he exhibited. If it was desired to obtain these organisms from the

air, the paper was supplied from a revolving drum, and the air to be examined was directed upon it by an aspirator. If rain water was to be examined the paper was shaped as a coil, and the water allowed to drop slowly upon it. He had, however, suggested to Dr. Miquel that collodion films should be used instead of paper, on account of the greater transparency and absence of structure.

The President thought that this opened up a new method of inquiry which would be likely, if properly used, to lead to some very valuable results.

Mr. Crisp exhibited and described Lord S. G. Osborne's Diatomescope (see p. 961), drawing attention to the fact that the lower lens was mounted excentrically in relation to the upper lens, which Lord S. G. Osborne regarded as an essential feature in the construction.

The Rev. Metcalfe Gray's Ether Freezing Microtome was exhibited and described (*supra*, p. 981).

Mr. H. G. A. Wright's letter was read as follows, accompaning a slide of the proboscis of the blow-fly:—

"The enclosed slide was shown at the last meeting of the Microscopical section of the Royal Society of N. S. Wales, and was of much interest to the members present.

It consists of the lobes of the proboscis of the blow-fly, mounted without pressure, in a solution of biniodide of mercury in one of iodide of potassium (both saturated solutions), and was prepared by my friend Mr. Henry Sharp, of Adelong, N. S. Wales. It shows details of the structure of the pseudo-tracheæ, which I have not seen hitherto described. The drawing (taken with the camera lucida by Mr. Sayer) shows the beautiful leaf-like processes of the endoderm, which pass through the forked openings in the chitinous rings of the pseudo-tracheæ, and point out a use for that forked arrangement, which all balsam mounts show so clearly.

These processes are not alluded to in Mr. B. T. Lowne's admirable monograph on the 'Anatomy and Physiology of the Blow-fly.'

Mr. Sharp, writing to me lately, says, 'I have several probosces of blow-flies mounted in balsam, with and without pressure, but there is nothing to be seen of the membrane in any of them; I can just see it in a glycerine mount, now that I know what to look for; but the glycerine does not make it visible like the mercury solution.'

The amplification of 1000 diameters was obtained with a Tolles homogeneous-immersion 1/10 N.A. 1·33, and a Tolles 1-in. solid orthoscopic eye-piece, both of the highest excellence. Direct illumination was used by means of Powell and Lealand's achromatic condenser."

The President said that those who looked at the drawing could not fail to be struck with it, and it would probably occur to them that if such details could be brought out by the use of biniodide of mercury and iodide of potassium, it deserved to be tried as a medium not only for diatoms, as hitherto, but for other objects.

Prof. Stewart said he was unable clearly to understand what was meant by the processes of the "endoderm" as that term was generally understood.

Mr. Michael said that in Mr. Lowne's 'Anatomy and Physiology of the Blow-fly' the term was not applied in its usual sense, but appeared to convey the same meaning as epiderm, and the author of the paper probably used it in this way.

Mr. H. Mills's letter was read as follows:—"In the April number of the Journal I notice the article on Dr. Vejdovsky's Fresh-water Sponge, *Ephydatea amphizona*. In my searches for sponge last autumn, I discovered three species with the same biserial arrangement of the birotulates, or amphidiscs. In some sections of the statoblasts *three* series are plainly manifest. These discoveries were made in the latter part of October, 1883, and announced to the Microscopical Club of this city. I send by mail small fragments of the sponges which can be made into sections by imbedding in paraffin, &c. The character of the water in which these were found may be of interest to Dr. Marshall, whose article referring to some habits of fresh-water sponge precedes that of Dr. Vejdovsky in the same journal. No. 1 was found in Bear Creek, Iowa, in a very gently flowing bend of the serpentine stream. No. 2 was found in a branch of the Calumet creek, near Chicago, where the water was apparently without motion. No. 3 was found in great abundance in the slowly running bends of Ischua Creek, forty-five miles east of Buffalo. In No. 1 the statoblasts are very scarce, owing, I think, to the immature state of the specimen when found." *

Mr. G. Massee's paper "Description and Life-history of a New Fungus, *Milowia nivea*" was read (see p. 841).

Mr. Bennett said that it was necessarily rather difficult to follow a paper of that kind, which dealt so largely with hypotheses, without reading it carefully when printed, but from what he had heard it seemed to him that some of Mr. Massee's conclusions were not a little startling. All the evidence, that he was aware of, seemed rather to show that it was impossible to draw a hard and fast line between sexual and non-sexual reproduction; but although his own observations would lead him to somewhat different conclusions from those of the author of the paper, he felt it would be unfair to enter upon any lengthened criticism of its contents without having previously studied it.

The President said that the paper was manifestly one of considerable interest, throwing out, as it did, some original suggestions which would well repay investigation.

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* See Ann. and Mag. Nat. Hist., xiii. (1884) p. 101, where Mr. Mills's discoveries are noticed by Mr. H. J. Carter, who, however, does not explicitly state that Mr. Mills has discovered three series of birotulates, but mentions his own observation of the same fact.

Prof. Bell read his paper "Notes on the Structural Characters of the Spines of the Echinoidea—Cidaridæ" (see p. 846).

Dr. Carpenter, C.B., said he must confess that he did not at present clearly understand Prof. Bell's meaning as conveyed in this paper. The spines of the ordinary *Echini*, whenever they were not annual spines—which were shed and renewed every year—presented certain well recognized features. In the large spines of the many tropical forms, they had in the transverse sections a series of well-marked rings of growth resembling the annual rings of the trunk of a tree, and these might go on increasing indefinitely because every new growth was added in the same way. But in the *Cidaridæ* there was nothing of the kind; there the whole interior of a spine seemed to be formed continuously, so that the cylindrical interior contained passages prolonged from the internal passage or solid network which was occupied by a protoplasmic substance. Now, when that kind of sheath was first formed he did not deny that it might increase up to a certain point, but he had yet to be informed that the interior continued to undergo an increase after the external portion had become hardened. They knew perfectly well now how lines were enlarged, and that there was a process going on there of continual removal of old matter and the addition of new. The old notion of interstitial swelling out was now given up, and he could not think of it as going on in the case of a spine. The only other mode of increase would be by the removal of the interior portion of the sheath and by addition to the external portion. So far as his observations went he could see no evidence that when the cylinder had once been encased by this nearly solid sheath, the internal portion of the spine underwent any increase.

Prof. Stewart said that so far as regarded the spines of the *Cidaridæ* his observations entirely tended to show that having once become invested with this calcareous sheath, the vitality of the spine was so lowered thereby that it allowed of the accumulation of parasites of all descriptions which infested these spines and these only. The process of investment amounted in fact to an arrest of growth. By means of a drawing on the black-board he showed that these spines were increased by additional layers being added to them, after which they became encrusted and *Serpulæ*, &c., became attached to them. In the *Goniocidaridæ* there was less liability to this.

Dr. Carpenter said that his experiences on these points entirely coincided with those of Prof. Stewart.

Prof. Stewart further said that wherever the spines were found in frictional contact with each other the interstices would be seen to be filled up with calcareous matter, just as similarly occurred when two portions of bone were in contact in cases of osteo-sclerosis.

Prof. Bell said he was sure that the meeting would understand that he had made himself acquainted with what had been done on these subjects by Dr. Carpenter and Prof. Stewart, but what troubled him to understand was how if the adult spine had a certain amount of incrustation, the crust should be proportionately thinner in the larger than in the smaller specimens. He had carefully examined

and measured the proportionate diameters of the outer and inner portions, and from the figures given it was clearly shown that the larger spines had the thinner crust. It was also found by taking measurements from various parts of the spine that the wearing down was not confined to the points. He was not prepared, however, to give an answer as to how the interior of the spine increased in size, though it was shown that in a full-grown specimen the interior cavity was not diminished by the fact that it had a comparatively thick crust. With regard to the growth of parasites, that necessarily had to be taken into consideration as a matter of some importance, and though of course he did not pretend to put his experience against that of Dr. Carpenter or Prof. Stewart, he might say that if he had to base his experience upon the large collection in the British Museum, he should not have been struck with the amount of parasitism apparent there. The crust had had ascribed to it a determining influence upon the growth of the spine, but he ventured to think that the figures which he had drawn gave a somewhat different aspect to the question from that which had been hitherto accepted.

Dr. J. D. Cox's paper "On Some Photographs of Broken Diatom Valves, taken by Lamplight," was read (see p. 853), and the photographs accompanying it were handed round for inspection.

Mr. J. Mayall, jun., and Mr. Crisp called attention to the points in the photographs establishing Dr. Cox's views.

Mr. Lewis Wright exhibited in operation and described a new lantern Microscope which, after considerable study and attention, he had been successful in bringing to a degree of perfection which he believed had not hitherto been attained. The want of some apparatus of the kind capable of exhibiting minute objects under high powers and free from distortion or colour had long been felt, and he had been urged by several Fellows of the Society to turn his attention to the matter on account of the great value to lecturers and others of some really good optical arrangement which would enable microscopical preparations to be properly shown to a large number of persons at the same time. Dr. Carpenter had suggested to him to take the tongue of a blow-fly, as prepared by Mr. Topping, and to work upon that as a test object, and Mr. Curties had told him that what was wanted was an apparatus which would show the tongue of the blow-fly six feet long. He had placed the mechanical arrangements in the hands of Mr. Herbert C. Newton, who had carried them out in a way which left little or nothing to be desired. The lantern employed was an ordinary one, the lime-light being used for illumination. As regarded the objectives, he need hardly say that perfection in these was of the first importance, particularly in the case of the higher powers, as many a lens which seemed to work very well upon the ordinary Microscope would completely break down under the strain

put upon it by this very severe test of its capabilities. The best 1/2-inch objective of many which he had tried was one by Powell & Lealand, which Mr. Crisp had lent him, and which worked in a most admirable manner. An objective of similar power by Gundlach had also been lent him by Mr. Curties, and the excellent qualities of this lens were brought out in a very remarkable degree. He was also greatly indebted to Mr. Topping and others for the specially beautiful slides which had been placed at his disposal, and which he proposed to exhibit, together with some prepared by Dr. Carpenter. The lights being lowered,

Mr. Wright then exhibited upon a screen the following series of objects, commencing with those of large size under a comparatively low power, and afterwards employing an 8/10 in., and the 1/2 in. objectives referred to, both with and without amplifiers. It was specially remarked that the images were shown with perfect sharpness of definition up to the very margin of the field:—Scorpion-fly; larva of vapourer moth; wood of elm; hand of monkey; human thumb; kidney, double-stained and injected; foot of *Dytiscus;* eye of dune fly; human tongue; cat's tongue; brain; *Echinus* spine (3); intestine of cat; coiled palate of limpet; tongue of blow-fly; circulation in foot of living frog.

At the conclusion of the exhibition, which prolonged the meeting to a later hour than usual, but appeared to give great satisfaction to the large number of Fellows present,

The President said that no doubt most of them had at some time felt the need of means by which they might be able to project objects with some degree of clear definition, and he was himself very thankful for the progress which had been made by Mr. Wright in this direction. He thought the successful results of Mr. Wright's efforts pointed to the attainment of even still greater success in the future.

Dr. Carpenter had great pleasure in moving a vote of thanks to Mr. Wright for his very interesting exhibition. He had been in communication with him during the progress of his experiments, and had been much pleased to see how great the success had been. He had never seen such definition at any exhibition of the kind before. For educational purposes, it was a matter of great importance and value to be able to show the real objects in this way.

Prof. Stewart said that what they had seen had been shown in such a really sharp and excellent manner that Mr. Wright was to be much congratulated upon his success, and the more especially so that most of the objects which had been exhibited in such an exceedingly satisfactory way had not been prepared for the purpose.

Mr. Michael said that the exhibition was a great step in advance of anything which had hitherto been accomplished. Although the perfection of detail brought out might not equal the definition under an ordinary Microscope it was of the greatest value in enabling any one to show objects with such perfection to a large audience at one time. He had great pleasure in seconding the vote of thanks.

Mr. Crisp said that the improvement in definition obtained by Mr. Wright over that of the "Giant Electric Microscope" exhibited last

year was very marked, and showed the value of what he had accomplished.

The President put the vote to the meeting, and declared it carried unanimously.

The First Conversazione was announced for the 26th inst.

The following Instruments, Objects, &c., were exhibited:—

Prof. Bell:—Transverse sections of spines of Cidaridæ, *Salenia* and *Echinocidaris*, illustrating his paper.

Mr. Bolton:—(1) *Vorticellæ* (? sp.); (2) *Syncoryne frutescens*.

Dr. J. D. Cox:—Photographs of Diatoms, illustrating his paper.

Mr. Crisp:—(1) Foot & Son's New Compound Microscope (4*s.* 6*d.*); (2) Fasoldt's Nose-piece; (3) Osborne's Diatomescope.

Rev. Metcalfe Gray:—Ether Freezing Microtome, and two sections of cancer cut with it.

Dr. Maddox:—(1) Miquel's Culture Slide; (2) Sterilized gelatinized paper.

Mr. J. Mayall, jun.:—(1) Swift Microscope with double "stepped-rack" and improved limb; (2) Bertrand Polarizing Prism.

Dr. Van Heurck:—*Amphipleura pellucida* mounted (1) in H. L. Smith's medium, Index 2·25, and (2) in Van Heurck's medium, Index 2 (*ante*, p. 656).

Mr. F. H. Ward:—Section of human spinal cord from a case of Syringo-myelus.

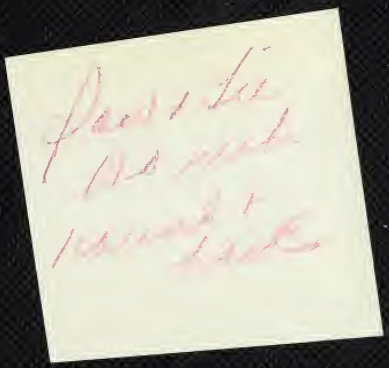
Mr. H. G. A. Wright:—Proboscis of Blow-fly showing the structure described in his letter.

Mr. L. Wright:—Lantern Microscope and the objects enumerated *supra*.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Augustus C. Bernays, A.M., M.D., J. W. Russell, R. P. Hart Durkee, B.L., Albert B. Hole, A. Longbottom, G. E. Mainland, P. C. Nixon, F. A. Parsons, John Rhodes, W. X. Sudduth, M.D., and the Rev. A. V. Miller, B.D. Prof. W. Kitchen Parker was elected an *Honorary* Fellow.

INDEX.

*** The Index includes the names of the Authors of all Papers, &c., printed in the "Transactions," or noted in the "Summary" or Bibliography, as well as those of the Designers of any Instruments or Apparatus described under the head of "Microscopy."



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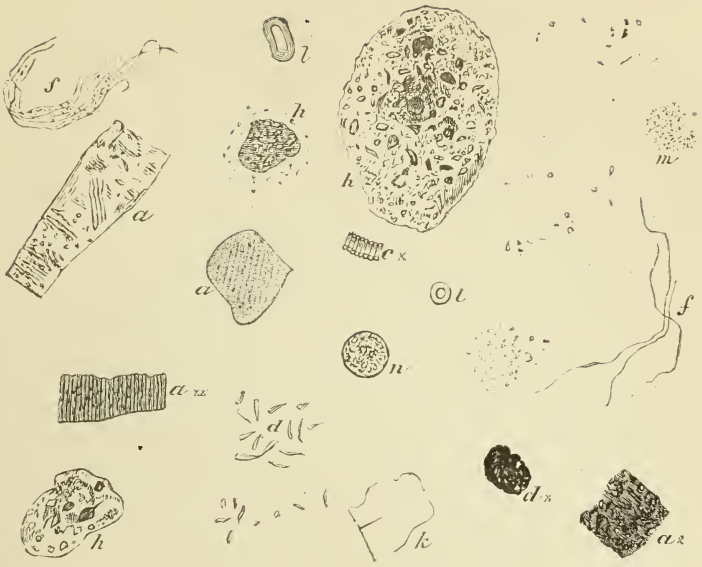

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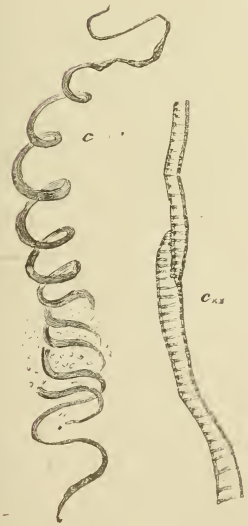

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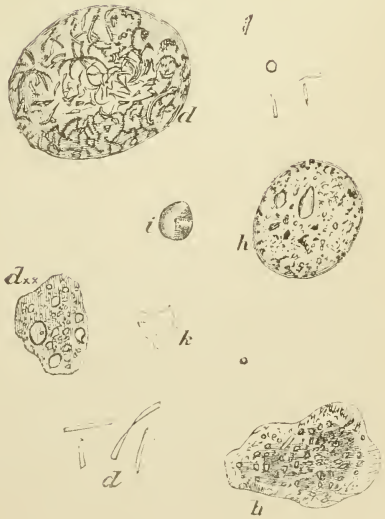

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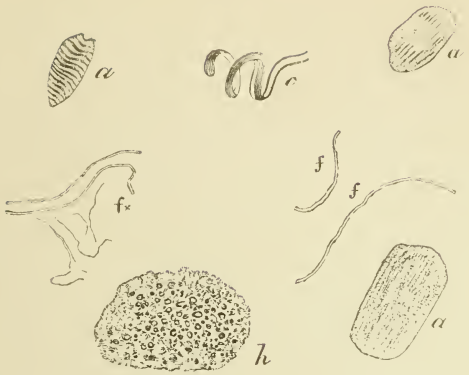

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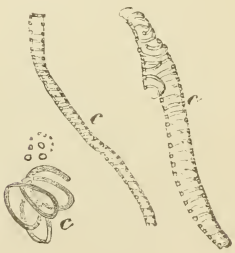

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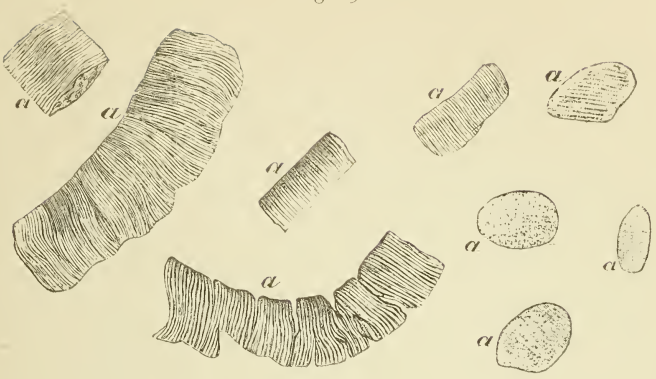

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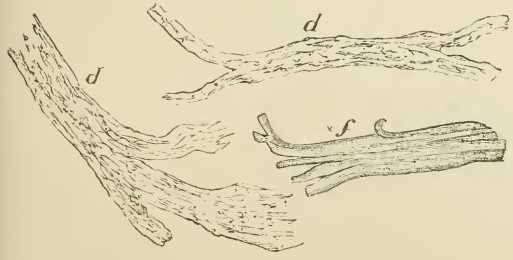

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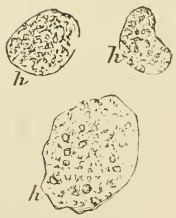

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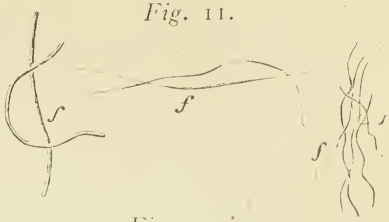

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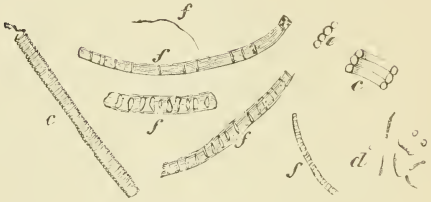

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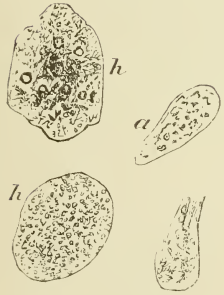

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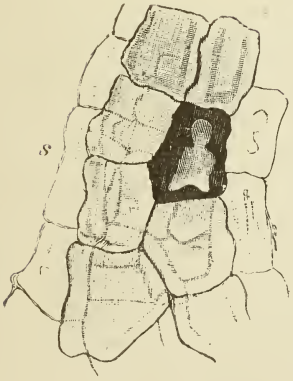

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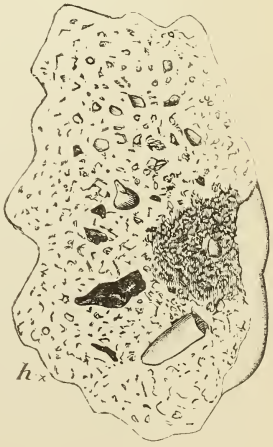

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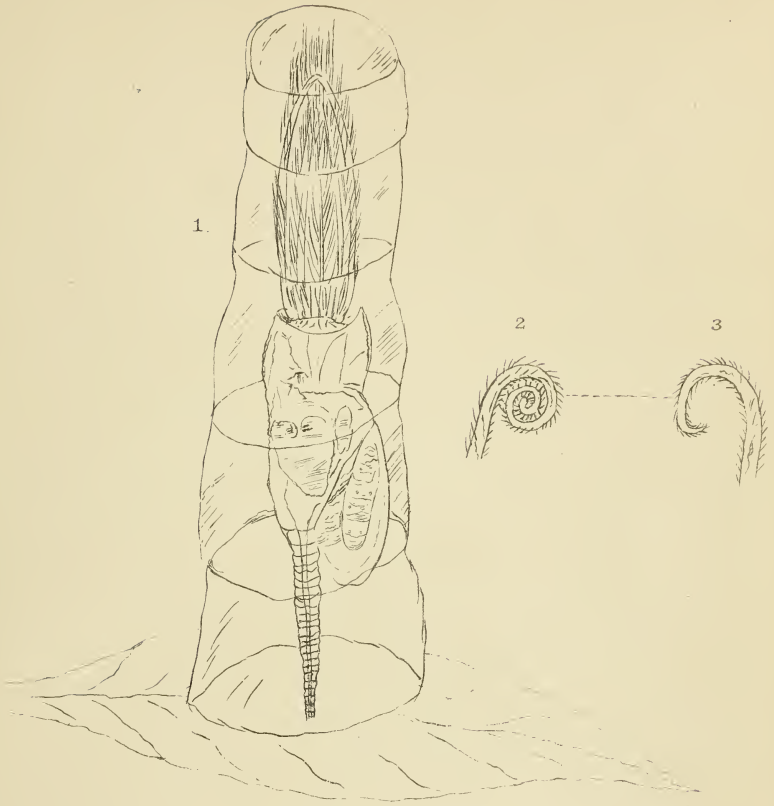

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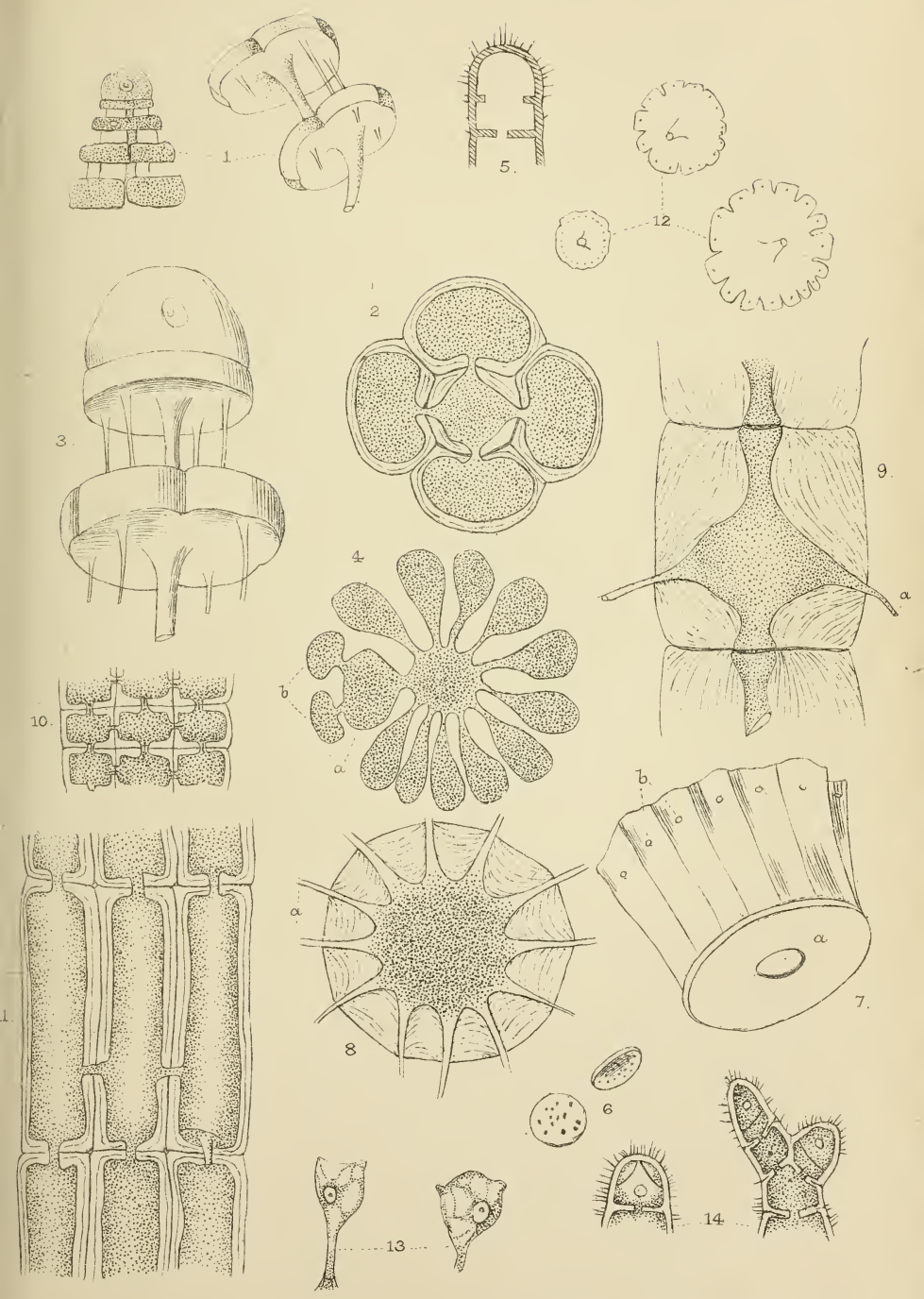
„ 4–7. Desmidieae.



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Formation and Growth of Cells in Polysiphonia.

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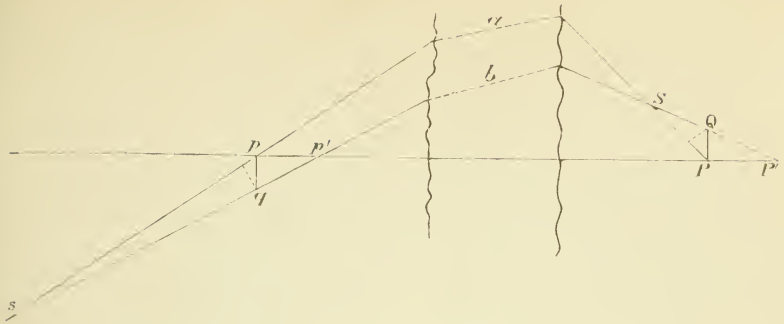

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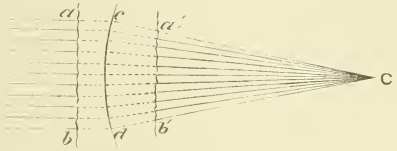

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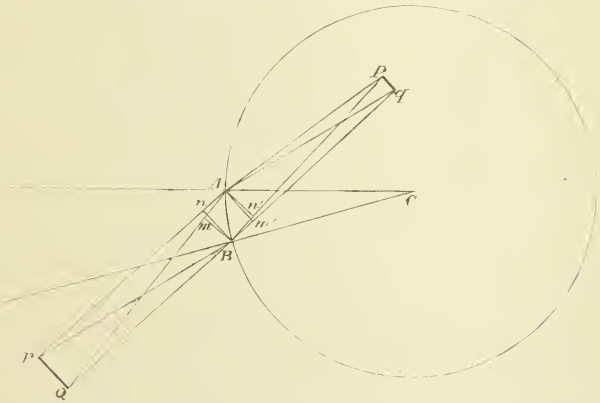

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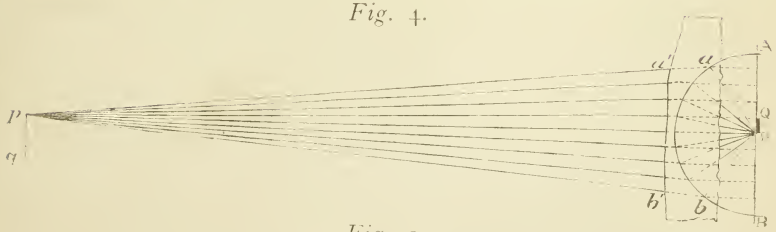

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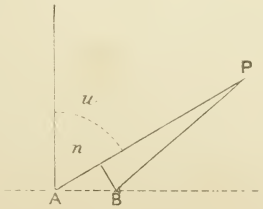

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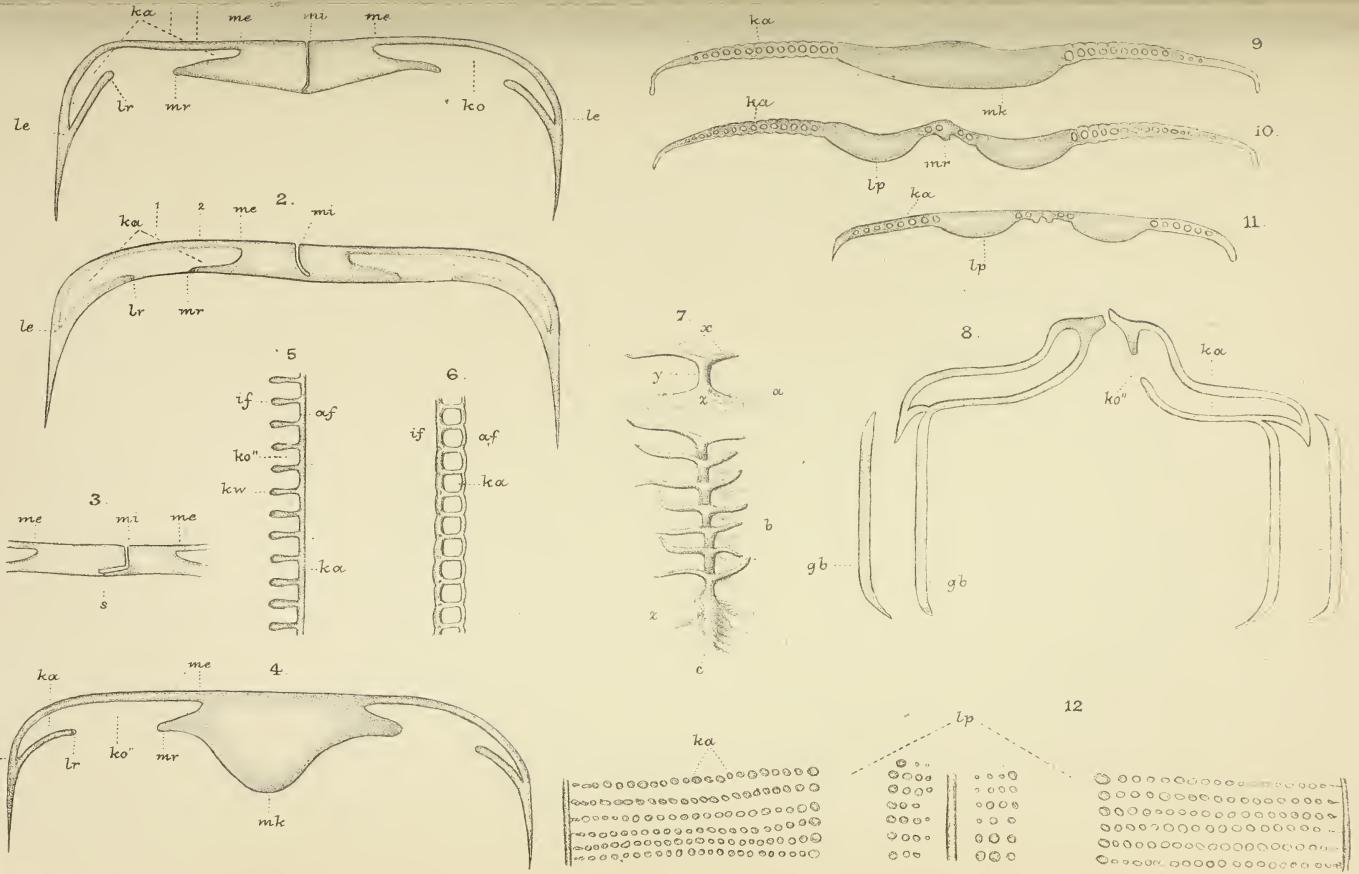

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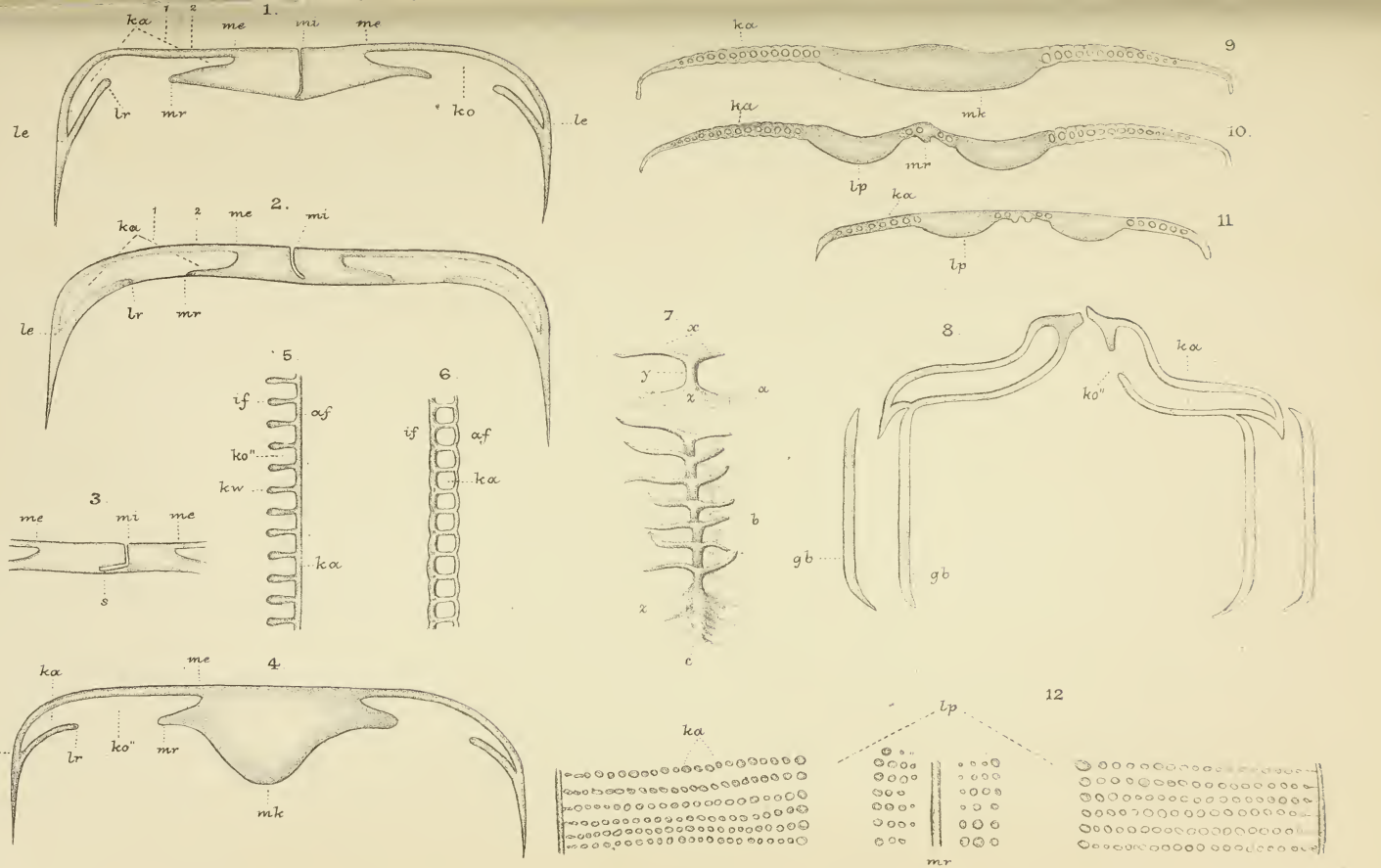

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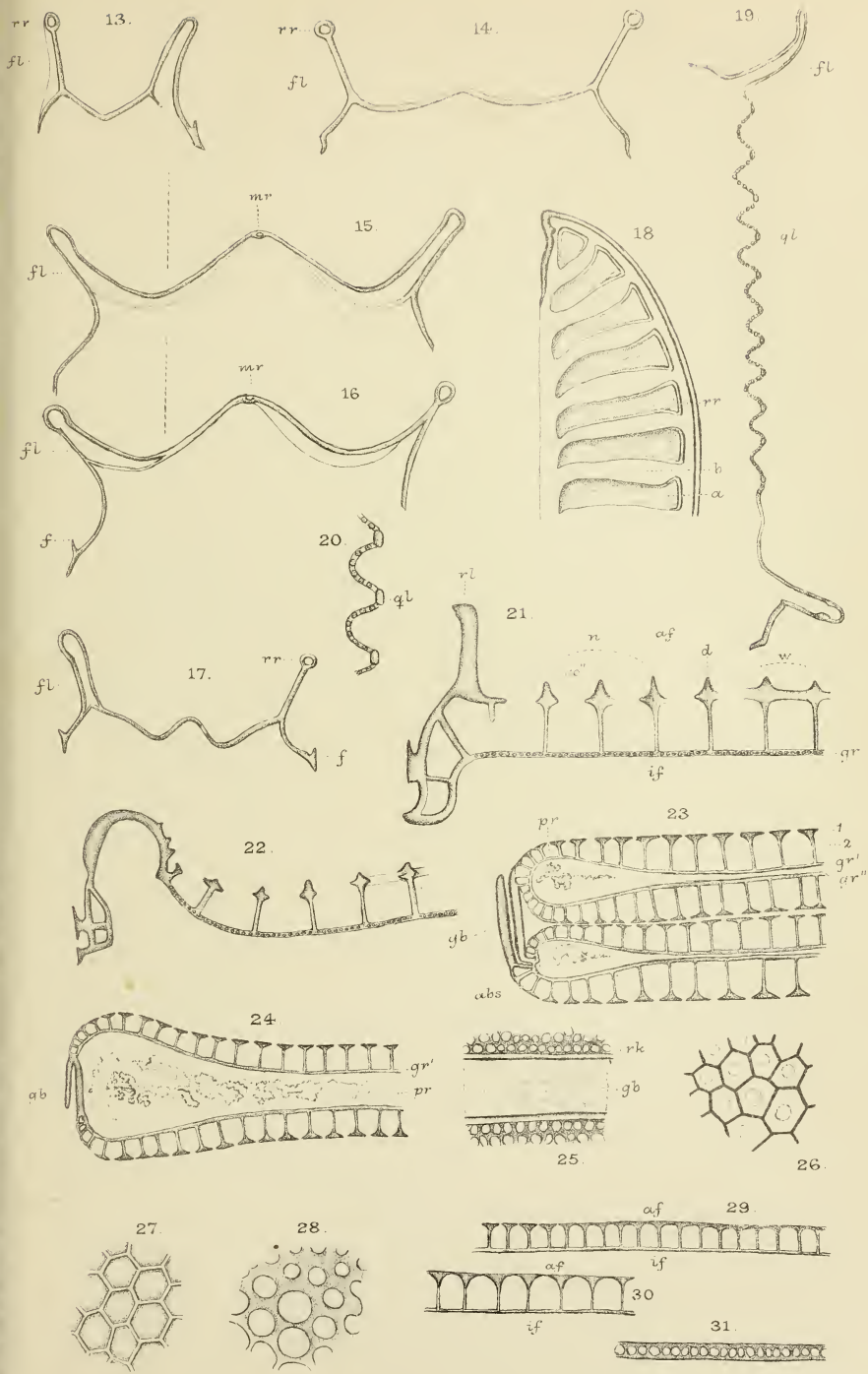

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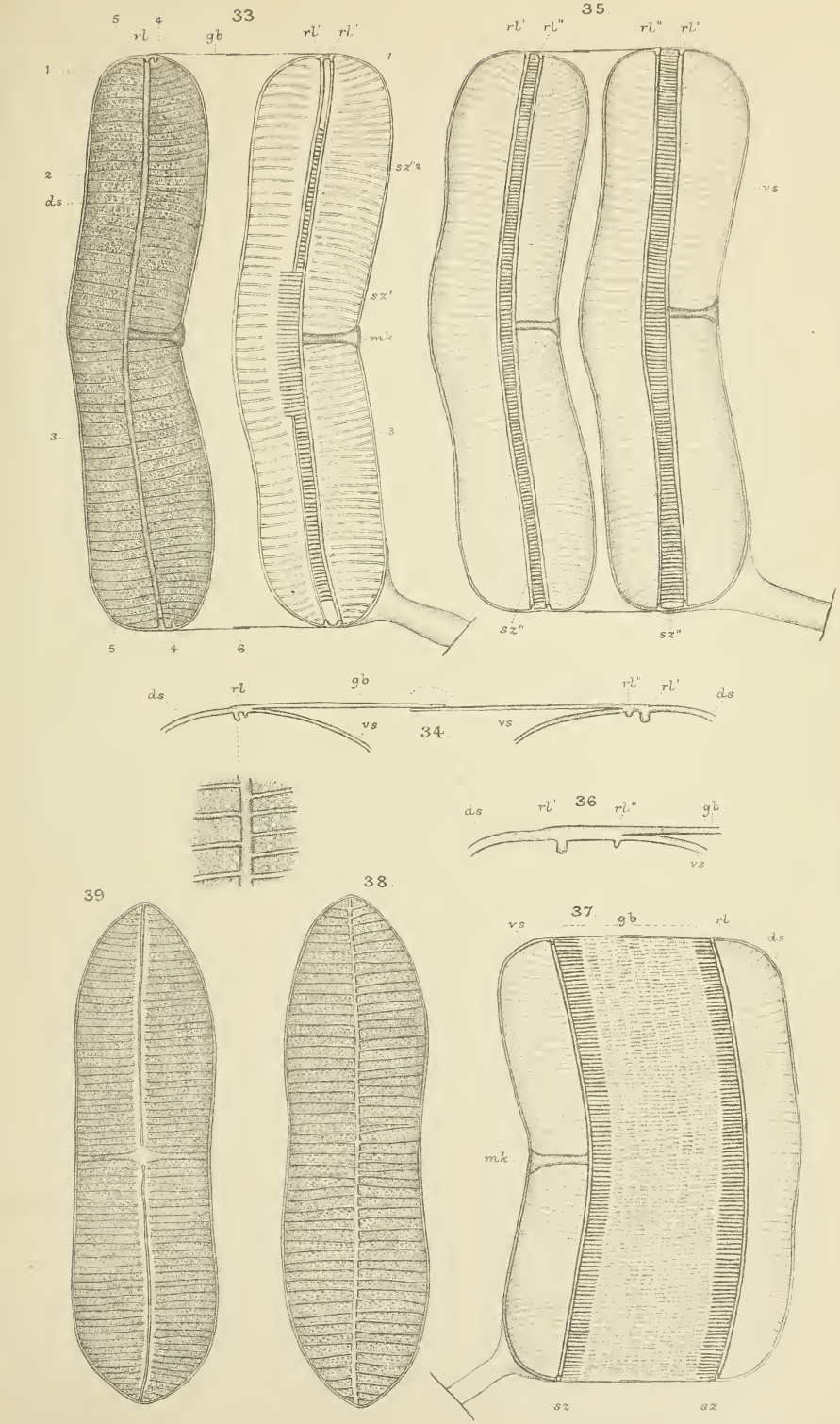

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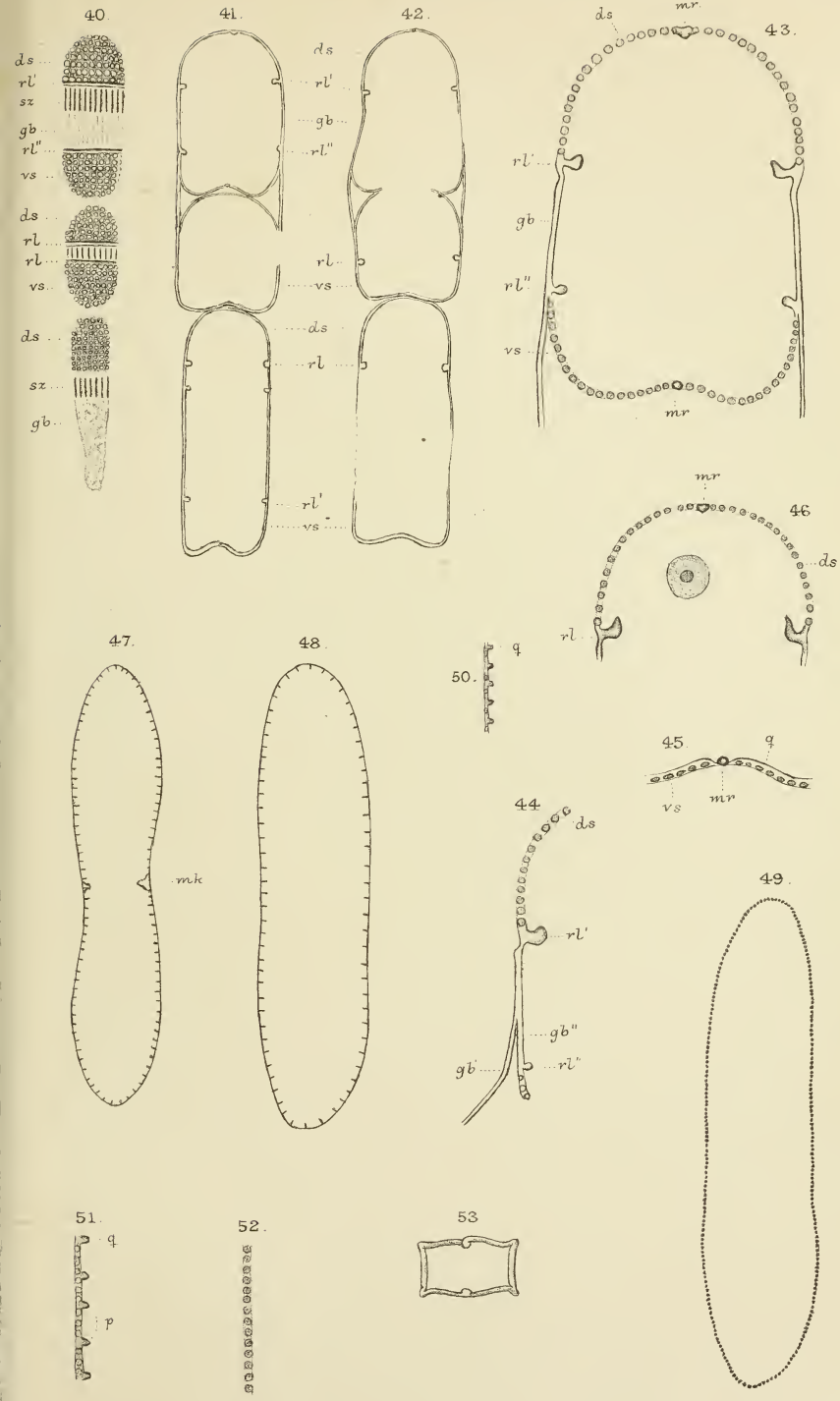

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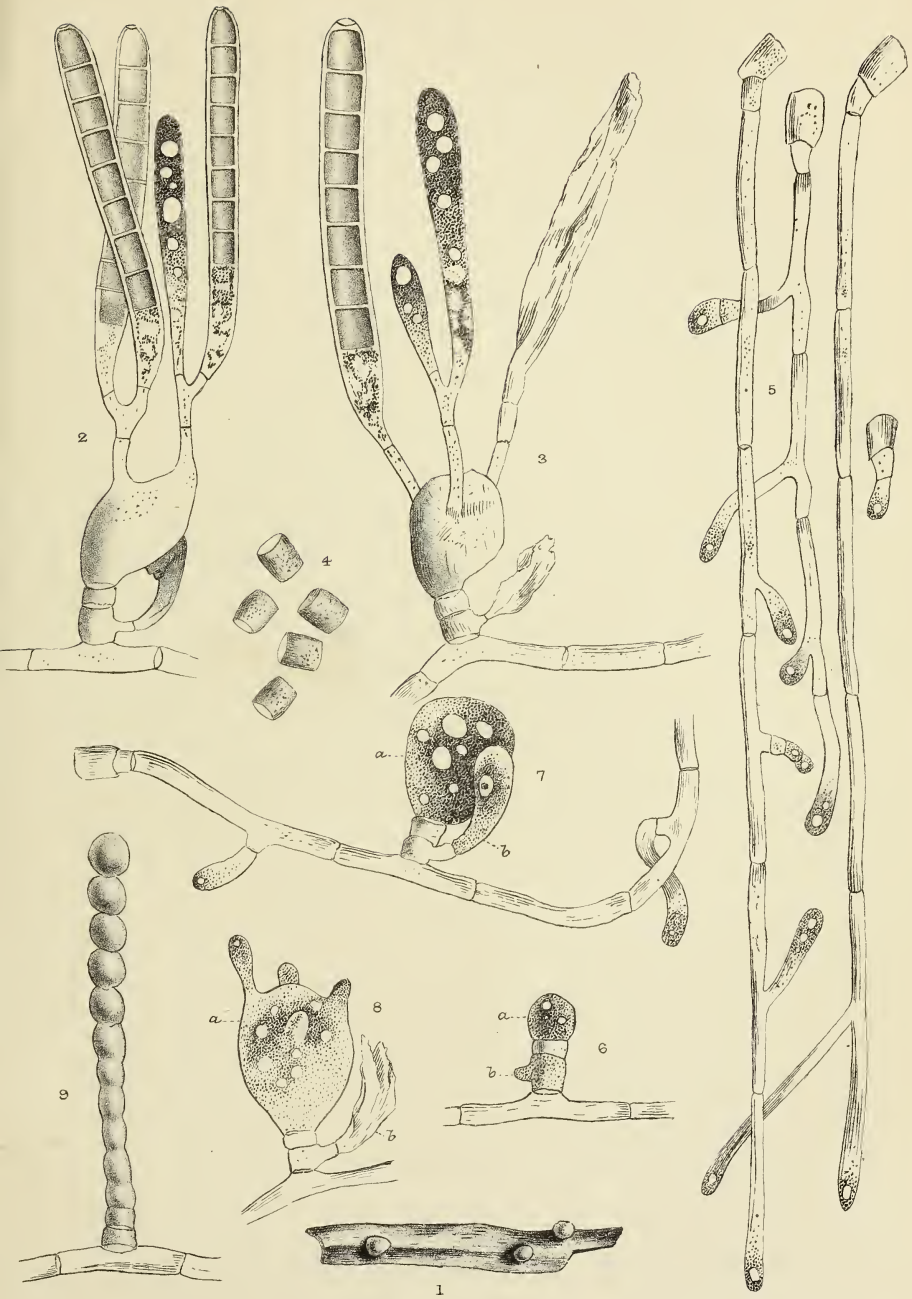

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Milowia nivea.