THE

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THE EDINBURGH NEW PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

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The First Lines of Morphology and Organic Development, Geometrically considered. By Dr Macvicar, Moffat, N. B.

Astronomy, though so old a science, is even to the present day content with being able to understand and to proclaim the laws by which the forms and orbits of the heavenly bodies are regulated. There are only a very few astronomers who have ventured on inquiries as to the mechanism by which these laws are realised and worked out; and that, by general consent, with very uncertain success. But naturalists, even already, although their science, compared with astronomy, is still in the period of its childhood, seem disposed to reverse this order of procedure. Naturalists, even previously to the discovery of the laws of biology, are bent on the discovery of the mechanism by which the forms and structures of living beings are determined, and by which they come to be what we find them. But in this undertaking, though gifted minds have bestowed themselves upon it, very little progress has been made; and any solution of the problem of life in this way in the present day seems to me quite hopeless. In the following communication, the method of astronomy, the discovery and the application of laws, is retained. Nor the method only, the grand instrument of astronomical investigation, is also retained. It is proposed to explain the elementary forms and transformations of orgasms and organised beings by the aid of elementary geometrical principles. Ultimately an appeal to these principles is inevitable, and I think that the sooner it is entertained the better. It is inevitable, because wherever there is a form or a transformation, there is a phenomenon taking place in the field of geometry; and with regard to organic forms, as with respect to all others, there is only one alternative possible; either they must be shaped in accordance with geometrical principles and proprieties, or else in violation of them. There is no neutral ground in reference to form, on which the principles of geometry may be simply ignored, or their silence secured, if they be violated. Neither are these two geometries, one, for instance, for the heavens, and another for the earth. Two are not possible. All geometrical principles and propositions whatsoever, do form, and must form, part and parcel of one and the same consistent code of doctrine. It is, indeed, but a few only of the simpler facts in geometry which have been deciphered by human intelligence; but it is certain that those which transcend the reach of our minds are consistent with those which we know. Geometry is, in fact, simply the expression of intelligence operating upon pure space, developing the pure forms which are possible to its parts, and discovering and describing the properties which necessarily attach to these forms. Nor can there be more satisfactory evidence that a Perfect Intelligence has framed the universe, expanded as it is in space, or that a Perfect Intelligence presides continually over it, than the discovery that geometrical principles are everywhere respected and acted upon in it. Other interests, indeed, besides those of form, may have to be attended to; and other interests obviously are attended to in the economy of nature—the interests of sensibility, for instance. And respecting sensibility, there is no assurance *à priori* that its laws are the same as the laws of form. We ought, therefore, to hold ourselves prepared for finding that possibly in certain regions of nature the principles of geometry are kept in abeyance by other, and it may be higher principles. But this we are not warranted to regard as a fact until we find it to be so; for in assuming it we are gratuitously limiting *à priori* the infinite resources of Almighty power. And if it be ascertained, as undoubtedly it has been, that the forms and movements of the heavenly bodies (those of light and heat included, to which nature owes everything) are exquisitely geometrical; and if it be certain, as it is, that the proprieties and improprieties belonging to geometrical forms and principles are the same universally, whether applied to the forms and courses of stars or of atoms, of plants or of animals, we are called upon, in the absence of evidence to the contrary, to anticipate that the forms and movements, whether of the intimate structures of orgasms or of entire organised beings, however much more elaborate and varied they may be than the forms or movements of the stars, are yet, equally with them, cases of applied mathematics.

Proceeding on this principle, which, if it receive mature consideration, cannot but secure the reader's acquiescence, I proceed to show that a few simple and well ascertained geometrical facts and relations, when viewed in reference to the media in which orgasms live, explain the most characteristic forms and phenomena of orgasms, for which, so far as I am aware, science has hitherto had no explanation to give.

The problem, in its most general terms, may be thus conceived. Given—as the highest generalisation which the observation of organic nature has supplied—the idea of a being which shall live, that is, a being which shall change continuously from within in a determinate manner, or according to law; given also the general conditions of its existence, it is required to explain the primary elements of the form and structure, and course of life of such a being. The problem is legitimised by the same fact which legitimises all philosophy, viz., that "our minds are curious, and our eyes are bad;"*—our curiosity attested by the great number of the students of nature; and the badness of our eyes by the fact that, after the much which the microscope has been made to reveal, still all the most exquisitely plastic fluids (white of egg, serum of blood, &c.), and all the most important tissues (intercellular substance, the walls of cells and tubules, elastic and contractile tissue, &c.), look as if they were perfectly structureless and homogeneous. Whence, also, we may understand at what a distance Nature keeps our organs of sense from her actual laboratory, and how altogether dependent we are upon the eye of the mind, the use of reason, if we are to find admittance

* Fontenelle's Plurality of Worlds, First Evening.

at all. Our position would indeed be altogether hopeless, were it not for the fact, which indeed alone renders any scientific inquiry possible, and sanctions it, namely, the uniformity of nature. But this uniformity is so great, that not only does it hold good in securing the recurrence of the same phenomena when the same conditions of existence recur; but, inasmuch as the Architect of nature is one, the same style of architecture prevails from the simplest to the most elaborate of all Nature's works. Moreover, there can be no doubt that the problem would be utterly insoluble by us, did we not see it actually solved in nature. Nor could we proceed were we without the principle that *the normal form, structure, and course of life in every orgasm and living being must be in harmony with the conditions of its existence.* The great value of this fact as a canon of biological research was first shown by Cuvier, and it has been generally acknowledged since his day. But it is possible to carry it now much farther than it could be carried then, and also to simplify its application. Thus, in order to ascertain the most general principles of morphology, it is not necessary to take into detailed consideration all the conditions of existence of living beings. It is enough to take into consideration the bearings upon life of the ambient medium in which an orgasm or living being is appointed to live, and by which it is constituted a member in the system of nature, and enters into the economy of nature. Hence, also, it is not necessary to consider even the ambient medium, in reference to its intimate constitution, or otherwise than in reference to the changes to which it is subject. Nay, it is not necessary to consider even these changes in detail, or in their relations among themselves, but only in their bearings upon the life which they touch. In a word, it is enough to regard them under one or other of the three categories within one or other of which they must all be comprised, viz., (1.) Changes which are unfavourable to the development of life; (2.) Changes which are favourable; and (3.) Alternations from either of these to the other, such as are constantly occurring during the vicissitudes of protracted existence. Now, the forms corresponding to these various states of the ambient medium, we may, in the meantime, provisionally designate as, (1.) Forms of hybernation; (2.) Forms of development; and (3.) Perfected or matured forms. What, then, are the teachings of geometry with respect to all of these? And first as to

Forms of Hybernation.

The ambient medium, from some cause or other which is not inquired into, is supposed to be unfavourable to the deployment of life in it; the form of the orgasm or living being, which is the object of thought, is supposed to be as yet undetermined; and the problem to be solved is supposed to be the construction of a form within which life may be best protected from the unfavourable action of the ambient medium, and best conserved until some favourable change take place in this respect, either in the medium where the orgasm is, or in the orgasm itself, by change of place. Suppose, for instance, that an orgasm or living being (in whose interior liquid water is, of course, necessary to the continuance of its life) is to have a bed of snow assigned to it as the medium which it is to animate. Or suppose an orgasm is to have, as its present abode, an ambient medium consisting of the same substances as itself, and from which it has just been separated or secreted, and into which, consequently, it cannot but tend to return by reabsorption and assimilation again, the question is, what form shall be assigned to it that shall best protect it from the unfavourable condition of the ambient medium, and preserve its being and its life till better times? Now, this is a definite problem in applied mathematics, and the solution is equally simple and explicit. In the circumstances described, an orgasm ought obviously to be moulded into that form which exposes the smallest number of its parts or particles to the ambient medium, and which, consequently, secludes and protects the largest number from it. It should obviously be moulded into that form which has the smallest surface and the largest interior or solidity. Now, what is this? Geometry finds no difficulty with the answer. Plainly it is the sphere. Wherever, therefore, the construction or the conservation of orgasms or living forms in a medium unfavourable to the deployment of their life is the aim of nature, and whether we view nature as the creation of Intelligence, or as itself instinct with intelligence, we should look for spherical forms as those dominant in the orgasms in it, or, at all events, for such forms as show that, but for the presence of influences either preventing the development of the spherical, or causing departures from it, they would have been spherical. This is our first landing place.

And let us, in a few words, show how nature verifies this deduction. And, in order to this, we may consider two cases—(1.) That in which the difference between the medium and the orgasm in it is not sufficiently great for the full enjoyment of life ; and (2.) that in which the difference is too great. That a difference, greater or less, between nearest neighbours is the condition of all life, and, indeed, of all molecular action except that of simple gravitation, is the teaching equally of all chemistry and of all biology. The difference must not be too great and urgent, indeed, otherwise a rapid solution or dissolution of the orgasm is the consequence. But neither must it be too small; for all vital, all molecular action, consists in an endeavour to lessen an initial difference by an exchange of particles ; and all molecular action, all life, ceases when assimilation has been completely effected. Hence it immediately appears that, when the difference between an orgasm and the ambient medium is too small, the conditions of existence, though they may be favourable to the conservation of life, are yet unfavourable to the deployment of life.

Now, the difference between an orgasm and the medium in which it exists cannot but be very small when that orgasm consists of the same kind of molecules as the medium in which it appears, and in which it has been merely individualised. Orgasms thus generated, therefore, we are to expect to possess spherical or hybernating forms, so far as mechanical pressures, modes of nutrition, and specific types permit. Now, in this category are obviously included all ova, seeds, spores, granules, and cells of all those kinds of which so many are produced in the plastic fluids and tissues of living beings. But of all these, it will be admitted that they tend to assume a spherical form. They therefore fully verify our theory.

Nor is it only while they are in a hybernating state that ova and seeds verify our theory. When, through influences more or less remote, they are forced to develop themselves, still, so long as they remain in their matrix, they are developed in forms far more rounded than those which they immediately assume on changing their medium and coming out into the world. From the simplest entozoa (*Ascaris acuminata*) to the chick in ovo and mammalian embryos (fœtus in utero, &c.), this fact is illustrated. To the same category also there obviously belong those orgasms which, though not produced within the parent tissue, are yet retained in such union with it that the deployment of individual life in them is prevented. Such are gems, buds, tubers, &c. And of these it is not to be denied that the sphere is the typical form. And so in other cases.

Here also the entozoa present themselves. They exist in a medium too similar to themselves to admit of a full development of life and of those expanded organs which, as we shall afterwards see, places a living creature in harmony with a favourable medium. Now, though it may be said that the entozoa tend to form an animal kingdom of themselves, and, as far as is possible, to represent all forms in the animal kingdom, yet they are very unsuccessful. In so far as they are truly simple, and neither compressed nor lengthened by currents plying along the walls to which they are attached, they tend to be eminently spheroidal (Acephalocystis, Gregarina, &c.), usually giving, as a departure from the spherical, only such head and neck as are necessary to secure their position (Echinococcus, Cysticercus, &c.) But among such animals there is no reason why their simple forms may not be repeated in continuity in the position in which one individual has succeeded in establishing itself, so as thus to give species of a higher order to nature, species composed of self-repeating parts either loosely jointed (tape-worms, &c.), or compactly annulated and unified (ascarides, &c.).

As to those conditions of existence in which the difference between the orgasm and its ambient medium is too great for the deployment of life, while yet it is not so great as to dissolve or destroy the orgasm, they are manifold, but they always sanction the same principle of morphology; they always give the spherical as the typical form of the orgasm or living being so situate. Such a living being may venture out perhaps, and even show a tail (*Amaroucium proliferum*), or it may try a succession of forms (many Acalephæ); but amid the over-action of the ambient medium, life is safe only by its having the power of reverting to the spherical form when things are at the worst. As a case of great difference between the orgasm and the ambient medium, we may instance that in which the latter is too cold. Life is compatible even with a bed of snow; but as to the form of the characteristic orgasm found in such a medium, its generic name Sphærococcus sufficiently indicates what it is. And generally, given any orgasm or living being which in a genial medium possesses an expanded form, or form furnished with expanded parts, such as tentacula or limbs, and let it be exposed to cold, does it not immediately shrink up into as rounded a form as it can? All the forms of hybernation, whether of the vegetable or animal kingdom, compared with their summer forms, are rounded. The same fact is also illustrated by such living beings as can adapt their forms from time to time to the ambient medium as it changes. Be it cold or hunger, or danger (provided they do not try to flee from it), or be it any other influence unfavourable to the deployment of life that assails them, they let fall, draw in, shrink up, coil round, and in a thousand ways attempt sphericity of form. And this form some of them, even quadrupeds—the hedgehog, for instance—successfully attain. Let only the conservation of life for future deployment, when the conditions of existence may become favourable, be the aim of Nature, then, even though that favourable change should never come, still Nature does her part in the meantime to secure under a spherical contour what of life exists. The back of the sick man falling into years may never be able again to support an erect figure, the bosom of the healthy virgin may never be called upon to give forth milk to an infant, still, in the meantime, as the form of conservation, both are rounded; and both being in the harmony of things, both being a homage to the same principle, both an obedience to a "law which is ordained unto life," both have a peculiar beauty, each its own; for beauty is universally the language of law triumphant.* Let it not be thought that

* See "The Philosophy of the Beautiful," by the author. Edmonston and Douglas, Edinburgh.

it is an argument against the law of morphology which I am now insisting upon, that in all such cases as I have mentioned a spherical form is obviously a necessity imposed by some physical force, or in itself the most fit. These are beautiful facts, anything but adverse to the theory now advocated. They take their rise in this, that the physical forces have been shaped by the Creator so as to be the prime ministers of a pure geometry, the architects of a pure morphology, shaped so as to work out and to realise the behests of Omniscience, manifesting itself in the segmentation by matter of space and time, according to the laws of form, magnitude, and number. What particular feature, among the many eminent properties of the sphere, shall be fixed upon in discourse as the determining reason of its being given to nature, depends entirely upon the naturalist's point of view. The point of view of this communication is the ratio of the superfices of the sphere to its volume. But that does not forbid others.

Forms of Development.

Let us suppose, next, that the conditions of existence have become quite favourable to the deployment of life, whether it be that the living orgasm has abandoned a medium essentially unfavourable, or that the medium in which it has remained has become favourable; the question now, therefore, is, what is the form which is suitable to this new condition of existence? And here the answer is obviously as explicit, if not quite so simple, as before. The problem is now, in fact, exactly the converse of the former. Obviously the orgasm or living form now, instead of exposing to the surrounding medium the smallest number of particles, the smallest extent of surface, ought to expose the greatest extent, the largest number possible. Thus are we led to ask, what is that geometrical form which, in reference to its interior, has the largest superficies? Now, to this the answer is, that there may be a form which is all superficies. This, in fact (in a general and physical sense), applies to many forms, not all equally fulfilling it, indeed, but all legitimately included under it. Thus a circular disk, in contact with the ambient medium all around, is all superficies. Still the circumference of a circle in reference to its area being a minimum, the disk will have a larger periphery, and will expose a larger number of parts or particles to the ambient medium, when from circular it becomes elliptical, oblong, lanceolate, and ultimately linear. Nor does the transformation stop here. If the medium be wholly favourable to the full deployment of life, then, in order that the given quantity of matter may come in contact and bask to the utmost in that medium, the linear form must become jointed, and break up into separate elements, each free in the medium, and all so small, that each is all surface and no interior, that is, all of them mere physical points and centres of force. Let, then, divisible matter be created or given, and let space in any region be, by an adequate power, willed or made to be wholly favourable to the deployment of life in that region, Intelligence meanwhile presiding, and proceeding on the principles of geometry, and that divisible matter, in obedience to that Will and that Intelligence, must be divided more and more, and ultimately resolved into such a medium as the æther is commonly believed to be. In that case, *Fiat Lux* is the first word of a purely scientific genesis.

And thus we are able to understand how the forms of the stars, whose containing cell is heaven itself, no less than the forms of granules of starch or oil in the microscopic cell of living tissue, fall under the theory which is advanced in this paper. The forms of the heavenly bodies are generally held to be sufficiently accounted for when they are shown to be the inevitable product of gravitation. Now, that they are, there can be no doubt. But gravitation, in determining them into spherical forms, is merely the finger of Intelligence imparting to them that form which is most suitable to the conditions of their existence, that form which possesses this, among other valuable properties, that bodies under it present a minimum of superficies to the ambient medium.

But to proceed. Let there be an orgasm located in a medium which is at first unfavourable to the deployment of life, but afterwards becomes favourable, either by a change in the orgasm or in the medium, we obtain from reason both an initial form for that orgasm, and a course of development. The initial form has for its type, as has been shown, the solid sphere. And the forms of development are either (1) discoid or *membranous* ; (2) axial or *filamentary* ; (3) a combination of both, such as *stellate* ; or if still kept in the massive state, then (4) *granular*, by the segmentation of a homogeneousness, whether spherule, membrane, or filament.

Now, these deductions are so fully verified by all observation, that I do not think it necessary to dwell upon this part of the subject. Thus a vegetative spherule, when placed in environments favourable to the deployment of its life, gives either a filamentary or a discoid frond, or one combining both. And when it has become full sized according to the hereditary type of the species, and the conditions of existence, consequently, are no longer favourable to the further deployment of life, then spherical forms are developed in it again which also tend to divide by segmentation into smaller grains, often in a very beautiful and geometrical manner (in algæ, pollen, &c.), whereby the spore is reproduced and the species preserved. Seeds also, and the same is true of buds and tubers when the conditions of the ambient media become favourable, develop into plants which are wholly composed of parts that are either discoid or linear, or of the nature of leaf and stem. Nor is it in the vegetable kingdom only that we find this law verified. The inner fabric of animals is entirely composed either of membranes or of fibres. And even as to their external forms, very many of them are discoid or radiant, and very many of them are linear. But here, it may be remarked in reference to the entire forms of animals, that geometrical properties of a higher order prescribe limits to the granting to them of simple and elementary forms. And, moreover, since even the simplest plant or animal consists of parts and particles, each of which has attained a perfected or matured form for itself, it is altogether necessary to determine the latter, before attempting to explain the forms of entire organised beings.

Forms of Maturity.

In the preceding investigation we have assumed that the condition of existence, at least in so far as the ambient medium is concerned, is either wholly unfavourable or wholly favourable to the deployment of life; and the only change that we have supposed is from the former to the latter. But it so happens, in the actual circumstances of our world, that there are many alternations both ways, and always one, at least, in the course of every day. We have therefore still to investigate, and if possible to determine, that form which shall be the most successful compromise between both—which shall be most safe during unfavourable vicissitudes, and most open to take advantage of every favourable change. Now, such a form we obviously obtain, when the solid sphere, the form of hybernation, (1) in opening into a membrane as the form of development, does so in such a way as to issue in a hollow spherical membrane pervious to the ambient medium, or (2) when extending into a filament it turns round upon itself as a helix, and thus generates a hollow spherical form by a spiral filament. Thus, as the perfected or matured form of an elementary orgasm, we reach

The Spherical Cell, its cell wall { a simple membrane, / a spiral filament, } or both.

Moreover, it follows, from our principle, that when the condition of existence is favourable to life, this spherical cell must tend to grow and increase to the utmost limits of size which it can without falling to pieces; for it must tend to become more and more pervious and fenestrated, so as to place its interior as much as possible in a condition as favourable as its exterior, with respect to the ambient medium. But when the relations of the ambient medium change, and become unfavourable, then it must tend to diminish the extent of surface exposed to that medium; it must tend to contract; whereby not only will the extent of the external surface be lessened, and that surface so far secured from injury, but the fenestræ, pores or mouths, also, may possibly be closed, and thus the ambient medium excluded from the interior altogether.

Thus, as the most perfect and mature organic element which our method enables us to reach, we obtain a pervious spherical cell capable of growth, and of expanding or contracting according as the conditions of existence are favourable or unfavourable to the deployment of life. Now, in reference to this result, still more than in reference to the two which have preceded, it is surely unnecessary to enlarge by illustration. It may be safely affirmed, that the grand discovery of modern times consists in this, that the mature structural elements of orgasms and living beings consist universally in cells which are pervious, and perform functions represented, so far as is known, by the reasoning above.

The Transformation of Cells.

The first fit of life, then, may be said to result in the transformation, by a variety of causes, of solid spheres, molecules, granules, and grains of various sorts, into hollow spheres or cells. It is obvious, however, that the course of life cannot stop here. During that same phase of the ambient medium which developes the cell out of the granule, cells previously existing must tend to undergo the same series of changes which the granule does, though not so urgently. Thus a cell, however pervious its wall, can never expose its interior surface to the ambient medium so fully as it exposes its exterior surface. It can never, in this respect, possess all the advantages which are possessed by an open tube or annulus of the same extent of surface, or by a filament which has no interior at all. Hence, under conditions of existence which are still more favourable to the deployment of life than those in which primordial cells were generated, we are to expect that such cells will be transformed into other forms analogous to those which we have traced in reference to solid grains or granules. They will also be nearer the region of visibility, if not actually within it. These transformations may be thus indicated:—(1.) *a.* Single cells will be transformed into annuli, which may be found in suitable positions, as in the interior of more persistent cells (see Vegetable Anatomy, Tradescantia, Musa, &c.) *b.* Each cell in a series may open in opposite regions, so as to constitute a short cylinder or bead, and so that a line of such two-mouthed cells will constitute a moniliform or variously constructed cross-barred cylindrical tube or annular duct. (For illustrations of this, also, in abundance, see vegetable anatomy, and the current theory as to the genesis of the capillaries in animal bodies.) But without opening by larger mouths than those on which their permeability depends, cells, when the ambient medium is favourable to the deployment of life, will tend to depart from the spherical form; for of that form the surface in contact with the medium is a minimum. Thus, *c*., they will be lengthened into spindle-shapes (see elements of many woods and muscles); for in such forms, when of the same volume as spheres, there is a larger surface, both external and internal, to enjoy the favourable conditions of existence. *d*. The spindle may become a tubule (as in many algæ and fungi, pollen on stigma, &c.) *e*. The lengthening cell may be spun out into a filament or fibre so small as to have no interior, and thus escape again into the region of invisibility, after having been already in it (Oscillatoriaceæ, &c.) *f*. But all these lengthened forms, when not prevented by attachments, must ever tend to reproduce the spherical, and therefore to turn round upon themselves, giving to nature twisted forms and spirals in abundance (found even among the simplest Algæ, Spirogyra, &c.) (2.) The cell, under conditions of existence still favourable, may also extend its surface to the benignant influence of the ambient medium by depressing itself in the line of some one axis, and thus becoming, *g*, lenticular (as in blood-cells, &c.), or *h*, discoid (as in epithelial cells, &c.), or *k*, stellate or radiated, that is, discoid at the centre, filamentary at the margin (as in pith of rush, &c.); *l*, the spiral tendency showing itself in the filamentary part (as in antherozoids, &c.) In short, the ways in which a cell may vary its form so as to embrace more fully the ambient medium, when the condition of that medium is favourable to the deployment of life, are almost endless.

Epithelium.

The same phenomenon—an opening of cells to the ambient medium—must also tend to ensue when, instead of a single cell, or a linear series of cells, there is a cellular mass. The interior of such a mass is, in fact, in a great measure secluded from the ambient medium altogether. It is only after permeation of the outer cells that the ambient medium can reach the inner cells. If, then, a single cell tend to open into an annulus or element of a tubule, so as to give ingress into its interior to the ambient medium when that medium invites to the deployment of life, much more will the cells forming the periphery of a cellular mass tend to do so. In order to protect them, therefore, from this opening power of the medium, and to preserve them as cells, they will require to have a more stable structure than cells in general. In a word, on surfaces exposed to an ambient medium which is favourable to life, an *epithelium* is called for.

Vessels.

Nevertheless, in those regions in which the ambient medium presses most urgently upon the cellular mass, we are to expect the cells to open and to admit the ambient medium to the interior. And thus, on the single principle on which the whole of this paper has been reasoned, we shall have in cellular masses, when the conditions of existence are favourable to the deployment of life, intercellular passages, lacunæ, and vessels which, when the external pressure is local, and the cells easily transformable, will be conical as they retire from the region of maximum pressure, and tend to ramify.

A Dermal System.

It is easy to perceive, however, that the limit of this process of vessel-formation, and of the admittance of the ambient medium to the interior of a cellular mass, is the complete solution of the cells which first formed the interior of that mass, and the reduction of the entire orgasm to a dermal body, pervious, by one or more openings, to the ambient medium.

Viscera, &c.

But as fast as this process of cell digestion proceeds in the interior of the mass, a peculiar liquid must be generated therein—a liquid composed of cell-material. Hence, we are only to expect that, within the persistent dermal envelope, new cellular structures will be formed, and differentiation proceed, special organs being modelled according to the type of the species. Thus far we can go on a single principle—and that, an element of pure geometry. But to explain the multiplication of cells, as also the morphology of compound forms generally, another law must be invoked—THE LAW OF ASSIMILATION. This, however, it forms the principal theme of a special work* to unfold, and I need not touch upon it here.

* The First Lines of Science Simplified, and the Structure of Molecules attempted. Sutherland and Knox. Edinburgh, 1860.

On the Production of Mist. By John Davy, M.D., F.R.S. Lond. and Ed., &c.

One cause has commonly been assigned for the production of mist, viz., the access of cold air and its admixture with warmer air saturated, or nearly saturated, with moisture, such as that resting on the surface of great bodies of water—the sea, for instance, lakes, and large rivers—and so strikingly exemplified in our autumnal and early winter fogs, when the bodies of water alluded to, owing to the heat absorbed during the warm summer season, are of much higher temperature than the inflowing air, especially if the wind be from a northerly quarter.

Another cause, and one which has had less attention paid to it, is of an opposite kind, and acting mostly at a different season—viz., a mild moist air coming in contact with a colder air, equally humid, incumbent on cold surfaces, whether of water or land, towards the end of winter and the beginning of spring. The production of mist in this way, at the times mentioned, may often be seen, especially during a thaw with a change of wind from the north and north-east to the south and south-west. In the Lake District, I have frequently observed it, when passing along Windermere under the circumstances described, and when, on trying the temperature of the water of the lake and the air over it, that of the former has been found to be ten or more degrees lower than that of the latter. In the same district, under the like conditions, the formation of mist on the hills is often to be witnessed—their surface-temperature at the time being many degrees below that of the mild moist air impinging on them.

One of the peculiarities of this later mist—if it may be so distinguished from the earlier—is, that it is low, rising but little above the surface, and never occurring at least over water, except with the gentlest breeze. Associated with this phenomenon is another, and one more noticeable—the precipitation of moisture on walls and flagged floors so situated as not to have had the benefit of fire, and consequently liable to acquire, during any severity of cold in winter, a low temperature.

I need hardly advert to the vulgar opinion, that the moisture in question is an exudation from the stone itself—a belief implied in the term "sweating," used to express it.

This precipitation of moisture and production of mist are most conspicuous in such situations as are exposed to great and sudden transitions of temperature, such as Constantinople situated between the Black Sea and the Mediterranean; the towns on the shores of the Adriatic, especially of its upper portion; the islands of the Mediterranean most exposed to the warm and damp sirocco, such as Malta; and in England, the towns on the south-west coast of Dorset and Devon.

A dread of it amongst the inhabitants of Constantinople has led them to give the preference to wooden houses, notwithstanding the constant danger of destruction from fire to which they are exposed, and from which they have so often suffered. Stone houses they consider unwholesome; and to a people such as the Turks, trusting chiefly to clothing for protection from the cold of winter, they can hardly be otherwise. In England, it is to feared, that amongst the poorer class, who cannot afford to keep their dwellings warm by fires, their health may suffer from this cause.* And, granting this, does it not follow, that the natives of the wilder parts of Scotland, the Highlands and Isles, and of the similar parts of Ireland, have reason on their side in keeping to their warm turf-built huts, preferring them to the cold stone-built slated houses?

Not only in relation to health and comfort is the subject of interest; it is hardly less so in relation to the well-keeping of objects which are liable to suffer from damp. And how few are there which are not! Moisture, which is essential to vitality, is, as is well-known, equally essential to decay. In Upper Egypt, the climate of which is so remarkable for its dryness, works of art are perdurable. In our moist climate, how great is the contrast; how few of our stately buildings, even though

* The health of prisoners is endangered from the same cause, when their sleeping cells, of massive masonry, are detached from the main building without the means of being warmed. This last winter, in a county house of correction, I have been informed that the inner walls of some of the cells were not only wet from precipitated moisture, but were in the morning actually covered with ice, the breath of their inmates corresponding in quality to the moist and warm sirocco.

recently erected—witness the Houses of Parliament—are not in progress of deterioration! Even within doors, unless due precautions be taken, articles of the greatest value, such as pictures and books, are liable to suffer from damp, especially the damp in question. I remember visiting an esteemed collection of pictures in the south of Devon, belonging to a nobleman not residing, and the rooms in which they were without fires, and being disappointed of an expected pleasure, owing to a precipitation of moisture on the paintings, almost completely obscuring them—the wind at the time blowing from the south, succeeding a continuance of cold weather with the wind from the opposite quarter.

Nor is it undeserving of attention in relation to the appearances in nature and in connection with climate—and this irrespective of the general consideration, that the aqueous portion of the atmosphere is the only one of its elements which is variable in a marked degree, and that were it not for this one, the aspects of the sky would be immutably the same. Not only are the low creeping mists of our valleys referrible to it, but also the clouds capping our mountains; indeed, the latter especially exemplify it:—

> "The south wind wraps the mountain top in mist."

So Homer sang as translated by Cowper. The same effect is witnessed at the present time in Greece; as soon as the south-east—the moist warm sirocco—blows, all the mountain tops are hid, and more than that, a veil is, as it were, spread over the mountains themselves, either concealing them entirely, or allowing them to be seen dimly, like indistinct shadows through the vapoury air. The setting in of the same wind, often beginning very gently, is anticipated at Constantinople, by a dense fog appearing low over the surface of the Sea of Marmora, so low that whilst the hulls of ships becalmed in it are hid, their top-masts may be seen in the clear air above.

To it, too, may be referred the large proportion of rain that falls in mountain districts, increasing in a certain ratio with the elevation of the mountains exposed to the impulse of warm or mild damp winds, of which we have so striking an instance in the Lake Districts of England; where, in one spot, Scathwaite, in Borrowdale, in the midst of the higher ranges of hills, the average fall of rain yearly is as much as 129·97 inches.

Description of a Method of Reducing Observations of Temperature, with a view to the Comparison of Climates. By Professor J. D. Everett, King's College, Windsor, Nova Scotia, late Secretary to the Scottish Meteorological Society.

The climate of a place, as regards temperature, involves three elements—mean temperature, range, and date of phase.* The first of these is subjected to measurement wherever meteorological observations are taken; the other two, and especially the third, have not received equal attention. These three elements appertain alike to daily and to annual variations, but we shall confine our remarks to the latter.

Annual range (*i. e.*, the range that occurs within the year) has been measured in various ways. Sometimes it is assumed as the difference between the two extreme readings which occur within the year; sometimes as the difference between the two extremes of daily mean temperature; sometimes as the difference between the mean temperatures of the warmest and the coldest calendar month; sometimes as the difference between the mean temperature of a certain number of the warmest calendar months, and that of an equal number of the coldest.

The two latter assumptions are defective in point of accuracy, because the times of maximum and minimum are not the same for all places. It is obvious that the range, if estimated as the difference between the mean temperatures of two calendar months, will (*cæteris paribus*) appear greatest when the maximum and minimum fall precisely in the centres of the two months; and if this condition is more nearly fulfilled at one of two places compared than at the other, the comparison will be unequal. The same remark applies when the mean of three (or any other number of) warm months is compared with that of the same number of cold ones, and the ratio of

* Phases are the successive states of an element which undergoes continual change. By "date of phase," I mean the earliness or lateness of the phases generally; in other words, the earliness or lateness of the seasons, upon the whole, as regards temperature.

the error to the deduced range will be upon the average the same in both cases.*

The element of "date," which thus interferes with the determination of range from monthly means, is for its own sake well worthy of careful investigation; but meteorologists generally content themselves with loose estimates of its amount, and I am not acquainted with any meteorological work which contains directions for computing it.

The design of the present paper is to supply this desideratum,† by describing a convenient method of deriving both "range" and "date of phase" from the mean temperatures of the twelve calendar months. I shall not enter into the mathematical investigation on which the method rests (for which I may refer to two papers, by Professor W. Thomson and the Author, read before the Royal Society of Edinburgh on the 30th April 1859), but shall confine myself to a brief account of the principle of procedure, with full details of its practical application.

The method virtually consists in removing the irregularities which characterise the actual curve of temperature for any place, so as to obtain in its stead a regular curve which can be expressed by a simple mathematical formula. In the reduced curves thus obtained for two places, we have a definite measure both of the interval of time by which the phases of temperature are on the whole earlier at one place than at the other, and of the annual range at each place, as deduced from a comparison of the warmer half of the year with the colder.

* If the variations of temperature conformed to the simple curve of sines, the difference between the mean temperatures of two equal and opposite portions of the year, of given length, would vary directly as the difference between the temperatures of their respective centres.

† [This cannot be called a desideratum, for the method here spoken of has been in familiar use among meteorologists for thirty years or more. It has been published in Kämst's Meteorology, is noticed by Sir John Herschel in the article "Meteorology" in the Encyclopædia Britannica, and is specially adopted by Principal Forbes in his article on the climate of Edinburgh, in the last volume of the Transactions of the Royal Society of Edinburgh. These authors have fully adopted it, and pointed out the significance of the three constants for—1. Mean Temperature; 2. Range; 3. "Date of Phase."—EDITOR *Edin. N. Philos. Journal.*]

The curve which is adopted as the standard of reduction is what mathematicians call a "simple harmonic curve," or "the curve of sines," and is expressed by the equation*

$$y = A + a . \sin (x + e),$$

where A will denote the mean temperature of the year, *a* the amplitude or greatest departure of the curve from the mean, which will be the same above as below, and will therefore be equal to half the annual range, and *e* is expressive of the "date of phase," the phases of temperature being earlier or later according as *e* is greater or less. The curve has one maximum and one minimum in the year, which are precisely half a year asunder; and exactly midway between these, are the two points where the curve intersects the line of mean annual temperature, corresponding to those two days in the year, one in spring and the other in autumn, whose mean temperatures are the same as that of the year.

The curve for a year will consist, in fact, of four precisely similar portions, the part which is above the line of mean temperature being precisely similar to that which is below, and each of these halves being divided symmetrically, at the points of maximum and minimum temperature respectively.

It is not, of course, pretended that the actual temperature of any place fulfils these conditions; but that when a uniform standard of reduction is to be applied to a number of places (in the temperate or frigid zones), such a curve as we have described is adapted to the purpose. While possessing the necessary amount of uniformity, the curve, at the same time, admits of infinite variety in respect of its amplitude (*i.e.*, the extent of its departure from a straight line), which may be increased or diminished, without limit, according as we wish to represent a climate where the annual range is great or small.

It is not necessary that the curve should actually be drawn.

* Some of our most important results will remain true if the temperature through the year be supposed to conform to the expression

$$y = A + a_1 . \sin (x + e_1) + a_2 . \sin (2x + e_2).$$

We shall indicate these in their place.

It will be sufficient to calculate the values of a and e, and the mode of doing this is shown in the subjoined example, in which the proposed method of reduction is applied to the monthly mean temperatures of Stornoway for the average of the three years 1856–7–8, as contained in the Report of the Scottish Meteorological Society, for the quarter ending June 30th, 1859:—

1	2	3	4	5	6	7	8	9	10
37·5	54·4	−16·9		−16·9	S_3	−16·9	−16·9	S_0	
38·8	57·0	−18·2	+11·7	−29·9	S_2	−25·9	− 6·5	S_1	−3·25
38·9	52·1	−13·2	+ 5·6	−18·8	S_1	− 9·4	− 7·6	S_2	−6·58
43·2	46·8	− 3·6		− 3·6	S_0		− 3·6	S_3	−3·6
48·1	42·5	+ 5·6				6)−52·2			6)−13·43
53·4	41·7	+11·7				P= − 8·70			Q = −2·24

$$\tan. e = \frac{P}{Q} = \tan. 75° \ 34' \qquad Q. \sec. e = -8{\cdot}99 = a.$$

The numbers at the head of the columns are simply for reference in the present description.

Column 1 contains the temperatures of the six months January to June, and column 2 those from July to December.

By subtracting the numbers in column 2 from those opposite to them in column 1, the numbers in column 3 are obtained, and the two last of these are written in reverse order in the second and third lines of column 4.

By subtracting the numbers in column 4 from those opposite to them in column 3, as far down as the fourth line, we obtain the numbers in column 5.

The symbols S_3, S_2, S_1, S_0, in the next column, denote respectively the natural sines of 90°, 60°, 30°, and 0°, which are 1, ·866, $\frac{1}{2}$, and 0. Multiplying the numbers in column 5 by these quantities, we obtain the numbers in column 7, which are then added and their sum divided by 6. The quotient is called P.

Column 8 is obtained by adding the numbers in column 3 to those opposite to them in column 4. The numbers in column 8 are then multiplied respectively by S_0, S_1, S_2, and S_3, and the products form column 10, which must be summed and divided by 6. The quotient is called Q.

The angle whose tangent is equal to P divided by Q is e, the "epoch" or "date of phase;" and Q multiplied by the secant of this angle is a the amplitude in degrees of temperature.

In finding a and e by logarithms, it will be sufficient to carry these to four places of decimals.

A check against large errors in determining a is afforded by knowing that if P and Q are the sides of a right-angled triangle, a is the hypotenuse.

If the year be supposed to consist of 360°, then e represents the interval from that day in autumn which forms the boundary between the warm and cold halves of the year to the 15th of January. The amplitude a is approximately equal to the difference between the mean temperature of the year and that of the warmest or coldest group of thirty days. More accurately,* it is proportional (but not equal) to the difference between the mean temperatures of the warm and cold halves of the year, bearing to this difference the constant ratio of 1 : 1·2879. In speaking of the warm and cold halves of the year, I suppose the year divided at two opposite points in such a manner, that the greatest possible amount of heat shall be contained in one half, and (consequently) the greatest possible amount of cold in the other.

I shall now give instances of the comparison of climates.

The subjoined table (Table I.) exhibits the results of the proposed method of reduction, as applied to all those stations of the Scot. Met. Soc. whose observations embrace the three years 1856–57–58. The data are the mean temperatures of the stations for each calendar month on the average of the three years above named, as contained in the Society's report for the quarter ending June 30th, 1859.

* This definition, and also that above given for e, are very close approximations to the truth as regards the actual temperatures, being true not only for a simple harmonic curve, but also for that more complex curve whose equation is given in the note, page 3. The first definition here given of a is only true for a simple harmonic curve.

TABLE I.—*Results from Three Years*, 1856–57–58.

Stations.	Values of A.	Values of *a*.	Values of *e*.	Days earlier, +, later, —, than mean.	Difference between Warm and Cold half.
Stornoway, .	46·4	8·99	75° 34′	−3·8	11·6
Culloden, .	47·5	10·17	80° 57′	+1·6	13·1
Elgin, . .	47·2	10·33	79° 24′	+ ·1	13·3
Castle Newe, .	44·2	10·83	80° 29′	+1·2	13·9
Braemar, .	44·9	10·89	79° 6′	− ·2	14·0
Aberdeen, .	45·9	10·69	78° 50′	− ·5	13·8
Fettercairn, .	46·9	11·56	83° 22′	+4·1	14·9
Arbroath, .	46·6	11·09	79° 53′	+ ·5	14·3
Barry, . .	47·7	10·54	78° 24′	−1·0	13·6
Kettins, .	45·8	11·20	80° 39′	+1·3	14·4
Callton Mor, .	47·2	10·37	80° 37′	+1·3	13·4
Greenock, .	48·4	10·97	76° 37′	−2·7	14·1
Baillieston, .	46·6	11·59	80° 28′	+1·1	14·9
Edinburgh, .	49·0	10·71	77° 6′	−2·3	13·8
Dalkeith, .	48·3	12·02	79° 25′	+ ·1	15·5
E. Linton, .	47·3	10·66	76° 16′	−3·1	13·7
Thurston, .	47·0	10·74	71° 43′	−7·7	13·8
Yester, . .	46·2	11·55	83° 56′	+4·7	14·9
Thirlestane, .	45·1	11·83	80° 46′	+1·4	15·2
Milnegraden, .	47·0	11·08	78° 43′	− ·6	14·3
Bowhill, . .	44·2	11·17	82° 9′	+2·9	14·4
Makerstoun, .	46·8	10·65	77° 22′	−2·0	13·7
Drumlanrig, .	47·0	11·96	81° 1′	+1·7	15·4
Kirkpatrick, .	46·5	10·85	81° 5′	+1·8	14·0
Means, .		10·94	79° 20′		

TABLE II.—*Results from Single Years.*

Stations.	Values of *e*.			Values of *a*.		
	1856.	1857.	1858.	1856.	1857.	1858.
Bressay, .	...	59° 41′	73° 43′	...	7·8	8·6
Sandwick, .	...	62° 2′	75° 49′	...	8·6	8·3
Tongue, . .	...	72° 29′	84° 19′	...	9·7	9·1
Stornoway, .	81° 50′	72° 3′	73° 27′	8·6	9·4	9·1
Culloden, .	80° 29′	74° 56′	87° 25′	9·8	10·4	10·4
E. Linton, .	76° 4′	68° 27′	84° 2′	...	...	...
Thurston, .	70° 56′	62° 10′	82° 40′	...	...	...
Yester, . .	87° 4′	...	...	...	...	...

The names of stations are entered in the order in which they occur in the Society's Reports, being nearly that of latitude, proceeding from north to south.

The first column of numbers contains the values of A, or the mean annual temperature obtained in the usual manner.

In the second and third columns are the values of a and e (amplitude and epoch) determined in the manner already explained.

The fourth column shows the number of days and tenths of a day by which each station is earlier or later (as regards the phases of its temperature) than the mean of all; days earlier than the mean being denoted by +, and days later by −.

The fifth column exhibits the difference between the mean temperatures of the warm and cold halves of the year.

The numbers in the 4th column have been obtained from those in the 3d, by taking the difference from the mean value of e for all the stations (79° 20′), and converting it into days at the rate of 1° to $1\frac{1}{72}$d day. (Since 360 : 365 : : 72 : 73).

The numbers in the 5th column are proportional to those in the 2d, and have been obtained from them by the formula log. a + ·1099 = log. n. (Since ·1099 is the logarithm of 1·2879).

To find the centres of the warm and cold halves of the year, we may proceed as follows. The mean value of e for all the stations is 79° 20′. To reduce to the beginning of the year, subtract 15°, since our reckoning has been taken from the middle of the first month. This leaves 64° 20′, which is the interval from the beginning of the cold half to the end or beginning of the year. The complement of this, or 25° 40′, is the interval from the beginning of the year to the centre of the cold half, which again is 180° distant from the centre of the warm half.

25° 40′ corresponds to 26 days (nearly.)
205° 40′ ,, 209 ,,

The 26th and 209th days of the year are January 26th and July 28th, which are therefore the centres of the cold and warm halves of the year for the mean of the stations. The corresponding dates for any particular station will be earlier or later than these by the amount shown in column 4.

By taking the sum and the difference of A and a, we shall obtain approximately the mean temperatures of the warmest and coldest groups of 30 days respectively at each of the stations; or if the difference between the warmest and coldest group is required, it can be found by simply doubling a. These determinations will, however, be inferior in accuracy to those which the table contains, and this is my reason for omitting them. (See note, page 23.)

With the joint purpose of testing the powers of the method, and comparing different years, I have calculated the values of a and e for single years for a few of the Society's stations, including three which are not contained in the first table. The results are given, without any reservation, in the following table (Table II.). Bressay (Shetland) appears to be the latest of the Society's stations, being about 13 days behind the mean of the 24 stations included in the first table. Sandwick (Orkney) precedes Bressay by about 2 days, and this interval is preserved nearly constant from 1857 to 1858, although the absolute times differ by nearly a fortnight. The amplitudes are also less for these two stations than for any others, the amplitude (and consequently the range) at Bressay being only about four-fifths of the average derived from the 24 stations. The extreme lateness of Thurston (near Dunbar) seems to be borne out by the results from single years, as appears from a comparison with the neighbouring station, East Linton. The extreme earliness of Yester cannot be so satisfactorily tested, as the interpolations (in defect of actual observations) at this station for the years 1857–58 are too numerous to admit of any safe inferences being drawn from these two years. In 1856 (which year is entirely free from interpolations), Yester appears to have been 16 days earlier than Thurston, and 11 earlier than East Linton, a remarkable difference, considering that all three places are in the same county (East Lothian). Comparing one year with another, it appears that the seasons were latest in 1857, being fully a week later than in 1856. The greatest difference appears at Thurston, where it amounts (in comparing the last two years) to nearly 21 days. All the inferences as to date, contained in this paragraph, are derived from mere inspection of the values of e, bearing in mind that a degree nearly corresponds to a day, and that the phases are earlier in proportion as e is greater.

As an instance of the convenience afforded by the present method, for comparing the climates of different countries, I subjoin the values of A, a, and e, for Edinburgh and Pictou, (Nova Scotia), the former derived from the monthly means of the late Mr Adie's observations, embracing a period of 40 years, for which I am indebted to a paper by Principal Forbes, as epitomised in the "Edinburgh New Philosophical Journal;" the latter from 11 years' observations by Mr Henry Poole, manager of the Albion Mines.

The monthly means themselves are :—

For Edinburgh.

36·69 37·99 40·61 44·83 50·27 55·66 58·27 57·44
53·73 47·47 41·21 38·60.

For Pictou.

19·85 19·90 27·41 37·38 48·58 58·14 66·10 65·19
56·05 46·28 35·59 24·47.

From which are derived the following values of mean temperature, amplitude, and epoch, or A, a, and e :—

	A.	a.	e.
Edinburgh, . .	46·9	10·8	83° 27′
Pictou, N. S., . .	42·1	23·0	78° 13′

Hence, cleared of technicalities, the relation between the two climates may be expressed by saying, that Pictou is on the average of the year about 5° colder than Edinburgh, that its range is rather more than double, and that its seasons are, on the average, 5 days later. No such definite information is obtained by inspecting the monthly means.

At Isle Jesus, nine miles from Montreal, the values of A, a, and e are about 40·9, 29·4, and 85° 56′. The range at this place is therefore nearly three times as great as at Edinburgh, and the phases of temperature are two or three days earlier.

With a view to satisfy myself of the accuracy of results obtained by the present method, I have examined two points which seemed open to suspicion.

I. If, in the process for finding the coefficients, we had commenced with some other month instead of January (*e. g.*, if we had written the temperatures of the months February to July in the 1st column, and those of August to January in the 2d), would the results have been affected by the change ?

I have made the trial in the case of the Edinburgh and Pictou temperatures above given, and have obtained the following results :—

			a.	*e.*
For Edinburgh,	commencing with	Dec.	10·79	53° 29′
"	"	Jan.	10·78	83° 27′
"	"	Feb.	10·78	113° 28′
For Pictou,	"	Dec.	23·07	48° 13′
"	"	Jan.	23·06	78° 13′
"	"	Feb.	23·05	108° 13′

The successive differences in the value of *e* ought to be precisely 30°, since a month corresponds to 30°; and this condition is exactly fulfilled for Pictou, while for Edinburgh the greatest discrepancy amounts to only 2′, or about a thirtieth part of a day, a difference which may be neglected in comparing the phases of annual temperature. The differences of the values found for *a* are also very small, not exceeding 0·02. These results may therefore be pronounced sufficiently coincident. If we had commenced with any other month, the arithmetical process would have been throughout the same as in one of the above three cases.

II. What is the amount of error produced by assuming the calendar months to be all of equal length ?

In order to test this point, I found from Principal Forbes' table of Edinburgh daily temperatures the mean temperatures of January, February, and March—

1*st*, When the last two days of January and first two days of March are reckoned part of February, giving February 33 days, and leaving January and March only 29 days each.

2*d*, When the last three days of February are reckoned part of March, so that January will have 31 days, February 26, and March 34.

3*d*, When the last day of January and first of March are reckoned part of February, so that January will have 30 days, February 31, and March 30 ; the resulting values of A, *a*, and *e*, are as under—

				A.	*a.*	*e.*
Jan. 29	Feb. 33	March 29	gives	46·91	10·87	83° 37′
„ 31	„ 26	„ 34	„	46·88	10·81	83° 19′
„ 30	„ 31	„ 30	„	46·90	10·78	83° 33′
Calendar months give		.	.	46·90	10·78	83° 27′

Hence, I think we may conclude that the probable error produced by using the calendar months as twelfth parts of a year is about a tenth of a day in phase, and about a hundredth of a degree in amplitude. These differences are rather greater than those which were detailed in last paragraph; but they are not peculiar to the present method, and will generally tend to destroy one another in making comparisons.

Apart from this small source of error, the conclusions deduced from monthly means are as accurate as those from daily means. Practically they will be found more accurate, because the comparative steadiness of monthly means renders their treatment more easy and certain.

Supposing the operations to be correctly performed, the value of e will be the same from daily means as from monthly, and that of a will be greater in the constant ratio of 1·0115 to 1, as I have ascertained by a mathematical investigation.*

The labour of computation involved in the present method is so small, that when the monthly means have been written down, the values of a and e can be found in 10 minutes.

It is not necessary that I should show in detail the advantages which meteorology may be expected to derive from the extensive application of the method of reduction here proposed. The superiority of definite measures to mere general estimates is universally recognised by those who have to deal with statistics; and yet no such measure has been usually, if at all, applied to the important element "date of phase;" and the measures which are usually applied to determine range are subject to an error which affects different places very unequally. Some such method as the present is therefore demanded by the requirements of science.†

* [Professor Everett seems not to have seen Principal Forbes' paper in which a similar correction is made for the annual range.—EDITOR *Edin. New Phil. Journal.*]

† [The "Date of Phase" was calculated by the same method by Kamst and Herschel, and was lately calculated by Principal Forbes for each of the forty

In the physical department of meteorology the determination of "date of phase" will furnish a measure of the precise amount of retardation which is caused by the sea, as well as by different kinds of soil. It is obvious that the interchange of heat between the soil and the air must have a tendency to retard the phases of temperature in the latter, since the soil is more slowly heated and more slowly cooled than the air above it; but I am not aware that comparison has ever been made between the retardations produced by different qualities of soil.

Or again, if it be required to determine whether the changes of temperature in the sea precede or follow those of the air (a question which was recently discussed with regard to the sea on the coasts of Scotland), the present method will afford an easy solution of the question.

The laws which connect date of phase with extent of range also offer an interesting field of investigation. Generally speaking, the causes which retard the former diminish the latter.

In the application of meteorology to agriculture, date of phase cannot, without serious error, be overlooked. The earliness of crops at one place, as compared with another, must necessarily depend upon this element as well as upon mean temperature and range, and it will be interesting to ascertain how much of the effect is due to each of these causes.

I will not further enlarge upon the importance of the elements determined, as the design of the present paper is rather to show how the determination may be affected than to speculate as to its ulterior uses.

Concluding Note.

The following theorem, which comprehends several of those above enunciated, will possess an interest for the mathematical reader. Let the expression for the mean temperature of the $\frac{1}{M}$th part of a year be—

$$Y = A_0 + A_1 \sin(x + E_1) + A_2 \sin(2x + E_2) + \ldots + A^n \sin(nx + E_n)$$

years of Adie's Observations, as given in the "Transactions of the Royal Society of Edinburgh."—EDITOR *Edin. New Phil. Journal.*]

where x is the time for the centre of the part; and let the corresponding expression for the $\frac{1}{m}$th part of a year be—

$$y = a_0 + a_1 \sin(x + e_1) + a_2 \sin(2x + e_2) + \ldots + a^n \sin(nx + e_n)$$

then the following relations will exist:—

$$A_0 = a_0,\ E_1 = e_1,\ E_2 = e_2,\ \ldots\ E_n = e_n.$$

$$A_1 : a_1 :: M \sin\frac{\pi}{M} : m \sin\frac{\pi}{m},\ A_2 : a_2 :: M \sin\frac{2\pi}{M} : m \sin\frac{2\pi}{m}.$$

$$A_n : a_n :: M \sin\frac{n\pi}{M} : m \sin\frac{n\pi}{m}.$$

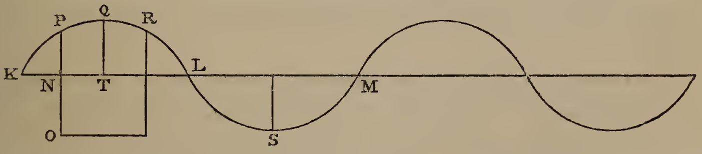
If $M = 2$, the coefficients $A_2\ A_4\ A_6$, &c. vanish (since $\sin\pi = \sin 2\pi = \sin 3\pi = \ldots = 0$). Hence the mean temperature of a half year is independent of the terms which involve these coefficients.

If M is infinite, we have $A_n : a_n :: n\pi : m \sin\frac{n\pi}{m}$, which is the relation between instantaneous and mean temperatures.

Demonstration of Theorems stated in Paper on Reduction of Observations of Temperature. By Professor J. D. Everett.

Definition.—A simple harmonic curve is one which is capable of being expressed by the equation $y = a. \sin x$, where a is a constant. The general equation of such a curve referred to any origin, but without changing the directions of the axes, is

$$y = a_0 + a_1 \sin(x + e_1).$$



The form of the curve will be as here represented, and the curve will extend indefinitely in both directions, continually repeating itself. The portion KQLSM of the curve contains an entire period, during which the quantity $x + e_1$ goes through all values from 0 to 2π, so that sin $(x + e_1)$ goes through all values which a sine can possibly have.

Our unit of length must be taken, such that the straight line KM = 2π, where π is 3·14159, &c.

Then if O be the origin of co-ordinates, ON is a_0 and KN is e_1. The maximum ordinate QT is a_1, and corresponds to that value of x which makes $x + e_1 = \frac{\pi}{2}$.

When the annual curve of temperature is compared with a simple harmonic curve, 2π must be taken to represent the length of the year, and the portion KQLSM of the curve will represent one year's temperature, the point K corresponding to the vernal mean, Q to the summer maximum, L to the autumnal mean, S to the winter minimum, and M to the vernal mean again. (By vernal and autumnal mean are here meant the days whose mean temperature is the same as that of the year.)

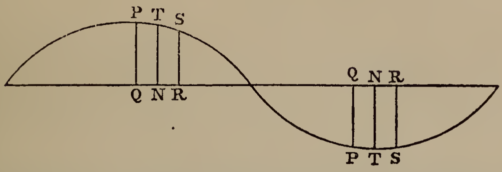
Definition 2.—By a harmonic series is meant a series of the form $a_0 + a_1 \sin(x + e_1) + a_2 \sin(2x + e_2) + a_3$ (sin $3x + e_3$) + &c. The quantity $2x + e_1$ goes through all values between 0 and 2π, *while* x goes through all values from 0 to π; and since π represents half a year, the term $a_2 \sin(2x + e_2)$ will go through its cycle of values in that period. It is therefore called the half-yearly term.

The term $a_3 \sin(3x + e_3)$ is the third-yearly term, and goes through its cycle of values in one-third of a year; and so on for the other terms.

The constants a_1 a_2 a_3, &c., are called the amplitudes of the respective terms, and the constants e_1, e_2, e_3, &c., the epochs. A little reflection will show that if the epoch of a term receive a small increase, the term will take its maximum just so much earlier.

Theorem I.—If a simple harmonic curve be represented by the equation $y = a \sin x$, the area intercepted between two ordinates, whose mutual distance is given, varies directly as the length of the ordinate drawn midway between them. (In the annexed figure, the area PQRS varies directly as TN. Areas below the axis of x must be considered negative).

Proof—Let the abscissa of N be $\bar{x}$, and let the given distance between the ordinates be $2c$, then the abscissæ of Q and R will be $\bar{x} - c$ and $\bar{x} + c$.



The area PQRS is the integral of ydx between the limits $x - c$ and $\bar{x} + c$

$$= a \cos \left\{ (\bar{x} - c) - \cos (\bar{x} + c) \right\} = 2a \sin \bar{x} \sin c = 2 \sin c \,.\, \bar{y}$$

if $\bar{y}$ be the middle ordinate.

Hence the area varies directly as $\bar{y}$.—*Q. E. D.*

Theorem II.—If the equation to the annual curve of temperature be $y = a \sin x$, the mean temperature of any $\frac{1}{m}$th part of a year varies directly as the temperature of its middle day. The value of m may be either integral or fractional.

Proof.—Let QR in last figure represent the $\frac{1}{m}$th part of a year, then we have $2c = \text{QR} = \frac{2\pi}{m} \therefore c = \frac{\pi}{m}$.

The mean temperature of the period represented by QR is the mean height of the figure PQRS; in other words, is the quotient of the area PQRS by the breadth QR.

But $$2 \sin c \,.\, \bar{y} \div 2c = \frac{\sin c}{c} \cdot \bar{y} = \frac{\sin \frac{\pi}{m}}{\frac{\pi}{m}} \cdot \bar{y}$$

Hence the mean temperature of any $\frac{1}{m}$th of a year is to the temperature of its middle day as $\sin \frac{\pi}{m} : \frac{\pi}{m}$

If $m = 12$, this ratio becomes $1 : 1{\cdot}0115$.

It obviously follows by transformation of co-ordinates, that if the equation to the annual curve be

$$y = a_0 + a_1 \sin (x + e_1),$$

the mean temperature of any $\frac{1}{m}$th part of a year is

$$a_0 + a_1 \frac{\sin \frac{\pi}{m}}{\frac{\pi}{m}} . \sin (x + e_1)$$

Hence the amount by which the mean temperature of any $\frac{1}{m}$th part of a year differs from that of the whole year, is always less than the amount by which the temperature of its middle day differs from the mean temperature of the year, in the ratio of $\sin \frac{\pi}{m} : \frac{\pi}{m}$.

This proves the second note of my paper.

Next, let the equation to the annual curve of temperature be

$$y = a_0 + a_1 \sin (x + e_1) + a_2 \sin (2x + e_2)$$

The mean temperature of any $\frac{1}{m}$ th part of a year will be, as in the previous case, the integral of ydx from $\bar{x} - c$ to $\bar{x} + c$, where $c = \frac{\pi}{m}$.

$$ydx = a_0 \, dx + a_1 \sin (x + e_1) \, dx + a_2 \sin (2x + e_2) \, dx.$$

$$\int ydx = a_0 x - a_1 \cos (x + e_1) - \tfrac{1}{2} a_2 \cos (2x + e_2),$$

which between the limits is

$$a_0 \left\{ (\bar{x} + c) - (\bar{x} - c) \right\} - a_1 \left\{ \cos (\bar{x} + c + e_1) - \cos (\bar{x} - c + e_1) \right\}$$
$$- \tfrac{1}{2} a_2 \left\{ \cos (2x + 2c + e_2) - \cos (2x - 2c + e_2) \right\}$$
$$= 2a_0 c + 2a_1 \sin (\bar{x} + e_1) \sin c + a_2 \sin (2\bar{x} + e_2) \sin 2c.$$

The mean temperature is the quotient of this by $2c$, which is

$$a_0 + a_1 \frac{\sin c}{c} \sin (\bar{x} + e_1) + a_2 . \frac{\sin 2c}{2c} \sin (2\bar{x} + e_2);$$

or substituting for c its value $\frac{\pi}{m}$

$$= a_0 + a_1 \frac{\sin \frac{\pi}{m}}{\frac{\pi}{m}} \sin (\bar{x} + e_1) + a_2 . \frac{\sin \frac{2\pi}{m}}{\frac{2\pi}{m}} \sin (2\bar{x} + e_2).$$

If $m = 2$, we have for the mean temperature of the half-year whose centre is x, the expression

$$a_0 + a_1 \frac{\sin \frac{\pi}{2}}{\frac{\pi}{2}} \sin (x + e_1) + a_2 \frac{\sin \pi}{\pi} \sin (2x + e_2)$$

$$= a_0 + \frac{2}{\pi} a_1 \sin (x + e_1)$$

since $\sin \frac{\pi}{2} = 1$ and $\sin \pi = 0$.

Hence the mean temperature of a half year is independent of a_2 and e_2, and is completely determined by finding a_0, a_1, and e_1.

In the expression $a_0 + \frac{2}{\pi} a_1 \sin (x + e_1)$,

the coefficient $\frac{2}{\pi} a_1$ is the difference between the mean temperature of the warmest or coldest half-year and the mean of the year; hence its double, or $\frac{4}{\pi} a_1$, is the difference between the mean temperatures of the warmest and the coldest half-year.

Since the amplitude for monthly means is less than a_1 in the ratio of $\sin \frac{\pi}{12} : \frac{\pi}{12}$, it follows that the difference between the warmest and coldest half-year will be obtained by multiplying this amplitude by $\frac{4}{\pi} \frac{\frac{\pi}{12}}{\sin \frac{\pi}{12}}$, or $\frac{1}{3} \operatorname{cosec} \frac{\pi}{12}$, which is 1·2879, as stated in my paper.

To prove the concluding note.

Let the expression for the temperature at time x be

$\alpha_0 + \alpha_1 \sin (x + \varepsilon_1) + \alpha_2 \sin (2x + \varepsilon_2) + \ldots + \alpha_n \sin (nx + \varepsilon_n)$.

It may be proved in the same manner as before, that if y and Y denote the mean temperatures respectively of the $\frac{1}{m}$th and the $\frac{1}{M}$th parts of a year, x being the centre of the parts,

then $$y = \alpha_0 + \alpha_1 \frac{\sin \frac{\pi}{m}}{\frac{\pi}{m}} \sin (x + \varepsilon_1) + \alpha_2 \frac{\sin \frac{2\pi}{m}}{\frac{2\pi}{m}} \sin (2x + \varepsilon_2)$$

$$+ \dots + \alpha_n \frac{\sin \frac{n\pi}{m}}{\frac{n\pi}{m}} \sin (nx + \epsilon_n)$$

and
$$Y = \alpha_0 + \alpha_1 \frac{\sin \frac{\pi}{M}}{\frac{\pi}{M}} \sin (x + \epsilon_1) + \alpha_2 \frac{\sin \frac{2\pi}{M}}{\frac{2\pi}{M}} \sin (2x + \epsilon_2)$$
$$+ \dots + \alpha_n \frac{\sin \frac{n\pi}{M}}{\frac{n\pi}{M}} \sin (nx + \epsilon_n)$$

Comparing these with the expressions contained in the note, viz.—

$$y = a_0 + a_1 \sin (x + e_1) + a_2 \sin (2x + e_2) + \dots + a_n \sin (nx + e_n),$$
$$Y = A_0 + A_1 \sin (x + E_1) + A_2 \sin (2x + E_2) + \dots + A_n \sin (nx + E_n),$$

we see that

$$A_1 : a_1 :: \frac{\sin \frac{\pi}{M}}{\frac{\pi}{M}} : \frac{\sin \frac{\pi}{m}}{\frac{\pi}{m}} :: M \sin \frac{\pi}{M} : m \sin \frac{\pi}{m}$$

$$A_2 : a_2 :: \frac{\sin \frac{2\pi}{M}}{\frac{2\pi}{M}} : \frac{\sin \frac{2\pi}{m}}{\frac{2\pi}{m}} :: M \sin \frac{2\pi}{M} : m \sin \frac{2\pi}{m}$$

$$A_n : a_n :: \frac{\sin \frac{n\pi}{M}}{\frac{n\pi}{M}} : \frac{\sin \frac{n\pi}{m}}{\frac{n\pi}{m}} :: M \sin \frac{n\pi}{M} : m \sin \frac{n\pi}{m}$$

also that $a_0 = \alpha_0 = A_0$, $e_1 = \epsilon_1 = E_1$, $e_n = \epsilon_n = E_n$.

Q. E. D.

On Certain Species of Permian Shells said to occur in Carboniferous Rocks. By Professor WILLIAM KING (Queen's College, Galway), Queen's University in Ireland.

In the "Geologist" (vol. iii. p. 19, Jan. 1860), Mr Thomas Davidson has appended a foot-note to a paper of his "On Scottish Carboniferous Brachiopoda," in which he affirms the probability that the Carboniferous fauna included the following Permian species,—*Dielasma sufflata*, *Martinia Clannyana*, *Spiriferina cristata*, *Camarophoria Schlotheimi*, *C. globulina*, and *Lingula Credneri*.

Shortly after the appearance of Mr Davidson's paper, a communication from Mr J. W. Kirkby was read before the London Geological Society,* "On the Occurrence of *Lingula Credneri*, Geinitz, in the Coal-Measures of Durham; and on the claim of the Permian Rocks to be entitled a System." In this paper, the following species are added to the number given by Mr Davidson,—*Cythere elongata*, *C. ornata*, *Bairdia gracilis*, and *Gyracanthus formosus*. With regard to most of these—the Entomostraca—Mr Kirkby, however, does not refer to them with much confidence, as "their determinations are certainly not so conclusive as those of the Brachiopoda" named. In the same paper, Mr Kirkby states,—"Through the critical and most elaborate researches of Mr Thomas Davidson, several of the Permian Brachiopoda have been proved to be recurrents from the Carboniferous fauna. Some of these had long been suspected by other palæontologists to be very closely related to, if not identical with, Carboniferous species." My share in this work is noticed in a foot-note, appended to the last passage, by a reference to the "remarks" on one species, viz. *Dielasma sufflata*, in my "Monograph of the Permian Fossils of England," p. 150, and in the "Introduction," p. xxv., to it; but it will be seen, by the following observations on the so-called "recurrents," that I have done a little more than might be concluded from simply reading the passage and reference above quoted.

* *Vide* "Quarterly Journal of the Geological Society," vol. vi. part i. p. 412, &c.

Dielasma sufflata—*Terebratulites sufflatus*,* Schlotheim.

In my Monograph (1850), it is stated that this species "appears to be identical with a shell found in the mountain-limestone of Bolland, probably hitherto considered a variety of *D. sacculus*—a distinct, though closely allied species. The latter differs from the former principally in having the front decidedly emarginate; both appear to graduate into each other" (p. 150). Referring to this same species in the Introduction to the work cited, I state that it "undoubtedly lived in the Carboniferous epoch" (p. xxi.); and in my "Notes on Permian Fossils—*Palliobranchiata*" (*Annals of Natural History*, April, 1856), the following remarks occur:—"I have been led to re-examine the 'shell found in the mountain-limestone of Bolland,' and I cannot but say that it agrees most remarkably with some specimens of the Permian species, particularly the testiferous one represented under figure 7, plate vii. of my 'Monograph.' On the other hand, there are specimens figured on the same plate closely approximating to true forms of *D. sacculus* in its mesial depression and emarginate front. The only difference I perceive between the Bolland shell alluded to, and the Permian fossil quoted, is, that on the former there are faint traces of a few longitudinal lines on the anterior half of the valves. I perceive nothing of the kind on any of the Permian forms, nor do I recognise any on normal specimens of *D. sacculus*. There appears to be no difference between them in their histological perforations."

On referring to Mr Davidson's remarks on *Dielasma sufflata* in his "Monograph of British Permian Brachiopoda," which contains all his published observations on the subject, I do not find anything more than the above passages (which he has fully acknowledged by reproducing them) calculated to prove that the Permian species is identical with the Carboniferous *D. sacculus*. Nay, it would appear that he considers

* The allied Permian species, *Terebratulites elongatus*, Schlotheim, forms the type of the genus *Dielasma*, so named at first in my "Historical Account of the Invertebrata occurring in the Permian Rocks of the North of England."—Effingham Wilson, 1859; and afterwards described in a paper which was read before the Dublin University Zoological and Botanical Association.—*Vide* "Natural History Review," vol. i.

the former to be merely a variety of another Permian species (*D. elongata*) not yet admitted by him to belong to the Carboniferous fauna, it being in his opinion "certainly specifically distinct" from *D. hastata*—a carboniferous species. Mr Davidson divides *Dielasma elongata* into two varieties, viz., *genuina* and *sufflata*, the latter being the species under consideration.

Martinia Clannyana, King.

Regarding this species, I have stated that it "closely resembles the Devonian *Atrypa unguicula* of J. de C. Sowerby, as figured by Professor Phillips in his 'Palæozoic Fossils of Cornwall' (pl. xxxvii., p. 19)"—a species, the identity of which with *Martinia Urei* Mr Davidson considers as "highly probable (if not perfectly certain)" (vide "Scottish Carb. Brach.," *Geologist*, vol. iii. p. 19). While preparing his "Monograph of British Permian Brachiopoda," Mr Davidson took some trouble in working out the relation of the last-named shell to the Permian species, and he then observed —"I am still uncertain whether it is in reality distinct, or simply a variety or race slightly modified by time" (p. 16). In a later publication, the one referred to in the "Geologist," he expresses himself more decidedly in favour of their identity; but I do not find that he has adduced any further evidence to support the view he has taken: on the contrary, I think if any point is proved, it is that *Martinia Clannyana* and *M. Urei* are quite distinct.

Mr Davidson, wishing to have my opinion as to the relationship of the two species, sent me several specimens of *M. Urei* from Carluke, for comparison with *M. Clannyana* from near Sunderland. I replied to him as follows:—"*Urei* and *Clannyana* are, I am decidedly of opinion, distinct species, though apparently closely allied to each other. *Urei* differs from *Clannyana* in being a wider shell; it has the umbone more incurved; the area of the small valve not so deep; the small valve flatter, and more excavated, as it were, towards the posterio-lateral angles; the spines decidedly less numerous; and the median sulcus more pronounced in both valves." The above, with a slight oversight, is inserted in Mr Davidson's "Monograph." My opinions on these two species are unchanged; so I cannot admit that either one or the other was common to both the Carboniferous and Permian periods.

Spiriferina cristata, Schlotheim.

It is stated in my "Monograph," p. 128, that this fossil "closely resembles one or more so-called species found in the Carboniferous and other formations, particularly the *Sp. octoplicata* of J. Sowerby. Having examined in Mr J. de C. Sowerby's collection the originals (from Derbyshire) of the figures in the 'Mineral Conchology,' the only difference I could perceive is, that they are wider than any examples which have occurred to me of the present species. Specimens bearing the name of *Spirifera insculpta*, in the Gilbertsonian collection of the British Museum, appear to be undistinguishable from *Sp. cristata.* The Jurassic fossil which Zeiten has identified with the *Sp. octoplicata* is another closely analogous species." I have also stated in the Introduction, p. xxi., that "*Sp. cristata* is closely related to, if not identical with, the Carboniferous *Sp. octoplicata.*" Mr Davidson, speaking of "a remarkable and unusually large individual obtained at Tunstall Hill by Mr Kirkby," observes,—"So closely did this specimen resemble some of Mr Sowerby's typical examples of the Carboniferous *Sp. octoplicata*, that it is very probable, if not entirely certain, that *Sp. cristata* is at most but a variety or race, slightly modified by time and circumstances, of the Carboniferous species. In the Permian period it was, however, in general a smaller shell, the number of ribs likewise frequently less numerous" (vide *Mon. Brit. Perm. Brach.*, p. 18). And on a later occasion, describing *Sp. octoplicata*, he says, "I am also still inclined to maintain the opinion expressed in my 'Monograph,' namely, that the shell under description bears so close a resemblance to the Permian *Sp. cristata* of Schlotheim that it cannot be specifically separated, and could not in any case claim more than a varietal distinction" (*vide Geologist*, vol. iii. p. 21, Jan. 1860). Mr. Davidson, it will be seen, has advanced no more evidence than myself to prove that these Carboniferous and Permian fossils are specifically identical.

Camarophoria Schlotheimi, Von Buch.

This species, I have remarked, "closely resembles the *C. crumena* of Martin, which appears only to differ from the former in being narrower and more acuminated behind. Occasionally, however, a variety of the present species occurs which can scarcely be distinguished from *C. crumena;* in short, both species apparently merge into each other so completely that many would be inclined to consider them as specifically inseparable. The Lamarckian might very reasonably instance them as proving proximate species to be modifications of each other; while, at the same time, his opponent might with equal reason contend for their being the result of a single specific creation. There is another species, undescribed, occurring in the Carboniferous limestone of Weardale, Durham, and having a still closer resemblance to *C. Schlotheimi* in form; but its spatula-shaped process is decidedly more curved—so much so, that its termination is not far removed from the anterior end of the arch of the large valve." And in a foot-note appended to the above, it is stated,—"The Gilbertsonian collection in the British Museum contains a card labelled *Terebratula plicatella*, Dalman, and mounting nine specimens with from three to five ribs in the sinus. No locality is given: they are undoubtedly Carboniferous. My note states that they are identical with *C. Schlotheimi;* but I now suspect them to be the same species as the one noticed in the text, found in Weardale, Durham" (*vide* "Monograph of Permian Fossils of England," pp. 119 and 120). Mr Davidson has not alluded to the relationship between the two species named in his "Monograph of British Permian Brachiopoda;" but I perceive he has united them in his "Scottish Carboniferous Brachiopoda"* under Martin's name *crumena*. Observing in the paper last noticed a reference to an unpublished part of the former work, I wrote to Mr Davidson, requesting him to favour me with a copy of his observations, if printed, on *Camarophoria crumena*. He in the kindest manner sent them to me by return of post. I perceive he has quoted most of the passages just extracted from my "Monograph," and has followed them up by these obser-

* *Vide* Geologist, vol. iii. p. 34, Jan. 1860.

vations,—"With all this evidence before me, I considered it necessary to ascertain what was really the *Anomites crumena* of Martin, and whether the Permian *C. Schlotheimi* does really occur in the Carboniferous limestone; and it was not until after much comparison and investigation that I became convinced that not only was the Carboniferous specimens alluded to by Professor King* and others specifically identical with the Permian Camarophoria, but that it was impossible to distinguish the last from *A. crumena* of Martin" (p. 114).

There is very little difference between Mr Davidson and myself. I have no doubt, considering the "nine specimens" I observed in the "Gilbertsonian Collection of the British Museum," that *C. Schlotheimi* occurs as a Carboniferous species. Besides, I find a confirmation of this belief in the following memorandum written in an interleaved copy of my Monograph,—"I observed some specimens of *C. Schlotheimi*, mounted on a tablet in the Collection of the Museum of Practical Geology, which were found in the mountain limestone of Dovedale in Derbyshire. Mr Salter named them as above at my suggestion. August 1851." But I do not agree with Mr Davidson in his conclusion that *Anomites crumena* is the same species.

In stating that *A. crumena* differs from *C. Schlotheimi* "in being narrower and more acuminated behind," I was guided by Martin's figure of the former species, and by the fossil represented under fig. 3, plate lxxxiii. of the "Mineral Conchology," and identified by Sowerby with the same species. As stated in a foot-note in page 119 of my "Monograph," it was in the autumn of 1848, while looking over the type specimens figured in the "Mineral Conchology," that I observed Martin's fossil to be a Camarophoria.† I was informed that it "originally belonged to Mr Martin." This circumstance, and the close resemblance of the specimen to the figure in the "Petrifacta Derbiensia" (pl. xxxv. fig. 4), led me to express

* Mr Davidson appears to have overlooked the Weardale species. I purpose describing it on another occasion.

† "The other specimens represented in the 'Mineral Conchology,' plate lxxxiii., figs. 2, 2*, belong to a very different species, and evidently to the genus Rhynchonella." This is stated in the foot-note referred to.

"little doubt" of its "being the original of the figure just cited." Possibly I am wrong on the last point, as I find that Mr Davidson does not believe Martin's original specimen could have been made use of by Sowerby for fig. 3, plate lxxxiii. of the "Mineral Conchology" (Brit. Carb. Brachiop., pp. 113 and 114).

The question next arises,—Is the original of Martin's *Anomites crumena* a Camarophoria or a Rhynchonella?* Mr Davidson evidently believes that it is a species of the former genus; but, unfortunately, mere belief does not settle the point, since immature, and occasionally mature, specimens of some Carboniferous Rhynchonellas have so close a resemblance to the external form of a Camarophoria, that they might readily be mistaken for one. But admitting that Martin's figure represents a Camarophoria, I certainly now feel considerable hesitation in believing it to represent *C. Schlotheimi;* for whether we examine specimens of the latter species from the Magnesian limestones of Durham, or the Zechsteins of Germany, they will be found to agree, allowing varietal exceptions, in being wider, much shorter posteriorly, and in having more sharply angulated ribs than the shell delineated, evidently with much care, by Martin.† I need only refer to the figures of *C. Schlotheimi* in my "Monograph" (plate vii. figs. 10–21), and to those in Mr Davidson's (Brit. Perm. Brachiop., plate xi., figs. 17–22), as well as to the one by Martin (Pet. Derb., plate xxxvi., fig. 4), to bear out the differences just pointed out.

As regards the specimen which I examined in Mr Sowerby's collection, although I am disposed to give it up as being the original of Martin's figure, I cannot think of relinquishing it as a Camarophoria.‡ Further, I am strongly inclined to believe that it too is distinct from *C. Schlotheimi*, from the following consideration:—I examined the "nine specimens" of Carboniferous *C. Schlotheimi*, in the Gilbertsonian Collection within a day or so of my seeing Mr Sowerby's specimen.

* I have no doubt of the original of fig. 3, plate lxxxiii., "Mineral Conchology," being, as stated in my "Monograph," a true Camarophoria.

† I am indebted to Mr Davidson for a careful tracing of Martin's figure.

‡ I am sorry to learn, through Mr Davidson, that Mr Sowerby's specimen appears to have got mislaid.

It therefore appears to be extremely improbable that I was able to perceive an identity in the former case and none in the latter. It must not be supposed that at that time I was unacquainted with all the varietal forms assumed by the Permian species.

I have gone somewhat into detail on the subject of Martin's *Anomites crumena*, to show that there are strong reasons against admitting it to be the same as *Camarophoria Schlotheimi*. Indeed, all circumstances considered, it appears to me that Martin's shell will have to be put down as an apocryphal species. All that can be said with any safety is, that *C. Schlotheimi* existed both in the Permian and the Carboniferous period.

Camarophoria globulina, Phillips.

Very little is stated in my "Monograph" on the relation of this species to any Carboniferous shell, except that it "has a close resemblance" to "the *Spirifer nucleolus* of Kutorga, found in the mountain limestone of Sterlimatak." Mr Davidson, having far more materials to work on than I had, expresses himself as follows in his "British Carboniferous Brachiopoda:" —"After a lengthened comparison of numerous specimens of Phillips' *Terebratula rhomboidea* and *T. semiluna*, it appeared to me evident that the last was nothing more than a young age of the first, and that neither could be distinguished from the *Camarophoria globulina* of Phillips. The resemblance was indeed so great, that having mixed several specimens of each it was with some difficulty that they could be afterwards separated" (p. 116).

I cannot but express my agreement with Mr Davidson in this case,—of course with some reservation, founded on considerations elsewhere stated in this paper. At the time my remarks on this species were written, I had not an opportunity of consulting Phillips' figures of *C. rhomboidea* in his "Geology of Yorkshire:" besides, looking at the figures (the only ones I was then able to consult) in his "Palæozoic Fossils" of a shell therein identified with this species (Pl. xxxv. fig. 158, *a b*), it will readily be explained how it happened that I had not arrived at the same conclusion as Mr Davidson. The figures last referred to seem to represent a fossil having some resemblance to the ribless varieties of *C. Schlotheimi.*

Lingula Credneri, Geinitz.

All the merit in connection with the Carboniferous age of this species is due to Mr Kirkby; and I am ready to admit that the specimens which he has found in the coal-measures "at the Ryhope winning, near Sunderland," belong to it.* I may be allowed, however, to retain some slight reservation, as it is well known that many species of Lingula, from widely separated formations, are with difficulty distinguished from each other.

It would be a waste of time to go further into a discussion on the Permian species referred to in the previous pages, because it is clear Mr Davidson and myself are not in agreement on first principles. His groups are more comprehensive than mine. Many groups, which I consider to be equal to genera or species, are regarded by Mr Davidson as mere sub-genera or sub-species. I have elsewhere stated my objections with reference to the latter view on genera;† I may now be permitted to make a few observations in the same sense with regard to species.

(To be continued.)

* When mentioning the localities of this species in my "Monograph," I added the following:—"Professor Johnston informs me" (I received the information from him first verbally and afterwards by letter) "that he has procured specimens of a Lingula in the underlying freestone (Rothe-todte-liegende) near Ferry Hill" (p. 84). Every one acquainted with the high scientific reputation of the author named, on reading the following remarks by Mr R. Howse, must have felt at least surprised. "I may be allowed to question the occurrence of this or any other species of Lingula in the underlying red sandstone, as stated in King's 'Monograph' on the authority of Professor Johnston, as this sandstone is a true coal-measure stratum" (*An. Nat. Hist.*, 2d Series, vol. xix. p. 44). They will be gratified to learn, however, that not only may "this or any other species of Lingula" occur, as stated in the "Monograph," but that specimens, identified by Mr Kirkby with *Lingula Credneri*, have actually been found by him in a "true coal-measure stratum," occurring at a depth of 951 feet below the surface! (Vide *Quart. Jour. Geol. Soc.*, vol. vi. Part I. pp. 412, 413.)

† *Vide* my Paper in "Nat. Hist. Review," vol. i.

Notes on Ancient Glaciers made during a brief Visit to Chamouni and neighbourhood, in September 1860. By DAVID MILNE-HOME, Esq. of Wedderburn.

1.—*Valley of Chamouni.*

1. On reaching Inn of Montanvert, situated on left side of Mer de Glace, and about 240 feet above it, first thing noticed, was accumulation of granite blocks, about 100 to 150 feet higher up hill, resting on schistose rocks. That these blocks transported thither and deposited without violence, evident from their position on slope of hill.

2. Whilst descending to glacier, observed the rocks on both sides of valley smoothed and scratched, at a height of about 250 to 300 feet above glacier. The scratches mostly horizontal, but some inclined downwards towards north.

3. On reaching glacier and crossing it to the Chapeau, saw old lateral moraines on each side. Examined more particularly those on the right bank. There found two very distinct, evidently formed at different periods. They were both more or less covered with vegetation; the largest, next the valley side, more so than the other. The former was about 120 feet above level of glacier, the other about 90 feet—both evidently composed of blocks of stone, none very large, and most of them pretty well rounded. There was an entire absence of stratification or arrangement according to size.

The relative position of the phenomena described in foregoing paragraphs shown by sketch in fig. 1.

Was at first rather at a loss to explain how these lateral moraines formed. That they were formed by glacier when its level much higher than at present, had no doubt. The conclusion I came to was, that the materials consisted of debris from the mountains forming the sides of the valley, brought down by streams, and rains, and frost. These accumulate between the steep sides of the valley and glacier. At place inspected by me, this interval is in breadth from 200 to 350 yards. If the glacier were to rise and swell by increased cold beyond usual limits, its sides would press against these debris and raise them into the form of an embankment similar to what now presented.

Fig. 1.

The two lateral moraines in question would of course represent two periods when the glacier had swelled laterally beyond usual limits.

4. Proceeded to near foot of glacier on east side, where a face of hard rock, almost perpendicular, and quite smooth, for about 80 feet in height and 60 or 70 in length. The ice of glacier is seen pressing against lower part of this rocky face. Walked on the ice where it was in contact with rock, and also looked under glacier at several places where it was resting on the rocks forming the bottom of valley.

Multitudes of hard blocks of stone between the ice and rocks, both at side and at bottom; had no doubt that the smoothing of the perpendicular wall, though about 80 feet of it now exempt from glacier action, produced by glacier rubbing and pressing on rocks as it flowed northwards.

Noticed several natural joints or cutters in this rocky face, alongwhich, as usual in such cases, portions of rock broken off, and which had originally formed little projections. In most instances these projections had been all smoothed down, so as to bring both sides of joint to one uniform surface. In some cases the projections remained, but only where these looked northwards, and had thus escaped the grinding action of the glacier.

Took notice also of the innumerable scratches and ruts which are over the whole face of rock; the most distinct being those low down near glacier. Had not least doubt that these formed by sharp-pointed hard stones pressed on rock by glacier.

These scratches not always parallel; but all were more or less inclined, some as much as 11° and 12° to horizon, and running N.W. by compass, corresponding with the movement of glacier at this point of valley.

In some parts of smooth face of the rock there were depressions or cavities, apparently natural to the rock, from 2 to 3 inches diameter, and half inch deep. The inner surface of these cavities rough. My attention directed to this circumstance by Auguste Balmat, the well known guide, to whom I had received an introduction from Principal Forbes. He said that when water the agent which smooths rocks, the inner surface of these shallow cavities smoothed also; when ice the agent, the inner surface rough.

5. Examined the great heap of debris near Les Tignes which has been described by De Saussure, and also by recent travellers, as an ancient moraine of Mer de Glace. Found the height of it by sympiesometer to be from 580 feet at its south end, to 400 feet towards the north, above the adjoining plain to the westward. It had evidently reached across valley to hill called La Flegère, thus blocking up valley. It is now cut through by the turbulent Arve, and thus its internal organisation can be studied. It is composed of primitive rocks, some of the granite blocks being of enormous size.

On Flegère hill, right opposite to the Mer de Glace valley, there is a band of blocks, at a height of from 2500 to 2700 feet above Chamouni, and which, most probably, have been transported by glacier, when it smoothed rocks near the Montanvert, and deposited the blocks there already referred to.

6. The next part of valley examined, about six miles westward, down the course of the Arve, near a village called Les Ouches.

Ascended a hill, opposite to small glacier of Taconnay, which my guide called Chavant. It is reached by a stone bridge over the Arve.

Almost the whole of this hill, which slopes upwards to north, presents smoothed rocks.

These appearances are the most interesting in the small intersecting ravines on the hill side, as the rocky sides of these ravines are smoothed also, especially the west sides looking towards Chamouni. Some of the smoothed rocks face different ways, principally, of course, due south, but occasionally also S.W. and S.E. They slope upwards, principally at an angle of about 15° or 20°, but occasionally they are nearly perpendicular. Nevertheless all are smoothed. In some places, the appearances before described, caused by natural joints of the rocks, occur, the projections, when there are any, uniformly facing north, showing that the glacier, which has moved up the face of this mountain has passed from south. By sympiesometer I made the height of it, above the channel of Arve, which washes its base, about 1030 feet, and about 790 feet above Chamouni. The smoothness of rocks does not reach quite to top, at least not there so striking.

The ruts and scratches on smoothed rocks of themselves form a separate and very interesting study. They begin about 50 or 60 feet above the channel of the Arve; where near the bridge, they run W.N.W. by compass, about half way up hill N.W., and near top N.N.W.

These directions quite intelligible on supposition that a glacier filled the whole valley, and flowed towards north. A sketch in fig. 2 shows that the valley, a little below point referred to, takes a rapid turn towards north; and therefore, as the general mass of the glacier, supposing it to have filled valley, would move towards north, the higher parts of the glacier must have moved more exactly in that direction, as higher parts of the hill would obstruct less than lower parts.

Hence, also, resistance being greatest in the lower parts, the rocks there show the greatest marks of smoothing and reduction.

These appearances, better understood after an examination of the valley on opposite or west side, at a place about two miles below Les Ouches, called Hameau of Le Grange. There

I found an oblong plateau of rock about half a mile long by a few hundred yards wide, flattened and smoothed most singularly. Had been advised by Professor Favre of Geneva to visit this spot, and was amply rewarded.

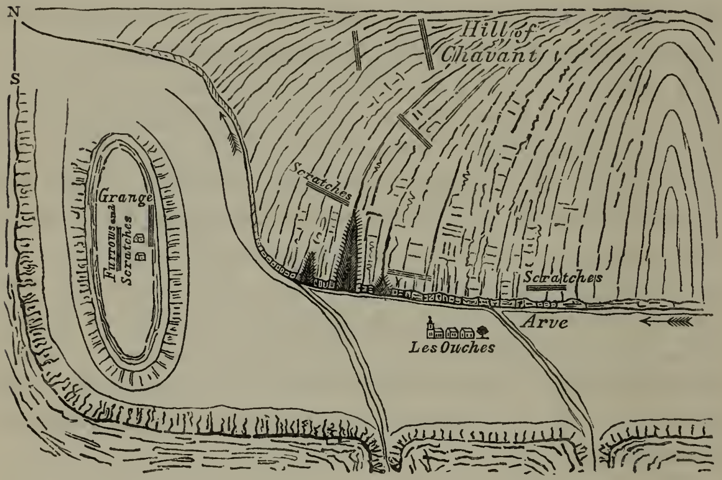


Fig. 2.

The rocks here of soft schist, the strata running vertically about N.E. by compass. In many places they are flattened and smoothed over extensive areas, of which advantage is taken for the erection at these places of cottages—the floors consisting of these smoothed rocks. The rocks, besides being smoothed, are occasionally marked by deep grooves or furrows, and also by sharp ruts or scratches, all parallel, and running N. and S. by compass—intersecting, therefore, the edges of strata. The grooves or furrows extend continuously sometimes 30 or 40 feet—the scratches 6 or 8 feet. Some of former I measured, and found to be 2 or 3 inches deep, and 5 or 6 inches wide.

Noticed particularly that in some places these furrows or grooves interrupted by veins of hard quartz, in the schist rocks. The agent which had ground down the schist had been unable to make any impression on the quartz. At these veins, accordingly, the furrows stopped, and always on south side. On opposite or north side of the veins, not only was furrow not continued, but the general surface of the schist rock not so low—having been protected, as it were, by the quartz veins.

It seemed very plain that these appearances indicated the passage and pressure of ice, and ice of an enormous weight and mass to produce such general smoothing, and also such extensive groovings or furrows; whilst the interruption of these by the quartz veins showed unequivocally that the glacier moved northwards down the valley.

The height of this spot, judging roughly by sympiesometer, was 1300 feet above Chamouni, and therefore 4725 feet above the sea.

On this, the west side of valley, there is an elongated hill, running north and south about 1500 feet higher—the general direction of which is parallel to the furrows and scratches.

It occurred to me, that reason why these deep furrows formed in this locality, and not in any of the other places before mentioned, where rocks found but slightly scratched, was that here the whole weight of glacier was pressing on the rocks; whereas at the hill of Chavant, on opposite side of valley, the weight of glacier on the rocks not so great, in consequence of the slope upwards. When under the Mer de Glace, I observed that the glacier was not one solid mass of ice, but that it consisted of great blocks, very irregular in size and shape; and therefore the glacier would not press on the rocks with equal force at all points. Hence furrows would be formed in different places.

Observed here several of the natural cavities or depressions, to which Balmat had referred, with the inner surfaces quite rough, as if not abraded or touched by the glacier.

7. In this part of valley of Chamouni, erratic blocks of prodigious size abound. On hill of Chavant they reach to top, and in some places rest on smoothed rocks. This is case also on rocky terrace just described on west side of valley. I account for their position by supposing that as the glacier shrunk back over its bed to its present limited dimensions, it left these blocks where we now find them on the smoothed rocks.

Of course, when glacier was passing over and smoothing the rocks, it must have been transporting blocks on its surface, and at a great height above its bed, and depositing these, in its downward course, at convenient spots.

I was unfortunately prevented from continuing my researches down the valley; but I learnt from my guide, that the mountains enclosing it, on each side, are at great heights strewed with blocks, almost all along course of Arve to Geneva. I see that Professor Neckar, in his "Etudes Geologiques dans les Alpes," speaks of several groups of granite blocks at Servoz, St Gervais, Sallenches, Mayland, Clases, and other places, along this valley; the group at St Gervais being stated by him to be at a height of 4812 feet above the sea.

Had however an opportunity, when at Geneva, of examining an immense accumulation of blocks, at lower extremity of the same valley, on Petit Salève mountain. This mountain which reaches to a height of 2800 feet above the sea, is situated on west side of the Arve; it slopes towards the E., S.E., and S., whilst to the N. and W. it is precipitous. Its E. and S.E. slopes, consisting of limestone strata, are covered with alpine blocks to the very top; even on edges of the crags facing Geneva, there are blocks perched, in apparently a very precarious position. On west side is the valley of Monetier, which separates the Petit from Grand Salève. It is rather important to remark, that in this valley there are no blocks except at its south and north extremities; and that the only parts of the mountain covered with blocks are those parts facing the valley which descends from Chamouni. On south slope of the Grand Salève, situated about a mile to the west, there are very few blocks; but then there is a hill on the south, which to a great extent prevents any glacier descending by the Arve valley, abutting on the Grand Salève.

I had no doubt that the blocks on the Petit Salève must have been lodged there by a glacier which descended from Chamouni by Les Ouches, St Gervais, and Sallenches, a distance of from thirty to forty miles.

8. Before leaving Chamouni valley, let me advert to some remarkable traces of ancient glaciers in higher parts, at entrance to Val Orsine.

(1.) Just above village of Argentier, there is an oblong heap of detritus, undoubtedly deposited as a moraine by glacier of Argentier. Its situation, height, and extent, bear to that glacier exactly same relations as the hill of Lisboli does to the Mer de Glace. The height of this old moraine I found to be from 250 to 300 feet above adjoining plain. At present it terminates in middle of valley, as Lisboli does, with the Arve washing its northern extremity. But it had evidently crossed valley, as there is on north of Arve another heap of detritus which exactly corresponds in position, direction, and height.

(2.) Still more undoubted traces of an ancient glacier to be seen in the smoothed sides of rocky pass close to the moraine now described, and which leads north into Val Orsine. Beyond this pass there is a col or summit, about a mile distant, called by my guide Moente, and the height of which I made out to be (by sympiesometer) about 600 feet about valley of Argentier. On the north side of this summit, valley slopes down to north, and is strewed by granite blocks of enormous size, and exceedingly angular in shape. This village opens into the greater valley of the Rhone, a little below Martigny.

The supposition is, that the glacier which formerly passed this way was no other than that now known as the Argentier Glacier. In this opinion I concur; and I believe also that the glacier of La Tour, which is a few miles east of Argentier, must have united with latter to pass the same way.

Since my return home, I became acquainted with a paper by my friend Mr R. Chambers, in which he expresses rather strongly his doubts as to probability of the Argentier Glacier having passed through the Val Orsine. He admits that it was, like all the alpine glaciers, on a much larger scale at a former period, but thinks that it must have descended by Chamouni. The levels, however, are repugnant to this view. We have seen that when the Mer de Glace choked up the valley and abutted on the hill of Flegère, it must have reached a height there of at least 2700 feet above Chamouni. Now the pass into the Val Orsine is only 1250 feet above Chamouni, so that this valley afforded both a more direct and a more easy outlet for Argentier and La Tour Glaciers, than the other route suggested.

II. *Valley of Rhone.*

1. In noticing the blocks found on the Salève mountains near Geneva, I mentioned that there are few upon the south slopes of the Grand Salève. The case, however, is different with the N.W. slopes of that mountain, for on them a great many blocks of granite and puddingstone occur, which Swiss naturalists have identified as belonging to the mountains situated to the eastward of Chamouni, and which they are all agreed must somehow or other have been brought down the valley of the Rhone. The blocks now mentioned, on the Grand Salève, are at a height of about 3235 feet above the sea. I regretted very much not having had it in my power to visit these blocks,—or those equally interesting mentioned by De Luc as resting on the N.N.W. slopes of Sion and Vouaches, situated still farther west, and close to the defile between these mountains and the Jura, through which Rhone flows. They are described as forming zones or bands on these mountains, at a height of about 2435 feet above the sea.

I allude to these facts, ascertained by very careful observers, and long well known to Swiss geologists, because they appear to me to throw light on a few observations which I happened to make during my brief visit, and which I shall now proceed to notice.

2. In various places along valley of the Rhone, I saw unequivocal tokens of a glacier which once filled it, down to the Lake of Geneva. Between St Maurice and Pissevache, the rocky and steep sides of the valley are smoothed and scored at heights from 150 to 350 feet above flat through which the Rhone wanders.

Where the sides of the valley come nearer to each other than usual, the scratches or ruts slope *upwards* to the north,—indicating that the glacier there could pass in its contracted channel only by rising like a tidal wave in similar circumstances.

3. In several places, as on south side of Monthey and at Bex, I observed great accumulations of detritus, apparently portions of ancient moraines. But the most striking phenomenon of this kind is presented by the celebrated blocks of Monthey. Many of them are the size of cottages; and on

one of them a good-sized summer house has been built. They are heaped one upon another in such a way as to suggest very vivid ideas of the stupendous power which was here at work. I found about twenty masons employed in mercilessly blasting these gigantic blocks, in order to convert them into gate-posts and window-soles. The people seemed well acquainted with the spots where the blocks occur, and assured me that whilst there were none to the south of Monthey, they extended all the way to near the Lake of Geneva, a distance of about three miles, and at about the same height above the Rhone, viz., 300 feet. The hill at Monthey faces the S.E., and is so situated that any glacier descending the valley would abut upon it.

4. There is one circumstance connected with the erratic blocks which much arrested my attention, and which I think has not received sufficient consideration. I refer to the enormous accumulations of sand, gravel, and clay existing in Low Switzerland, and to the fact that very many of the blocks are buried in these pleistocene strata. The well-known granite blocks of Steinhoff, near Soleure, which I visited, are evidently imbedded in these strata, in that neighbourhood largely developed, as may be seen from the numerous quarries of sand and gravel. Along lakes of Bienne, Neufchatel, and Geneva, there are whole hills of sand, gravel, and clay, with reference to which I made following notes :—

Bienne Lake.—The little island of St Pierre is a recent deposit of clay, reaching to a height of at least eighty feet above level of lake. In the recent cuttings along north bank for railway, beds of gravel are cut through containing alpine blocks.

Neufchatel Lake.—A few miles west of the town of Neufchatel, near Columbier station, there are stratified beds of sand and gravel to a height of about 500 feet above lake, which cover smooth beds of Jura limestone. These beds contain occasionally large alpine blocks, most of them rounded. At Gorgier, and various other places between Neufchatel and Iverdon, these appearances repeated.

In district between the lakes of Neufchatel and Geneva, there are on south side of railway several hills of fine gravel and sand, at least 200 feet in height. At the west end of a railway tunnel, large portions of limestone rock were being tirred of the stratified gravel beds lying over them, which showed extensive smoothings. Near Bussigny and Cossonay, hills of sand and gravel occur, containing great blocks of granite, and in several places there are deposits of fine clay, from which bricks are made.

To the north of Lausanne there is a hill called the Signal, 2000 feet above the sea, near the top of which beds of sand and gravel occur, some of them 20 feet thick. Similar deposits are seen at Aubonne and to the east of Nyon; at this last mentioned place, imbedded schistose blocks are very numerous. West of Nyon there are brick-works.

Along the south side of Lake of Geneva great cliffs may be seen, even from the deck of the steamboat, of fine clay, sand, and gravel, with occasionally boulders protruding; and there are immense numbers of these along all the shores of lake, partly covered by the water, which have probably fallen out of these pleistocene cliffs when undermined. These superficial deposits along south bank rise in level towards the east, and form a slope which had previously attracted my attention when looking across the lake from Lausanne. It can be distinctly observed extending from Meilliere, near the valley of the Rhone, towards Geneva. I afterwards discovered that Mr Neckar had, in his "Etudes Geologiques," taken notice of this deposit; and he mentions that at its east end it rises to a height of about 1900 feet above the lake, or 3235 feet above the sea. Near Boisy, which is more than half way from Meilliere to Geneva, Mr Neckar mentions that the height of this diluvial deposit above the sea is about 2277 feet, where it consists entirely of "alternate beds of fluviatile sand, gravel, and primitive blocks." Near St Julien, which is three miles west of Geneva, there are diluvial terraces about 182 feet above the lake, and 1517 feet above the sea; and Mr Neckar mentions that there are similar terraces a little S.E. of Geneva, which are 162 feet higher; thus proving that the whole of the south side of the valley presents a series of pleistocene deposits, which, at the mouth of the valley of the Rhone, are at a height of 3300 feet above the sea, and slope gradually down towards the west, where at a distance of about thirty miles, they are only 1500 feet above the sea. Now, it is important to remark, that Mr Neckar describes these deposits as not only containing large alpine blocks, but as composed of rounded pebbles and gravel, also alpine in their origin. He also adverts to the circumstance, that the lowest pleistocene deposits of the district are beds of gravel and sand, arranged generally in horizontal beds, and which seem to have been deposited in currents of water. In these lowest beds, no erratic blocks are ever found. It is in the upper set of deposits that they occur, and the lowest of which generally consists of finely comminuted clay, on which are situated the numerous brick-works before alluded to on both sides of the lake.

There is another important fact to be kept in view in the consideration of this matter, that it is towards the east end of the Lake of Geneva, and near or opposite to the mouth of the valley of the Rhone, that erratic blocks occur of great size, in great numbers, and at apparently the greatest altitudes. Mr Neckar describes many on the north-west of Neufchatel Lake as occurring at a height of 3575 feet above the sea, and at the east end of the Lake of Geneva at a height of 3550 feet, whilst on the south side they occur at the height of 3265 feet; all of which altitudes, it will be observed, are greater than those given for the altitudes of the blocks to the west of Geneva.

III. *Inferences.*

1. After what I saw of the mechanical effects of the Mer de Glace on the adjoining rocks, I formed a very decided opinion that the evidence is undeniable of the existence of a glacier, which in ancient times filled the whole valley of Chamouni, and, descending along the present course of the Arve, was capable of depositing on the Petit Salève and intervening mountains the alpine blocks which are now strewed over them.

If this was the case with the valley of the Arve, I cannot hesitate to admit that the larger valley of the Rhone must have been occupied by a glacier of corresponding size, which, on emerging from that valley would pass across to the plains of the Jura, and then turn towards the west and lower extremity of the valley, where the Grand Salève and other mountains are situated, whose northern slopes have alpine blocks scattered on them. The relative height of these blocks in the different parts of this great valley point clearly to such a result.

The blocks of Monthey, which are only about 300 feet above the Rhone, form no ground of objection to this view, because they were most probably left by the Rhone glacier as it was shrinking to its present dimensions, in which case they would not have travelled so far from their parent hills as others; a supposition corroborated by the appearance of the blocks themselves, all of which are much more angular than the generality of the blocks in lower parts of the country.

2. The great difficulty, of course, is how to account for such a change of climate as would produce glaciers on so much greater a scale than at present. The question is too large to be discussed in all its bearings in this paper. It may be sufficient to mention that two causes have been suggested—one of which would affect the whole of Europe simultaneously, and the other one would affect Switzerland alone. According to the first hypothesis, a great elevation of land took place in northern Europe, in virtue of which (to use the words of Sir Charles Lyell, who suggests it) "nearly the whole sea, from the Poles to the parallel of 45°, would be frozen over." Switzerland, however, being in latitude 46°, would scarcely be reached by such a cause; and there are other objections. According to the second hypothesis, this district of Europe alone may have been elevated, and elevated to such a level that the Chamouni and Rhone glaciers would require to descend to the low country about Geneva before they could reach their melting point.

With reference to this last hypothesis, it may be asked, What amount of elevation would be required to produce the required extension of these glaciers?

They melt now at an average elevation of 4400 feet above the sea; and as Geneva is 1335 above the sea, the difference of these two levels, *i. e.*, 3065 feet, gives the height to which Low Switzerland would require to be raised, to cause such a temperature there as to enable glaciers formed in the Alps to reach Geneva before melting.

This conclusion is also arrived at by comparing the mean annual temperature of Geneva with that of the localities where the glaciers now melt. Thus (as has been shown by Principal Forbes) the mean annual temperature of the Arveiron, where the Mer de Glace terminates, is 38½° Fahr., whilst that of Geneva is 48°, being a difference of about 10°; and assuming the usual rate of 1° Fahr. for every 300 feet, these 10° correspond roughly to a height of 3000 feet.

I am quite aware that the view which I have adopted, of supposing this part of Europe to have stood 3000 feet higher above the sea than at present, is rejected by De Charpentier, who, I believe, is the latest Swiss geologist who has gone deeply into this subject; and it seems rather presumptuous to offer an opinion at variance with so great an authority. His way of accounting for the lower temperature necessary for the production of extended glaciers is by supposing (I quote his words) "a long series of seasons, similar to the rainy and cold seasons which succeeded one another from the year 1812 to 1818" (Charpentier "Sur les Glaciers," p. 319). And he adds, that a very long continuance of such ungenial seasons should be no objection, considering that in the explanation of any geological phenomenon, it is allowable to assume as much time as may be necessary. I confess, however, that the reason thus assigned by De Charpentier for his theory is not satisfactory to my mind; for during the cold and rainy years referred to none of the alpine glaciers extended more than a few hundred feet beyond their usual limits; and therefore, to cause a glacier to grow to the length of 80 to 100 miles beyond its present dimensions, it would require *ages* of unfavourable years, which cannot be adopted without admitting a permanent change of climate, and of course such a permanent change in the earth's surface as would cause that result.

No doubt it is at first sight startling to suppose that this part of Europe stood 3000 feet higher than now. But it should be remembered that there is conclusive proof from other sources, that Switzerland, even in comparatively recent times, underwent several movements both of elevation and depression. The period immediately preceding the transportation of the erratic blocks was characterised by the formation of the *Molasse*, a deposit which Agassiz has compared to the well-known Till of Scotland. Now this clay deposit in Switzerland consists of two beds, the lower bed containing fresh-water fossils, the upper bed containing marine remains; which last fact implies submergence beneath the sea. Then it appears from the researches of Professor Favre of Geneva, that since the deposition of these molasse beds there was an extensive upheaval of some of the mountains, and especially of the Salève hills, on whose sides these molasse beds were deposited; for instead of being horizontal, as they must originally have been, or at all events sloping at a low angle, these molasse deposits are in some places now inclined at angles from 35° to 45°, and at one place dip in opposite directions.

Therefore, immediately antecedent to the transportation of the erratic blocks, this district sank beneath the sea, and subsequently rose up, dislocating these molasse beds—implying, therefore, an upheavel of the Western Alps.

But it can also be shown, that, immediately after the same period, another depression of this region, and a submergence in deep waters, took place; for how else can those stratified beds of gravel, sand, and clay have been formed which now lie over the molasse, and which we have seen occur in all parts of Low Switzerland up to the height of 3000 feet and more above the present level of the sea? It is quite impossible to account for the formation of sand-hills and gravel-beds 200 feet thick, composed of regular layers, mostly horizontal, except on the supposition of their having been formed in the waters of a sea, not subject to much violence, but agitated by ordinary tides and currents.

I infer that this depression and submergence took place at a period posterior to the transportation of the erratic blocks, because these blocks (as I have shown) are in many instances enveloped in the heart of the stratified beds.

Then this submergence was followed by a re-elevation of the country to its present levels.

Thus, immediately before the transportation of the blocks, the country was successively depressed and elevated; and immediately after that event these operations were repeated, so that there need be little reluctance in adopting the view suggested for explaining the extension of these ancient glaciers.

My view, then, of the sequence of events is as follows :—

1. This district of Switzerland stood above the sea 3000 feet higher than at present. Glaciers then filled the valley of Chamouni, passing over the hill of Chavant, producing the scratches and furrows mentioned in a previous part of this paper, and descended as far as the Salève mountains, depositing blocks in its course and at its termination. Glaciers filled also the whole valley of the Rhone, and reached the basin now occupied by the Lake of Geneva ; and then turning westward towards Geneva, spread everywhere loads of alpine detritus, and lodged huge blocks on the mountain sides.

2. Next came a period when the land gradually sunk, and when, of course, the temperature rose, so that the glaciers shrunk back to the higher parts of the valleys.

The land was then submerged beneath the waters of a deep sea, and the glacial deposits were arranged into the stratified beds before referred to ; but these deposits were not so entirely rearranged as to lose all the outward features of their glacial origin. In particular, they still retained the gradual slope from the mouth of the Rhone towards the west, which they must have had when deposited by a glacier.

During this period of submergence, when, as we have seen, the land was lower than at present by so much as 3000 feet, the climate of Switzerland was probably better than it has been since ; in which case we obtain a better explanation than has yet been given of the discovery of the bones of elephants, antelopes, and some other animals, requiring a mild climate, in quarries of gravel in different parts of Low Switzerland.

During this period the glaciers must have been very much smaller than at present, and many of them would not exist.

3. Then followed the last movement, when the country rose up to its present levels, and when, of course, the glaciers would again enlarge, but to a more limited extent.

This last movement may have been gradual, or it may have been sudden. Of course, the more sudden it was, the more easily can we account for the removal of detritus from the valleys, which has taken place to a great extent, as is well marked by the terraces along the course of the Arve and the Rhone.

On the Discovery of an ancient Hammer-head in certain Superficial Deposits near Coventry. By the Rev. P. B. Brodie, M.A., F.G.S.

As the occurrence of the remains of works of human art in beds of gravel, at greater or less depth, associated with the remains of extinct mammalia, has lately excited much attention among geologists, the following particulars relative to the discovery of an ancient stone hammer which was found in certain superficial deposits near Coventry, may be generally interesting. The details were, at my request, kindly communicated to me by my friend Mr J. S. Whittem of Cownden, near that town, on whose land it was dug up, and who first drew my attention to it. It is one of the most ancient relics of human art, far older than the Celtic, and belongs to what archæologists call the "stone age." It is a stone implement, either used as a hammer or a weapon of war. It is somewhat water-worn, and looks as if it had been used. The stone of which it is made resembles mill-stone-grit, or some hard igneous rock; but I could not speak decisively on this point. In its present condition, it is impossible to determine this without breaking it. It was procured in draining, in the parish of Sowe, about two feet six inches from the surface, lying in the midst of the detritus about to be described. This consists chiefly of red marly clay, of varied thickness, from three to nine feet, mixed with sand and pebbles, and fragments of rock, which are rather thinly dispersed amongst it. Many of these are angular, others rounded and almost polished as if by friction. Amongst them are various ancient rocks, such as granite, greenstone, and syenite. The fossiliferous portions differ much in size, and belong chiefly to the mountain limestone. A few are decidedly oolitic and contain shells, amongst which was a piece with shells resembling cyclas and mytilus, remarkably like some of the Purbeck beds; a cardium and a lima in brown oolitic limestone; oolitic stone with rhynchonella, the surface of which is smooth and almost polished as if rubbed; there was also a remnant of chalk with the cast of a pecten and a small bit of coal. Flints are not uncommon, and some are of considerable size.* Generally speaking, these fragments do not seem to have undergone so great an amount of attrition as that which usually characterises the ordinary detritus in this neighbourhood. They are, on the contrary, in most cases very angular, and Mr Whittem refers to an angular fragment of syenite not in the least abraded, and another fragment of rock not only worn, but very smooth and grooved; and therefore, on the whole, the inference would seem to favour the idea of their having been carried by icebergs, and if so, the age of the deposit may be considered to belong to "the glacial period," and the hammer-head to all appearance was conveyed with them. The polished surface of many of the stones also favours this assumption. The term "drift" is certainly inapplicable to this deposit. There is nothing to indicate that this relic was buried on the spot, for the soil had not the *least* appearance of having been disturbed, and there were no roots or peaty matter such as prevail in bogs, the spot being table land of some height, with an inclination on three sides at least. No bones of any extinct animals were found with it, and I never heard of any being noticed in the neighbourhood. If, then, we are correct in assuming that this hammer-head was deposited with the superficial accumulations above referred to, it is clear that the human race must have inhabited the earth during this more recent geological epoch; a subject of great interest and importance, but I am unwilling to hazard any

* In the parishes of Hatton and Hazeley, three miles N.W. of Warwick, there is a bed of gravel with numerous flints of all sizes (some very large), many of which are as fresh and angular as if they had just been dug up from a chalk-pit, and some of the neighbouring fields are covered with broken flints, interspersed with numerous small rounded pebbles of ancient and other rocks. Ice seems to be the only agent by which these flints could be conveyed in such a condition, and this stratum was perhaps coeval with the one near Coventry. This accumulation of flints may be traced for a considerable distance across the country, along a narrow and limited tract.

decided opinion in this matter, wishing rather to draw attention to the facts which *seem* to be correct, and the more so as these were carefully noted on the spot by Mr Whittem himself.

NOTE.—Near Warwick, and the district which lies to the north and north-west, there are at least three pleistocene deposits of different age,—

1. Flints interspersed with numerous small rounded pebbles of ancient and other rocks belonging to the glacial period.

2. The great northern drift, generally and widely distributed over a considerable area.

3. Certain gravel-beds near Warwick, and along the valley of the Avon, containing occasionally mammalian remains.

The Flora of Iceland. By W. LAUDER LINDSAY, M.D., F.R.S.E., F.L.S., F.R.G.S., &c.

A visit to Iceland in June 1860 gave me an opportunity of becoming acquainted with some of the general features of its Flora; and a residence of eight days in Reykjavik, its capital, further enabled me to collect details as to its vegetation from its principal naturalists, as well as to study the literature of the Icelandic Flora in the archives of the National Library. Since my return, I have availed myself of the public libraries of Edinburgh, &c.; of correspondence with various British botanists, whose names will hereafter appear; and of catalogues of foreign works on botany, with a view to discover all the floras of Iceland, or works of any kind containing lists of its plants, hitherto published. My inquiries at home have not enabled me to add many to the works, which, I ascertained in Reykjavik, contain lists of Icelandic plants. An enumeration of all the works—both British and foreign—bearing on the Icelandic Flora, so far as I am aware, hitherto published, and some only of which have been accessible to me, will be found in a bibliographical appendix to this paper. The general result of my investigations is, that our present knowledge of the plants of Iceland is not so satisfactory as is desirable, and as the number of lists of such plants would lead one at first to infer; that there is no full list, accurate as to names and number, up to the present day; and that it is impossible, short of re-collecting and re-naming from fresh specimens actually collected anew in Iceland, to draw up a perfectly accurate and reliable Flora of Iceland. Dr Hooker, than whom there is no more competent authority on such a subject, either in Britain or out of it, informs me that "we have *no good Flora of Iceland.*" This arises from a variety of causes to which I would direct attention. So far as I am aware, the only separate volume on the Flora of Iceland is that of Dr Hjaltalin, published in 1830. It is written in Icelandic by a native Icelander now dead. He was one of the provincial or district surgeons of Iceland, appointed to office by the Danish Government; a brother of the present Physician-general of Iceland, my friend Dr Jón Hjaltalin; and I was informed in Reykjavik, not only an enthusiastic but an accomplished botanist, and an accurate observer, whose statements may be relied on. His volume gives the native Icelandic names of the plants described, and he enters fully on the subject of their economic uses. It is to be presumed that this volume contains, as it purports, a full list of the plants of the whole island, as known up to the date of publication in 1830; and also that due advantage had been taken in its compilation of the lists published by previous observers—British or foreign. This work of Hjaltalin seems to be quite unknown in Britain. I do not find it mentioned in foreign catalogues of works on botany or natural history; and from inquiries made by me there, it appears to be equally scarce in Iceland and Denmark. I was fortunate enough, however, to have the loan of a copy from the National Library of Reykjavik during the whole period of my stay in that town, and I availed myself of the opportunity of transcribing the names of *all* the plants mentioned therein.

The list of the plants of Iceland most familiar to British, and apparently also to continental botanists, is that of Sir William Hooker, who visited Iceland in 1809, and whose "Journal" was published in 1813. This list was reproduced in Sir George Mackenzie's "Travels," which were published in 1811. Sir William Hooker appears to have incorporated in his list that of Zoega, which was published in Olafssen and Povelsen's Travels in 1772; and, doubtless, he also availed himself of the lists of Mohr, Pálsson, and others of his predecessors. The latest published full list of the plants of Iceland is that of Vahl, contained in Gaimard's narrative of the voyage of "La Recherche" (1840). The volume of this magnificent work which treats of mineralogy and geology (Part I.), contains chapters on—(1.) The General Vegetation of Iceland; and, (2.) General Considerations on the Coldness of the Climate in its relation to Vegetation, by M. Eugène Robert, who appears to have accompanied Gaimard in the conjoint capacities of mineralogist, geologist, and botanist. Before setting out, his attention was specially directed by M. Adolphe Brongniart, Professor of Botany in the Museum of Natural History, Paris, to such points in Icelandic botany as the following:—1. Is *Pyrus domestica* really a native? 2. Are there no other native amentaceous plants than those mentioned by Sir William Hooker? 3. Is there no conifer save *Juniperus communis?* 4. What are the limits of growth on the mountains of such genera as *Betula*, *Juniperus*, *Salix*, *Erica*, and *Vaccinium?* 5. General geographical distribution of plants of Iceland. 6. Presence or absence of particular plants. 7. Collection of Cryptogams, with a view, for instance, to a more complete list of Algæ, &c. M. Robert traversed the greater part of the island during the years 1835–36, and collected, he says, the greater number of its plants. Throughout his tour, he states that he paid minute attention to the points indicated by Professor Brongniart. At his request, too, it was that M. Vahl, a Danish botanist, who had resided long in Greenland, revised all former published lists of Icelandic plants, especially that of Hooker, and drew up a fresh list corrected up to that date (1835–40). This list is added as an appendix to M. Robert's chapters on the Botany of Iceland (p. 337). With Vahl's enumeration M. Robert compared his own collectanea, and expresses himself satisfied with the results, though he disclaims having added a single new plant; that is, I presume, one not previously found by his predecessors in travel. In 1846, Mr Babington of Cambridge, the well-known author of the "Manual of British Botany," visited Iceland, and made some botanical collections. He appears to have carefully revised Hooker's and Vahl's lists, the acracy of which he substantially confirms, adding a few plants mentioned by neither. The revised list of plants, collected by Babington, was published in 1848. Since this date I am not aware that any addition or contribution to the botany of Iceland has been made, either in this country or on the Continent. There is only one other work, containing reference to the plants of Iceland, which it seems necessary to mention here, viz.,—The Edinburgh Cabinet Library volume on "Iceland, Greenland, and the Faröe Islands" (1840). This work contains a chapter on botany, partly relating to Iceland, its data being mainly based on Mörck's "Catalogue of the Plants of Iceland," contained in Gliemann's account of that island, published in 1824. The Edinburgh Cabinet Library volume states the number of Icelandic Phanerogams at 472

Cryptogams at	398
Total	870

This number is considerably higher than that given by any other writer. Vahl's list, for instance, which ought to be the fullest, as it is the most recent, being sixteen years posterior in date to Gliemann's, gives only 432 flowering plants. I have not been fortunate enough to procure a perusal of Gliemann's work, and therefore cannot say how far Mörck's catalogue of Icelandic plants bears the appearance of accuracy. But there is every probability that a list so full would not have escaped the notice of Dr Hjaltalin, who would have incorporated in his "Flora of Iceland," published some six years later, such plants as he was satisfied were really natives of that country. Several of the works mentioned in my "Bibliographical Appendix" are mere papers, mostly by Icelanders, published in Icelandic or Danish journals, which have not been accessible to me; but which have every appearance, from their titles and places of publication, of possessing only a minor importance.

With a view to showing the impossibility of drawing up from such materials as the foregoing, or those mentioned in the Appendix, a complete and reliable list of the plants of Iceland, I have the following remarks to offer. I am disposed to regard Dr Hjaltalin's Flora as at once the most accurate and complete hitherto published, for reasons which I have already in part mentioned incidentally. Such, for instance, as these:—It is a work specially devoted to the subject of which it treats; the author was an accomplished botanist and a native Icelander, resident in Iceland; the presumption that such an author should have been better qualified to describe correctly the Flora of his own country than strangers merely visiting it, mostly for very short periods; the probability that he was himself acquainted with the vegetation of the greater part of the island, and not only with a small section thereof; and also that he duly availed himself of the results of the inquiries and collections of all previous botanists. But since the date of publication of this work (1830), every botanist knows that great progress, or, if not in all cases great progress, at least great change, has taken place in the nomenclature and classification of plants. For example, the introduction and use of the microscope has almost revolutionised cryptogamic botany, particularly our knowledge of fungi and lichens. Many genera and species have been abolished as mere varieties, forms, or states of other species, while some of the old *species* have been subdivided into as many as four or five different *genera!* Under such circumstances, to determine the precise plant intended to be indicated by a particular name in some of the existing Icelandic floras, is frequently absolutely impossible, and the endeavour to do so frivolous in the extreme.

By others, however, the list of Vahl, and the chapters on Icelandic botany by Robert, may be regarded as at once the most recent and accurate Flora of Iceland. As I have already mentioned, M. Robert appears to have made a more systematic and complete exploration of Iceland than any previous or subsequent botanist, if we except Dr Hjaltalin; and I only *presume* that the latter was familiar with the greater part of his native island (there being still portions of it that never have been, and that perhaps never will be, thoroughly or at all explored!) Yet, so far from having added to former lists, Robert does not seem to have collected all the plants enumerated by Vahl. It may hence be inferred, as I fear it has by some botanists been inferred, that no species new to Iceland, if not to science, remained to be discovered. Such a conclusion, however, is quite at variance with that to which my own observations and inquiries have led me, as I will shortly show. Vahl's list is most significantly headed, "Liste des Plantes que l'on *suppose* exister en Islande, dressée par M. Vahl; toutes celles devant lesquelles il y a un astérisque s'y *trouvent positivement*," a distinction being drawn between plants *believed* or *supposed* to occur, and those which have been *actually found* in Iceland. I do not know on what grounds he introduces the names of plants simply *supposed to occur*, and which have *not been actually found!* But I fear that some other writers may have lost sight even of this distinction, and may have mentioned as natives of Iceland, or really found therein, plants which are only by them supposed to occur! If this has really happened, the writers have probably been seduced by their knowledge of the Floras of the nearest countries, viz., Greenland and Lapland. Further than this, however, Vahl's list, as given in M. Robert's volume, not only contains many mis-spellings, in most or all cases mere typographical mishaps, but it does not give the authorities for the names of the plants enumerated. This omission opens a door for endless difficulties in ascertaining what the plants found really were. The question of synonymy becomes most intricate and confusing, and in too many cases it is a substantial barrier to all progress. I have pointed out some of the defects of two of the Floras of Iceland; but the same, or similar faults, are less or more chargeable against *all*.

Admitting the impossibility of drawing up a complete and accurate "Flora Islandica" from existing data, still it appears to me that it would be an advantage to possess a list of the plants of Iceland, revised up to 1860. I refer to one based on a comparison of lists hitherto published—in the absence of a re-examination and re-naming of a complete collection of Icelandic plants, which no existing herbarium, so far as I am aware, possesses—the naming and arrangement of the plants in such revised list being in accordance with modern standard works on botany. Such a list might be accepted as a fair representation of the present state of our knowledge of the vegetation of Iceland, and it might therefore serve as a basis for the labours of future botanical travellers in that island, by obviating the necessity of their wading through all former published Floras. Moreover, steam navigation is opening up to British and American tourists Iceland as a new field both for science and sport; and it has already been visited by not a few travellers of the book-making class, who, I find, are not only committing, but in their works are likely to propagate, errors regarding its vegetation. A revised list of the plants of Iceland might not only prevent some of these errors, but might contribute towards a better knowledge of the plants in question, by directing the attention of tourists to the defects of existing Floras, and so induce them to make collections and submit them to competent botanists for naming. With a view to supply this desideratum, I have drawn up the appended Flora, which is based essentially on the lists of Hjaltalin, Hooker, Vahl, and Babington. I found the preparation of the list a matter of much greater difficulty than I had at first anticipated; and even with all the care that has been bestowed on it, the result cannot be regarded as otherwise than in great measure unsatisfactory. Great discrepancies occur between writers as to the numerical strength of the Icelandic Flora—some authors giving as many as 100 species, both of *Phanerogams* and *Cryptogams*, more than others, who equally profess to give a *full* list. I cannot help *suspecting*—though at present I am not in a position to *prove*—that some of the larger lists have been swelled by the names of plants which are either only *supposed* to be natives, or which *cannot be* natives, of Iceland! I have already mentioned that my own observations and inquiries alike, as I will hereafter more fully explain, lead me to regard with great suspicion the accuracy of the lists of Robert and Vahl. But my main difficulty has been in determining the modern synonymy of the plants enumerated in the various lists I have consulted; and I cannot better indicate the nature and extent of such a difficulty than by giving a few illustrations.

1. *Fungi.*—The Rev. M. J. Berkeley wrote to me of the following:—*Mucor Erysiphe:* "This is now a tribe rather than a species, consisting of *several genera and numerous species.*" *Peziza zonalis:* "I know *nothing* of this. I cannot find the name anywhere." *Clavaria coralloides:* "*Several*

species have been so called." *Peziza lentifera* "may be *Nidularia campanulata, N. striata,* or *Crucibulum vulgare,* Tulasne. All are included by Linnæus, though distinguished as varieties." *Agaricus fimetarius*—" *Coprinus comatus,* Fr., probably. *A. fimetarius,* Sow., however, is *Coprinus atramentarius; A. fimetarius,* L., is *Coprinus cinereus.*" Mr Berkeley adds, "It is scarcely possible to say what is meant by the *names* of fungi. . . . It is impossible to get nearer to the truth *without specimens.*"

2. *Lichens.—Isidium defraudans,* Ach., appears to be *Parmelia poliophæa,* Fr.; *Lichen defraudans,* Olafs. It. Island. app., p. 17; *L. poliophæus,* Wahlb. Lapp., p. 410, t. 27, f. 3; *Lecanora poliophæa,* Ach., Lich. Univ., p. 398. Probably all these are the *Lecanora spodophæa,* Ach., of E. B., t. 2083, f. 3, p. 82; and Hooker's Brit. Flora, vol. ii., p. 188. The latter is said to be closely allied to *Lecanora aipospila,* Ach., E. B., t. 2083, f. 2, p. 81. But neither *L. spodophæa* nor *L. aipospila* can now be identified as distinct British species, whereas it is probable that *Isidium defraudans* is an isidioid condition of our familiar *Lecanora sophodes,* Ach. The latter, however, has not been mentioned by any botanist as a native of Iceland; and if it really occur in its normal or fruit-bearing state, it has probably been confounded with some other *Lecanora,* or altogether overlooked!

Lichen lacteus, L., is the *Variolaria lactea,* Pers., E. B., p. 50, t. 1998: it is probably a sterile and variolarioid state of the common *Lecanora parella;* but it may be a similar state of *L. tartarea, L. glaucoma, L. Hæmatomma,* or *L. cinerea;* or even of *Lecidea atro-alba,* Flot., or *L. ambigua,* Ach. The plate in E. B. would lead me to refer it to *L. parella;* but that in Westring's "Schweden's vorzüglichste Farbeflechten" (1805) would attribute it rather to *L. cinerea.* The name of the lichen in the last mentioned work, "Milchflechte" (German and Swedish), is nearly identical in meaning with the Icelandic name of the *Lichen lacteus,* "Mjolkhvitr Mosi." From this it may be inferred that the Icelandic lichen may be the same as the Swedish one, and that both are equally referable to *L. cinerea.* But there is an objection in the fact that *L. cinerea* does not possess the colorific property that is undoubtedly possessed, for instance, by *Lecanora tartarea* or *L. parella*, and by the *Lichen lacteus*.

Lecidea fusco-lutea, Ach., E. B., p. 74, t. 2065, Hook. Br. Fl. p. 183, vol. ii., *Lichen fusco-luteus*, Dicks. Crypt. Fascic., 2. 18, tab. 6, f. 2, may be a variety or form of *Lecanora ferruginea*, Huds., of *Lecidea vernalis*, Ach., or *L. sanguineo-atra*, Ach. Or, according to Nylander ["Prodr. Lichenographiæ Galliæ et Algeriæ," p. 75], it may be only a muscicolous form of *Lecanora cerina*, Ach., var. *gilva*, Nyl., or, in other words, it is *L. cerina*, Ach., var. *fusco-lutea*, Dicks. And it occurs to me, further, that it may sometimes be var. *frigida*, Ach. of *Lecanora tartarea*, Ach., or var. *Turneri*, Sm. of *L. parella*, Ach.

The Rev. Mr Berkeley refers *Byssus cryptarum* to "some imperfect *lichen*." I do not know to what lichen to refer it; nor am I satisfied it is a *lichen* at all! I am disposed to transfer it to either the fungi or algæ. All that can be certified at present is, that the precise plant intended to be indicated by the name *B. cryptarum* cannot possibly be determined either by the lichenologist, fungologist, or algologist!

3. *Algæ*.—Professor Harvey of Dublin writes me regarding *Ulva plicata*: "*U. plicata* of 'Flora Danica,' t. 829, may be a variety of *U. latissima*. It is *Phycoseris plicata*, Kütz. Sp. p. 477." *Fucus muscoides*, "I suppose must be the *F. muscoides* of Gunner, not of Linnæus. If so, then it is *Desmarestia aculeata* when young and feathery." *Conferva æruginosa*, Huds. "No one knows what it is, unless it be *C.* [*Cladophora?*] *arcta* [Dillw.?] which is probable." *Fucus cartilagineus* is partly referable to *Gelidium cartilagineum*, Gaill.; but the latter "is a native of the Cape of Good Hope, not of Iceland." *Fucus spermophorus* may be that of Gunner or of Turner. The former occurs in Iceland, and is the *Gigartina mammillosa*, G. and W. The *F. spermophorus*, Turn., is the present *Phyllophora spermophorus*, L., and is not a native of Iceland. *Fucus gigartinus* is partly referable to *Gigartina pistillata*, Lamour, but this "could never have been found in Iceland. It is quite a southern plant, barely reaching as far north as Cornwall." Mr Croall of Montrose, the author of the recently published handsome

volumes of the "British Seaweeds Nature-printed" (1860), writes me:—"I had much more difficulty in tracing the synonymy of some of the species than I expected, owing to the want of the authorities. Some of the species I have not been able to find at all. These are possibly not British" (*e.g.*, *Fucus albus*, *F. clavatus*, and *Conferva œgagropila;* which latter may be *C. œgagropila*, Linn., E. B. t. 377). "Even some of those I have settled are uncertain." Thus *Fucus crispus* may be *Callophyllis laciniata*, Huds. Kütz. Phyc. Gen., p. 401; Brit. Seaweeds Nature-printed, p. 51. The latter occurs on the coasts of Norway and Faröe, and therefore is likely also to be found on those of Iceland. "*Ulva plicata* may be *Rivularia plicata;* but I have not been able to trace its identity, and perhaps could not, even with a work on general algology—so unsatisfactory are *names without authorities*." Mr Berkeley tells me *Byssus Iolithus* is an alga—"*Chroolepis Iolithus*, Agardh, probably only a form of *Chroolepis aureus*." And lastly, the *Conferva dissiliens* of Vahl's list may be *Vesiculifera dissiliens*, Hassall, or *Galœoprium dissiliens*, Berkeley. The *Zonaria deusta* may be *Hildenbrandtia rosea*, Kütz.; and the *Sphœrococcus ciliatus* may be *Rhodophyllis veprecula*, J. Agardh.

4. *Mosses* and *Hepaticœ.*—*Dicranum flexuosum* of Vahl's list may or may not be *D. flexuosum*, Hedw.; and the latter may be *Dicranodontium longirostre*, Br. and Sch., or *Campylopus torfaceus*, Br. and Sch. *Bryum pyriforme* may be either *Leptobryum pyriforme*, Hook. and Wilson, or *Physcomitrium pyriforme*, Br. and Sch. *B. ventricosum* may be either *B. Wahlenbergii*, Schwægr. or *B. bimum*, Schreb.

5. *Phanerogams.*—Professor Balfour informs me that *Salix ovata* may be *S. ovata*, Host., or *S. ovata* of Seringe, "which is a synonym of *S. Waldsteiniana* of Willd. or *S. alpestris*, Host., and perhaps a variety of *S. myrsinites*, L., and *S. prunifolia*, Sm." *Carex atro-fusca* may be "*C. atro-fusca*, Steven, found in the Caucasus, which is the *C. nigra* of Allioni," or "*C. atro-fusca* of Schkr., which is *C. ustulata;*" or "*C. atro-fusca* of Sieber, which is *C. fuliginosa* of Sternberg and Hoppe, found in Carinthia." "*Saxifraga punctata* is mentioned as a species by Hooker; but it seems to be a variety.

S. cuneifolia, L., is the same as *S. punctata* of Gunner. This is probably your plant. DC. gives *S. punctata*, Ser., as a variety of *S. hirsuta*, L., not British." *Geranium fuscum*. "I cannot find any variety called *montanum*." *Bromus cristatus* may be *B. cristatus*, L., which is "*Triticum cristatum*, Schreb., a British plant—Eng. Bot. t. 2267, found in the Taurus, Caucasus, Siberia," &c. This "British plant" is not, however, mentioned in Bentham's "Handbook of the British Flora" (1858): and in Hooker and Arnott's "British Flora" (1850, p. 556), there is the following note regarding it:—"A plant almost peculiar to the east of Europe and Asia, rarely occurring (and perhaps only when introduced) in the south of Europe—not, we believe, a native of France—and which *could not have been indigenous to the station assigned above*." The latter remark, I fear, applies equally to its being found in Iceland; and further, this does not appear to be the only plant mentioned in the older Icelandic Floras, to which such a remark may be properly applied.

Only some of the difficulties above alluded to have been overcome; and that they have been so is due to the assistance of the following botanists, whose names are a sufficient guarantee for the value of their respective criticisms. Professor Balfour, with the aid of such works as Steudel's "Nomenclator Botanicus," De Candolle's "Prodromus," Kunth's "Enumeratio Plantarum," and Sprengel's "Systema Vegetabilium," has unravelled the synonymy of certain of the Phanerogams in regard to which I was in doubt. Professor Harvey and Mr Croall revised the lists of the Icelandic Algæ. Dr Carrington of Yeadon, Leeds, who is at present preparing a critical work on the "British Hepaticæ," revised the list of the Mosses and Hepaticæ; while that of the Fungi was submitted to the Rev. Mr Berkeley. By the aid of these gentlemen, to whom I am glad of this opportunity of publicly expressing my obligations, the list of plants which is appended has been rendered comparatively or approximatively more complete and accurate than it otherwise could have been. Such of the Phanerogams, Ferns, and their allies, as are British, have been named and arranged in my list according to Bentham's "Handbook of the British Flora." I have selected it because the scheme or principle of its compilation—Mr Bentham's views of the relative position of species and varieties—seem to be more philosophical than those of any other similar manual with which I am acquainted. I regret that the same judicious principles of classification have not yet been more widely extended; but I have every hope that they will be so. It follows from the use of this work, however, that my list of Icelandic Phanerogams is greatly less than if I had followed such a manual as Babington's, in which the number both of species and varieties is greater. It is also necessarily less than the older Icelandic Floras, in which varieties were not unfrequently recorded as species. But further, inasmuch as the works, according to which the other groups or families of plants in my list have been named and arranged, are not compiled on the same plan as Bentham's "Handbook," or, in other words, contain proportionally a larger number of species and varieties, my list does not exhibit a strictly accurate numerical proportion or relation between the Phanerogams and Cryptogams, or between the different families of either. In other words, it may appear to some botanists that the number of species of Phanerogams is comparatively meagre, while that of the Cryptogams is comparatively full. Nor do I see how this can be avoided, even had another manual than Bentham's been used in naming the majority of the Phanerogams. Uniformity could be attained only if the Phanerogams and Cryptogams were both named from a work written on the same plan by one author, on whom reliance could be placed. But this is, under the circum stances, impossible. Any statistics, therefore, based on my list must necessarily lead *pro tanto* to false conclusions; and I neither place any fixed value upon such statistics or conclusions myself, nor do I recommend others to do so.

Such of the Phanerogams, Ferns, and their allies as are not British have been mostly named and arranged according to Hartman's "Handbok i Skandinaviens Flora" (Stockholm, 1854, 6th ed.) The Mosses are named and arranged according to Wilson's "Bryologia Britannica" (1855), such as are British; and the others according to Hartman's work above mentioned. The Hepaticæ are according chiefly to the "Synopsis Hepaticarum" of Nees von Esenbeck, Gottsche, and Lindenberg, and partly according to Hartman. The Algæ are named according to the "Species, Genera et Ordines Fucoidearum" of T. G. Agardh (1848–1852); Professor Harvey's "Manual of the British Marine Algæ" (2d ed. 1848); and Dr Hassall's "History of the British Freshwater Algæ" (1857). The Lichens are named and classified essentially according to Nylander's "Synopsis Lichenum" (1858–1860), and "Enumeration générale des Lichens" (1858). The Fungi and Algæ are arranged in accordance with the classification given in Lindley's "Vegetable Kingdom" (3d ed. 1853). It seemed advisable to omit from my list all plants which are doubtful natives of Iceland. Nor have I introduced such names, occurring in the older Floras, as may refer to one of several plants, when the precise plant cannot now be determined, examples of this are given in pages 70 to 74. I have excluded also the names of those plants in Vahl's list, which are not indicated by an asterisk as having been actually found, and which, in addition, I do not find mentioned by other botanists as natives of Iceland. Neither have I mentioned varieties, states, or forms of plants, except such as are very marked, and deserve record apart from the species to which they belong; or such as were regarded as species by the earlier botanists. I have thought it advisable in all cases to give the native Icelandic names of the plants. In order to secure uniformity and accuracy, these have, in all instances, been taken from Hjaltalin's Flora. Apart from any other interest attaching to them, such as serving to identify the botanical species, the vernacular names, and more especially the number in certain cases of native synonyms, indicate the plants which are most abundant in Iceland, and most familiar to the Icelanders (being employed by them in medicine, or the domestic arts, or as food for man or cattle), as well as their relative abundance. For instance, the two to five or six native synonyms indicate the abundance of such plants as *Thalictrum alpinum*, *Caltha palustris*, *Cardamine pratensis*, *Nasturtium palustre* and *amphibium*, *Capsella Bursa-pastoris*, *Viola tricolor*, *Silene acaulis*, *S. inflata*, *Lychnis alpina*, *Arenaria peploides*, *Geranium sylvaticum*, *Vicia Cracca*, *Dryas octopetala, Geum rivale, Rubus saxatilis, Potentilla anserina, P. Comarum, Alchemilla alpina, Epilobium latifolium, Sedum Rhodiola, Saxifraga oppositifolia, Scabiosa succisa, Erigeron alpinus, Achillæa Millefolium, Taraxacum Dens-leonis, Arctostaphylos Uva-Ursi, Pinguicula vulgaris, Gentiana campestris, Menyanthes trifoliata, Rhinanthus Crista-galli, Thymus Serpyllum, Plantago lanceolata, Rumex conglomeratus, Polygonum aviculare, Empetrum nigrum, Urtica dioica, Betula alba, Salix Lapponum, S. herbacea, Juniperus communis, Orchis maculata, Anthericum ramosum, Phleum alpinum, Lycopodium clavatum, L. Selago, Equisetum hyemale, E. arvense, Aspidium Filix-mas, Laminaria digitata, L. saccharina, Alaria esculenta, Fucus vesiculosus, F. nodosus, Cladonia rangiferina, C. uncialis, C. furcata, Cetraria Islandica, Platysma nivale, Parmelia saxatilis, Umbilicaria proboscidea, Lycoperdon Bovista*, &c.

In my list I have indicated by an asterisk all plants which are not British, so as to afford some means of contrasting the Flora of Iceland with that of Britain, and especially of the north of Scotland.

Numerically, my list represents the Flora of Iceland as follows; for the sake of convenience, well-marked and noteworthy varieties, states, or forms, being counted as species.

Numerical View of the Flora of Iceland as in 1860.

I. PHANEROGAMS.

a. Dicotyledons.

Nat. Order.	No. of Species, including marked varieties, states, and forms.
1. Ranunculaceæ,	13
2. Papaveraceæ,	1
3. Cruciferæ,	24
4. Violaceæ,	4
5. Caryophyllaceæ,	26
6. Linaceæ,	1
7. Geraniaceæ,	3
8. Polygalaceæ,	1
9. Papilionaceæ,	8
10. Rosaceæ,	21
11. Onagraceæ,	12
12. Portulaceæ,	1
13. Paronychiaceæ,	1
14. Crassulaceæ,	8
Carry forward	124

Nat. Order.	No. of Species, including marked varieties, states, and forms.			
Brought over,	124			
15. Saxifragaceæ,	19			
16. Umbelliferæ,	7			
17. Araliaceæ,	1			
18. Cornaceæ,	1			
19. Stellatæ,	7			
20. Valerianaceæ,	1			
21. Dipsaceæ,	1			
22. Compositæ,	24			
23. Campanulaceæ,	2			
24. Ericaceæ,	15			
25. Primulaceæ,	3			
26. Lentibulariaceæ,	2			
27. Gentianaceæ,	11			
28. Boraginaceæ,	6			
29. Scrophularineæ,	14			
30. Labiatæ,	7			
31. Plumbagineæ,	1			
32. Plantagineæ,	6			
33. Chenopodiaceæ,	3			
34. Polygonaceæ,	12			
35. Empetraceæ,	1			
36. Callitrichineæ,	2			
37. Urticaceæ,	2			
38. Amentaceæ,	16			
39. Coniferæ,	2			
		290		
b. Monocotyledons.				
40. Typhaceæ,	1			
41. Naiadaceæ,	8			
42. Alismaceæ,	2			
43. Orchidaceæ,	13			
44. Liliaceæ,	4			
45. Juncaceæ,	13			
46. Cyperaceæ,	51			
47. Gramineæ,	44			
		136		
			426	
Number *not British*,	72			

II. CRYPTOGAMS.

1. Lycopodiaceæ,		8		
2. Equisetaceæ,		7		
3. Filices,		14		
4. Characeæ,		2		
5. Musci,		149		
6. Hepaticæ,		54		
7. Algæ,		97		
8. Lichenes,		93		
9. Fungi,		13		
			437	
Number *not British*,		15		863

ABSTRACT.

		No. of Species, including marked varieties, states, and forms.
Total number of Phanerogams :—		
British, ...	354	
Not British, . . .	72	
		426
Total number of Cryptogams :—		
British, ...	422	
Not British, . . .	15	
		437
Total numerical strength of Icelandic Flora as in 1860, ...		863

As I have already explained, the data on which these statistics are founded are imperfect, and hence the statistics themselves must be equally so. I therefore base on them no comparisons with the statistics of the Floras of Greenland, Norway, Scandinavia generally, or Britain; nor do I wish at present to found on them any general conclusions. I abstain from such a subject farther than to point out the remarkable equality in numbers between the Phanerogams and Cryptogams, and to indicate the probable extent to which the numbers in the prefixed table fall short of the number of plants at present actually natives of Iceland. I believe that future botanical research will increase the Phanerogams less extensively than the Cryptogams; and I believe farther, that whereas the foregoing tabular view sets down the total Icelandic Phanerogams at 426, 450 is more likely to be the real number; and whereas the Cryptogams appear as 437, 550 is a more probable minimum; so that I incline to estimate the Icelandic Flora as likely to be numerically represented more truly by 1000.

After the remarks which have preceded, it is perhaps unnecessary to repeat that my revised list of Icelandic plants is confessedly imperfect; but I wish this to be distinctly understood. It is imperfect in so far as it does not represent the entire existing Flora of Iceland. I believe that many Phanerogams, and still more Cryptogams, remain to be added to the list by the labours of future botanical travellers. I can speak, however, with greater confidence in regard to the Cryptogams than to the Phanerogams. For instance, the collections I made in Iceland last summer, though very limited in extent and variety, have enabled me already to add *several dozen species* to the *Lichens* enumerated in the appended list. But I do not incorporate these in the list; because, *firstly*, I have not yet thoroughly examined them microscopically, and cannot therefore as yet determine how many or what species are new to Iceland; *secondly*, I prefer reserving the results of my own botanical investigations and collections in Iceland for a separate communication; and thirdly, my list appended professes only to come up to 1860. In regard to our present knowledge of the Icelandic Algæ, Mr Croall informs me, "I have not the least doubt that the list of Iceland seaweeds might be doubled, perhaps trebled, by a careful search, especially as the Polar seas are much more fertile than the land. I wish I could have a week or two on its shores. . . . . I am sorry I can add very little to the list, although I have looked over all the books I have. Very little seems to be known of the seaweeds of Iceland." On the same subject Professor Harvey writes, "I have scarcely any Algæ from Iceland. Sir William Hooker made a collection of them, but they were all lost at sea, except a few specimens of *Rivularia* (*Tetraspora*) *cylindrica*, and one of these, saved in his pocket-book, I possess." And in regard to the Mosses and Hepaticæ, Dr Carrington observes, the list is "evidently imperfect, and a good botanist might add many species of these tribes."

Notwithstanding the number of published works or papers on the Flora of Iceland, it must be confessed that but a fraction of the island has been thoroughly examined by competent botanists. Some parts of the island have never been explored by man at all! Such, for instance, is the range of the Klofa or Vatna-jökul in the south of Iceland, covering a surface of several hundred square miles. Nor generally speaking, do the Icelandic Alps, the jökuls or mountains covered by perennial snow or ice, at and above an elevation of 3000 feet, appear to have been botanically explored. The dangers of ascent are such that only a very few of them have been visited by travellers of any kind, and we may therefore conclude that much remains to be learned of the alpine vegetation of Iceland. Again, though such a traveller as Robert spent two years in perambulating the greater part of the island, the fact that he did not add a single new plant to the list of Vahl, or to previous lists, suffices to prove to my mind the want of care with which he conducted his botanical researches or made his botanical collections. British botanists have visited, for the most part, only a very limited portion of the island, viz.,—the vicinity of Reykjavik and the country to the north and south-west of that town, that is to say, parts of the Guldbringé, Arness, Borgar, and Myré-Syssels or districts. This is very far from being the most fertile section of Iceland —that most prolific in vegetation; indeed, there is perhaps scarcely a more barren inhospitable waste in the whole island than the neighbourhood of Reykjavik. The entire range of the southern alps, the mountain ranges generally, the Westmanna, and other islands off the shores of Iceland, the fertile valleys and fjords of the north and east coasts, and a large part of the north-west seaboard, seem to me still open botanical fields. Mr Babington appears to participate in this belief, in so far as he states in his paper (p. 16), " there is great reason to think that a rich and almost unexplored field for botanical research exists in the *northern* part of Iceland. All the accounts of that part of the island describe it as by far the most fertile portion of the country. It is also believed that the *eastern* districts would well repay examination."

Not only is my appended list *imperfect* in extent, or as to the number of species enumerated; it may possibly also be *erroneous* to this extent, and in this wise, that I do not feel satisfied (notwithstanding the care that has been bestowed on it) that it does not contain unwittingly the names of species which are really not natives of Iceland, or that the synonymes are in all cases correct. How far I am justified in entertaining such suspicions can only be determined by the future labours of botanical travellers, who will require to collect and determine anew the names of the species so collected.

My object at present being simply to revise the lists of Icelandic plants up to 1860, I do not here enter at all on such topics as the present and former so-called "forests" of Iceland—the present or former state of its agriculture or garden-culture—its "Surturbrand" and fossil Flora—the economic uses of its common plants by the natives—the drift timber from America and the West Indies—the peculiar influence on its vegetation of the Gulf-stream and polar-ice—of the climate and geology—the geographical distribution of its plants, or the relations of the Flora to that of different parts of the European and American continents, or of the British Islands, the Faröes, &c. Nor do I here touch upon topics to which my attention was more especially directed in Iceland, such as all points bearing on the natural history of Icelandic *Lichens*. These, and other subjects relating to the Flora of Iceland, I leave for exposition on a future occasion, when I may have had an opportunity of improving or extending my knowledge thereof by further visits to and explorations of Iceland—when I may therefore be able to speak more from personal information than I can at present do.

The botanical traveller in Iceland is at once struck by the strong general resemblance between the Flora of Iceland and that of Britain, especially that of Scotland; and this impression is confirmed by the fact, that out of the 426 phanerogams mentioned in my list, only 72, while of the 437 cryptogams only 15, are *not* British. As might be expected from its latitude and climate, however, the number of species in Iceland, especially of phanerogams, is greatly less than in Britain. But the great peculiarity of Icelandic vegetation, as contrasted with that of Scotland, appeared to me to consist in the distribution of many of the Icelandic plants. In Iceland, the rarest Scotch alpines are found at, or slightly above the sea-level, bestrewing the deserts; and they are among the commonest plants of the country. No plant, for example, did I find so common as *Silene acaulis*, which was in beautiful flower; and none, it may be observed, strikes tourists so much. It is abundant on the road between Reykjavik and the Geysers—the excursion, which of all others in Iceland never fails to be "done" by the tourist. The plant grows where almost no other phanerogam is usually found; and its red flowers render it conspicuous. While galloping from Reykjavik to the Laxá or

Salmon River, our rare *Lychnis alpina*, also in fine flower (and which in Iceland is sometimes white), frequently caught my eye. As an illustration of the vegetation of the lower lands of Iceland, let me cite that of the vicinity of Reykjavik, of which I can speak from personal observation. This district is in general little elevated above the sea, and is essentially a barren, stony desert—the soil being made up chiefly of fragments of dolerite, trachyte, and lava. In some localities, it is a lava field, or series of lava fields, as in the neighbourhood of Havnafjord; in others, it consists of morass or moorland, having quite as desolate an aspect as the stony deserts just referred to. Associated with the alpine plants above-mentioned (*Silene acaulis* and *Lychnis alpina*) occurred also, in beautiful flower, *Thalictrum alpinum*, *Cerastium alpinum*, *Alchemilla alpina*, *Draba incana* in large handsome tufts, *Dryas octopetala*, *Salix herbacea*, *Potentilla verna* var. *alpestris*, *Luzula spicata*, and *Oxyria reniformis;* and the following sub-alpines, *Aira cœspitosa* var. *alpina*, *Festuca ovina* var. *duriuscula*, form or state *vivipara*, *Arctostaphylos Uva-Ursi*, and *Empetrum nigrum*. On the Reykjavik deserts or moors, especially to the north-west of the town, some of the commonest British wayside weeds occur in a dwarf or pigmy, and greatly altered, form. *Cardamine hirsuta*, and its var. *sylvatica* are abundant here and on the banks of the Laugar; but it is a pigmy, about 1 to 2 inches high, resembling strongly a similar dwarf form of *Capsella Bursa-pastoris*, and is scarcely recognisable at first sight as our familiar *Cardamine*. The dwarf form of *C. Bursa-pastoris* is also about 1 to 2 inches high, and is quite a miniature of our common roadside weed. The following plants are also common in the neighbourhood of Reykjavik, all of them associated indiscriminately with the Scotch alpines and sub-alpines already mentioned, many of them more especially abounding on the streets or roadsides of Reykjavik, or in the immediate vicinity of habitations. *Caltha palustris* is the most abundant marsh plant about Reykjavik. *Armeria vulgaris* is very abundant on all the moors, as are also *Luzula campestris*, *Silene inflata* var. *maritima*, *Veronica serpyllifolia*, *Vaccinium uliginosum*, *Cardamine pratensis* in fine flower, and *Galium* *saxatile*, with its var. *pusillum*. In more marshy localities, many forms of *Carex cæspitosa* abound, as does also *Equisetum limosum*. Occurring also on the moors .and marshes, but met with in greater profusion on the roadsides about Reykjavik, *e.g.*, on the road to the cemetery or burying-ground to the south-west of the town, are such common British lowland plants as *Ranunculus acris* and *repens*, *Rumex acetosa* and *Acetosella*—the latter in beautiful flower —*Cerastium vulgatum* and *Stellaria media*. A delicate form of *Anthoxanthum odoratum* is common on the moors. Among the shingle on the beach to the west of the town *Glaux maritima* is abundant. On the banks of the Laxá, or Lax-elv (the Salmon River of British tourists), about the Falls and Salmon weir I found our common *Spiræa Ulmaria* and *Geum rivale*. And on the Havnafjord lava field, growing luxuriantly in crevices of the old lava on the heights immediately behind the village, I picked tufts of *Saxifraga cæspitosa*, *Draba incana*, *Arabis petræa* and *Viola canina* var. *flavicornis*. Of the *algæ* found on the coasts, none were so abundant as *Desmarestia aculeata*. I found it in immense tangled masses on the shore about Reykjavik, but in greatest profusion in a little bay midway between Reykjavik and Havnafjord. Mr Croall tells me that this is "a very common plant in the North Atlantic, at least on its eastern shores, and is perhaps scarcely less so on the shores of the Pacific, and even in the Southern Ocean, where it is represented by forms very nearly allied, if not identical, *D. media*, &c." I found also almost everywhere on the shores about Reykjavik, *Laminaria digitata* and *saccharina*, *Fucus vesiculosus* and *serratus*, *Chondrus crispus*, *Wormskioldia sanguinea*, and other algæ quite as familiar on our own coasts, and which appear to be known to the Icelanders under the common name of "Tang" (a word very near the "*Tangle*" of our own Newhaven fishwives). In my Bibliographical appendix (No. 19) will be found mentioned a special dissertation, by a native Icelander, on the economical applications of the Icelandic algæ ("Tangarter"). Of the *mosses*, by far the most common—so common, indeed, as to give a tone to the more minute features of the landscape—is the *Racomitrium lanuginosum*. It is especially abundant on the lava fields, growing in crevices of the lava in all directions, and in great profusion about Havnafjord. Of the *lichens*, *Platysma nivale* was very common on the deserts to the south-east of the cemetery of Reykjavik, occurring frequently where no other cryptogams or phanerogams could grow. It was usually associated in tufts with *Cetraria aculeata*, both plants being sterile in all the cases in which I examined them. The *Cetraria islandica* and *Cladonia rangiferina*, which might be expected here in profusion, I found only sparingly, and usually growing in tufts, especially the former, with *Racomitrium lanuginosum*. Seen from any distance, the surface of the district about Reykjavik has a brown or blackish-brown colour, and a bleak, sterile aspect. Vegetation is not so luxuriant, or of such a character as to give rise to verdure, unless in such localities as the alluvial banks of rivers, streams, or lakes—occasional marshes—the farm-lands enclosed by or immediately surrounding farms, and designated the "tun,"—and the pasture-lands in the vicinity of towns and villages. In such situations the verdure generally formed a more or less striking contrast to the earth-brown colour and bleakness of the surrounding deserts or moors. There was frequently an excellent though very irregular sward, and the same lowland plants were met with as occur under similar circumstances in Britain.

But the strongest and strangest contrast to the general vegetation of the Reykjavik district was to me that of the hot springs at Laugarness. The ground immediately surrounding the springs, as well as the banks of the Laugar (stream), to which the said springs give rise,—at least for some hundred feet of its course towards the sea,—formed quite an "oasis in the desert." Unfortunately the pocket thermometer I had with me was not marked higher than 130°. But the water of the springs was so hot that my finger or hand was once severely scalded on being immersed: I could not retain either submerged for an instant. The water was boiling and bubbling up from the bed of the springs, and was steaming copiously on its surface; eggs might be cooked in the water in the course of four or five minutes, and fish and fowls in a correspondingly short time. The water of the Laugar, which is a comparatively large stream, was hot, then warm, then tepid, for several hundred feet in its seaward course, also steaming more or less abundantly according to its temperature; the mud and stones in the bed, and facing the banks, of the stream at its fountain-head, as well as the spring-deposits, were too hot to be handled with impunity. Add to these facts, that, on the occasion of my second visit to the springs, I found several washerwomen established on the banks of the Laugar, considerably below its fountain-head, where they found the water warm enough for washing purposes, their washing tubs steaming as satisfactorily as if they had been supplied with water boiled artificially—and that the said washerwomen found the water of the springs sufficiently hot for "masking" their tea or coffee; and I think I am justified in inferring that the temperature of the springs must have been at least 180°. The springs have deposited incrustations, which, like those of the Geysers, are essentially silicious, though they bear the closest resemblance to the stalagmitic (calcareous) deposits of many of our own so-called petrifying springs or streams, as that of Starley Burn, near Aberdour, Fife. The bed and banks of the stream in the vicinity of the springs consist essentially of parti-coloured muds, some of a deep blackish-green, others of a cobalt blue—some of an ochreous red colour; all having a sulphurous smell when fresh, and being very friable when cold and dry. Chemical analyses of these deposits are given in my "Contributions to the Natural History of Volcanic Phenomena and Products in Iceland" (*Proceedings of Royal Society of Edinburgh*, Dec. 17, 1860), and in my account of "The Eruption in May 1860 of the Kötlugjá Volcano, Iceland," (*Edin. New Philosophical Journal*, Jan. 1861.) In the stream, from immediately below the springs, for a considerable distance downwards, and where the temperature of the water must have ranged from about 130° to 90°, grew luxuriantly a couple of *Confervæ.* The one was of a deep greenish, the other of a yellow or rusty colour; both occurred in long tufts, and formed a slimy coating on the small gravel and sand, which constituted the bed of the stream, to which gravel, moreover, they adhered firmly. I collected and brought home with me specimens of both, but I had at the time no proper means of preserving them ; and though I subsequently submitted them for determination of the species to one of our most eminent algologists, no communication having been received from him, I infer that the specimens were in such a condition as to render their determination impossible.

I found *Poa annua* and *Stellaria media* growing in hot mud on the margin of the springs, and with their roots in the hot water, their leaves immersed in steam. The former was apparently healthy and vigorous ; the latter was dwarfed and bleached, closely resembling *Montia fontana*, for which, indeed, it was at first mistaken. The ground immediately around the springs was unusually verdant, being covered with a fine sward, on which many of our commonest British weeds grew in remarkable beauty and luxuriance. Such were *Plantago major*, *Potentilla Anserina*, *Prunella vulgaris*, *Cardamine pratensis*, *Alchemilla vulgaris*, *Thymus Serpyllum*, *Taraxacum Dens-leonis* var. *palustre*, *Ranunculus acris* and *repens*, *Pinguicula vulgaris*, and various forms of *Stellaria media* and *Cerastium vulgatum*. The five plants first mentioned were especially large and handsome. Above the hot springs there is a marshy pond, the water of which is cold, stagnant, and ochreous from ferruginous impregnation. Here luxuriated *Menyanthes trifoliata* and *Eriophorum polystachyon* in beautiful flower ; many *Carices*, especially forms of the common *C. cæspitosa ;* many grasses, such as *Catabrosa aquatica*, *Glyceria fluitans*, *Poa annua ;* several *Potamogetons*, as *P. natans*, *P. perfoliatus*, and *P. crispus ;* and several *Equisetums*, as *E. palustre*, *E. limosum*, *E. arvense*, and *E. hyemale*. The same luxuriance of vegetation which characterised the immediate vicinity of the hot springs and of the marsh above them, was also met with on the banks of the Laugar for several hundred feet of its seaward course. The causes of this profusion and richness of vegetation are easily found in the increased temperature of the soil and of the air immediately above it, as well as in the constant abundance of a warm moisture in the said air, in the form of the steam which never ceases to arise from the hot water.

This account of the vegetation around the hot springs of Laugarness does not apparently accord with Mr Babington's description of that of the vicinity of the Geysers. "The neighbourhood of the Geysers does not," he says, "appear to be rich in plants; nor does the hot water, which issues from the ground in a state of active ebullition, seem to hasten their growth. I could not perceive that individuals growing in the warm mud by the side of steaming currents were at all more forward than others at a distance from the heated spots" (p. 16). I have every reason to believe, however, that the vegetation in and around the Laugar hot springs, as described above from personal observation, represents generally that of the hot springs of Iceland; and not only so, but that of hot springs in similar positions in every quarter of the world. This is strikingly borne out by Dr Hooker's description of the vegetation of certain hot springs in India and the Himalayas. The vegetation of those visited by Dr Hooker and myself respectively in distant and opposite portions of the globe is wonderfully alike; so much so that two *Confervæ* described by Dr Hooker as growing in the hot springs of Soorujkoond, near Burdwan, Behar, India, so far as external characters are concerned, might be identical with the two I gathered in those of Laugarness. The Indian springs in question have temperatures respectively of 169°, 170°, 173°, and 190°. "*Confervæ* abound in the warm stream from the springs, and two species, one *ochreous brown* and the other *green*, occur on the margins of the tanks themselves, and in the *hottest water*. The brown is the best salamander, and forms a belt in deeper water than the green. Both appear in broad luxuriant strata wherever the temperature is cooled down to 168°, and as low as 90°." (Dr Hooker's *Himalayan Journals*, vol. i. p. 27.) "Of flowering plants, three showed in an eminent degree a constitution capable of resisting the heat, if not a predilection for it. These were all *Cyperaceæ*,—a *Cyperus* and an *Eleocharis* having their roots in water of 100°, and where they are probably exposed to greater heat" (p. 28). "From the edges of the four hot springs, I gathered sixteen species of flowering plants" (p. 28). Dr Hooker also mentions a *Conferva* as growing in the hot springs at Yeumtong, in the

Lachoong valley, Sikkim-Himalaya—elevation above the sea, 11,730 feet—temperature of springs, 112°. (Vol. ii. p. 117.) And he further describes the Momay hot springs near the great glacier of Kinchinjhow, also in Sikkim-Himalaya (elevation above the sea, 16,000 feet), from the luxuriance and greenness of their vegetation, as quite an oasis in the desert, bearing in this respect the most striking resemblance to those of Laugarness. (Vol. ii. p. 133.)

Revised and Corrected List of the Plants of Iceland (*so far as known to the Author*) *up to* 1860.*

I. PHANEROGAMS.

a. Dicotyledons.

1. *Ranunculaceæ.*

Thalictrum alpinum, L. (*Vèlindisurt, Krossgras, Júfrsmein, Brjóstagras, Kverkagras.*)
Ranunculus aquaticus, L. (*Lónasóley,*) and form capillaceus.
R. Flammula, L. form reptans.
R. acris, L. (*Brennisóley.*)
R. repens, L.
R. aquaticus, L. form hederaceus.
*R. glacialis, L. (*Dvergasóley.*)
*R. Lapponicus, L.
*R. hyperboreus, Rottb.
*R. nivalis, L. (*Dvergasóley.*)
*Batrachium heterophyllum, Fr.
Caltha palustris, L. (*Lækjasóley, Hófbladka, Hofgrasi.*)

2. *Papaveraceæ.*

*Papaver nudicaule, L. (*Melasól.*)

3. *Cruciferæ.*

Arabis petræa, L.
*A. alpina, L.
Cardamine pratensis, L. (*Hrafnaklukka, Kattarbalsam, Lambaklukka.*)
*C. bellidifolia, L.
C. hirsuta, L., and var. sylvatica.
Nasturtium palustre, DC., N. amphibium, Br. } (*Hrafnaklukka med gulu blomstri.*)
N. officinale, Br.
Cochlearia officinalis, L (*Skarfakál*), and vars. Danica and Anglica.
Draba hirta, L., and var. rupestris.
D. incana, L., and var. *stricta.
D. muralis, L.
D. verna, L.
*D. nivalis, Liljebl.
Capsella Bursa-pastoris, DC. (*Rungarfi, Hjartarfi.*)
Lepidium campestre, Br.
Subularia aquatica, L.
Cakile maritima, Scop.
*Erysimum alpinum, Baumgarten.

4. *Violaceæ.*

Viola palustris, L. (*Fióla.*)
V. canina, L., and var. flavicornis. (*Tirsfióla.*)
V. tricolor, L. (*Fióla, Threnumgargras, Blódsóley.*)

5. *Caryophyllaceæ.*

Silene acaulis, L. (*Lambagras, Holtavól, Hardasægjur, Gulltoppr.*)
S. inflata, Sm. (*Pungagras, Holurt, Hjartagras*), and var. maritima.
Lychnis Flos-cuculi, L. (*Mukahetta.*)
L. viscaria, L.
L. alpina, L. (*Kveisugras, Angufræ.*)

* Those marked with an asterisk (*) are *not* natives of Britain; all others are common to Iceland and Britain.

Sagina procumbens, L.
S. nodosa, Fenzl.
S. Linnæi, Presl.
Arenaria verna, L., var. rubella, Br. and var. *hirta, Hn.
A. peploides, L. (*Barja-arfi, Smedjukal, Fjörnarfi.*)
A. ciliata, L., and var. norvegica.
A. serpyllifolia, L.
Cerastium trigynum, Vill.
C. vulgatum, L., var. viscosum, Sm. and var. *holosteoides, Aspegr.
C. alpinum, L., and var. latifolium.
*Stellaria, Edwardsii R. Br.
S. media, L.
*S. humifusa, Rottb.
*S. crassifolia, Ehrh., var. subalpina.
Spergula arvensis, L.
*Alsine biflora, Wg.

6. *Linaceæ.*

Linum catharticum, L.

7. *Geraniaceæ.*

Geranium sylvaticum, L. (*Storkablágresi, Litunargras.*)
G. pratense, L.
G. phæum, L., var. fuscum, L. (*Stóra-blágresi.*)

8. *Polygalaceæ.*

Polygala vulgaris, L.

9. *Papilionaceæ.*

Lotus corniculatus, L.
Vicia Cracca, L. (*Umfedmingsgras, Flækja, Samflattingr, Krokagras.*)
Lathyrus pratensis, L.
L. maritimus, Bigel. (*Bannagras.*)
Anthyllis Vulneraria, L.
Trifolium arvense, L.
T. repens, L. (*Smari, Smæra.*)
T. pratense, L.

10. *Rosaceæ.*

Spiræa Ulmaria, L.
Dryas octopetala, L. (*Rjúpnalýng, Rjúpnalauf, Holtasóley, Petrssóley.*)
Geum rivale, L. (*Fjalldæla, Fjalla-fífill, Solsekvia,*) and state intermedium.
Rubus saxatilis, L. (*Hrútaber, Skollareipi.*)
Fragaria vesca, L.
*F. collina, Ehrh.
Potentilla verna, L., var. alpestris or aurea.
P. anserina, L. (*Mura, Murusóley, Mýrutágar.*)
P. Comarum, Nestl. (*Engjarós, Mýratág, Blódsóley.*)
P. Tormentilla, Sibth.
*P. maculata, Pourr.
Sibbaldia procumbens, L.
Alchemilla vulgaris, L. (*Mariustakkr*), and var. *montana.
A. alpina, L. (*Ljónsfóttr, Ljónskló, Ljónslappi, Kverkagras.*)
A. arvensis, Scop.
Sanguisorba officinalis, L.
Rosa villosa, L., var. hibernica.
R. pimpinellifolia, L.
Pyrus Aucuparia, Gærtn. (*Reynir.*)

11. *Onagraceæ.*

Epilobium montanum, L.
E. angustifolium, L.
E. palustre, L.
E. alpinum, L.
E. tetragonum, L., and var. virgatum.
*E. origanifolium, Lam.
*E. latifolium, L. (*Purpurablómster, Mariuvöndr.*)
*E. rosmarinifolium, Hænke.
Myriophyllum spicatum, L.
M. verticillatum, L.
Hippuris vulgaris, L. (*Markálmr.*)

12. *Portulaceæ.*

Montia fontana, L.

13. *Paronychiaceæ.*

Scleranthus annuus, L.

14. *Crassulaceæ.*

Sedum Rhodiola, DC. (*Burni, Burkni, Höfudrót, Hellmuhnodrarót, Greidurót.*)
S. anglicum, Huds.
S. album, L.
S. villosum, L.
S. acre, L. (*Helluhnodri.*)
S. rupestre, L.
*S. annuum, L.
*Bulliarda aquatica, DC.

15. *Saxifragaceæ.*
Saxifraga oppositifolia, L. (*Snjóblómstr, Vetrarblóm, Lambablóm.*)
*S. aizoon, Jacq.
S. aizoides, L.
S. Hirculus, L.
S. hypnoides, L.
S. cæspitosa, L., and var. palmata.
S. cernua, L., and var. *racemosa.
S. rivularis, L.
S. tridactylites, L.
S. nivalis, L.
S. stellaris, L.
*S. tricuspidata, Retz.
*S. Cotyledon, L. (*Klettafrú.*)
S. granulata, L.
Parnassia palustris, L. (*Mýrasóley.*)
Drosera rotundifolia, L.
D. longifolia, L.

16. *Umbelliferæ.*
Hydrocotyle vulgaris, L.
Ægopodium Podagraria, L. (*Geitnarjól.*)
Carum Carui, L.
Ligusticum scoticum, L.
*Angelica Archangelica, L.
A. sylvestris, L. (*Geitla.*)
Peucedanum Ostruthium, Koch. (*Sæhvönn.*)

17. *Araliaceæ.*
Hedera Helix, L.

18. *Cornaceæ.*
Cornus suecica, L.

19. *Stellatæ.*
Galium verum, L. (*Gulmadra.*)
G. palustre, L.
G. saxatile, L., var. pusillum, L., and var. sylvestre.
G. boreale, L. (*Krossmadra.*)
G. Mollugo, L.
G. uliginosum, L.

20. *Valerianaceæ.*
Valeriana officinalis, L. (*Vélantsurt.*)

21. *Dipsaceæ.*
Scabiosa succisa, L. (*Púkabit, Stúfa.*)

22. *Compositæ.*
Erigeron alpinus, L. (*Jakobsfífill, Smjörgras.*)
Achillæa Millefolium, L. (*Jardhumall, Vellhumall.*)
Gnaphalium sylvaticum, L. (*Grájúrt*), and var. fuscatum or Norvegicum, Gunn.
G. uliginosum, L.
G. supinum, L.
*Antennaria alpina, Gærtn. (*Fjandafæola.*)
Senecio vulgaris, L.
S. sylvaticus, L.
Carduus arvensis, Curt.
C. heterophyllus, L.
C. lanceolatus, L.
Leontodon autumnalis, L. (*Fífill*), and var. Taraxaci.
Taraxacum Dens-leonis, Desf. (*Ætififill, Bifukolla*), and var. palustre.
*Crepis præmorsa, Tansch. (*Undafífill.*)
Hieracium Pilosella, L.
H. alpinum, L.
H. murorum, L.,
*H. Auricula, L.
} (*Undafífill.*)
Tussilago Farfara, L.
Chrysanthemum inodorum, L., (*Baldurslrú,*) and var. maritimum.

23. *Campanulaceæ.*
Campanula patula, L.
C. rotundifolia, L. (*Bláklukka.*)

24. *Ericaceæ.*
Vaccinium uliginosum, L.
V. Myrtillus, L. (*Adalbláberjalýng.*)
V. Oxycoccus, L.
V. Vitis-Idæa, L.
Arctostaphylos Uva-Ursi, Spr. (*Sortulýng, Mulníngr.*)
A. alpina, Spreng.
*Andromeda hypnoides, L.
Loiseleuria procumbens, Desv.
*Rhododendron Lapponicum, Wg.
*Ledum latifolium, Lam.
Erica vulgaris, L. (*Beitilýng.*)
E. Tetralix, L.
Pyrola rotundifolia, L. (*Vetrarlaukr.*)
P. secunda, L.
P. minor, L.
*Diapensia Lapponica, L.

25. *Primulaceæ.*
Primula farinosa, L.
Glaux maritima, L.
Trientalis europæa, L.

26. *Lentibulaceæ.*
Pinguicula vulgaris, L. (*Hleypisgras, Jonsmessugras, Lifjagras, Kœsirs-gras.*)
P. alpina, L.

27. *Gentianaceæ.*
Gentiana nivalis, L. (*Digragras.*)
G. Amarella, L.
G. campestris, L. (*Mariuvöndr, Kveisugras.*)
G. verna, L.
*G. involucrata, Rottb. (*Mariuvöndr.*)
*G. tenella, Rottb.
*G. serrata, Gunn., and *var. detonsa, Rottb.
*G. bavarica, L.
Menyanthes trifoliata, L. (*Horbladka, Kveisugras, Reidingagras.*)
*Pleurogyne rotata, Grisebach.

28. *Boraginaceæ.*
Echium vulgare, L. (*Kisugras.*)
Mertensia maritima, Don. (*Strandarfi.*)
Myosotis palustris, With. (*Kattarauga.*)
M. arvensis, Roth.
M. collina, Hoffm.
M. versicolor, Pers.

29. *Scrophularineæ.*
Limosella aquatica, L.
Veronica saxatilis, L.
V. alpina, L.
V. officinalis, L. (*Æruprís.*)
V. Anagallis, L.
V. Beccabunga, L. (*Vazarfi.*)
V. scutellata, L.
V. serpyllifolia, L.
*V. peregrina, L.
Bartsia alpina, L. (*Lokasjódsbródir.*)
Euphrasia officinalis, L. (*Augnagras.*)
Rhinanthus Crista-galli, L. (*Lokasjódr, Oskugras, Penínga-gras.*)
Pedicularis sylvatica, L.
*P. flammea, L.

30. *Labiatæ.*
Thymus Serpyllum, L. (*Blódberg, Hellinhagra, Brádbjörg.*)
Prunella vulgaris, L. (*Brunella.*)
Galeopsis Ladanum, L.
G. Tetrahit, L.
Lamium purpureum, L.
L. album, L.
L. amplexicaule, L.

31. *Plumbagineæ.*
Armeria vulgaris, Willd. (*Gullintoppa.*)

32. *Plantagineæ.*
Plantago major, L. (*Grædisúra.*)
P. lanceolata, L. (*Selgresi, Fuglatúngur.*)
P. maritima, L. (*Kattartúnga.*)
P. Coronopus, L.
P. media, L.
*P. alpina, L.

33. *Chenopodiaceæ.*
Atriplex patula, L.
A. rosea, L.
A. hortensis, L. (*Gardasól.*)

34. *Polygonaceæ.*
Rumex conglomeratus, Murr. (*Heimilisnjóli, Heimula, Fardagakél.*)
R. Acetosa, L. (*Vallarsúra.*)
R. Acetosella, L.
R. aquaticus, L.
Oxyria reniformis, Campd. (*Olafs-súra.*)
*Kœnigia Islandica, L. (*Nablagras.*)
Polygonum aviculare, L. (*Oddvari, Blodarfi.*)
P. viviparum, L. (*Kornsúra.*)
P. amphibium, L.
P. Persicaria, L. (*Flóarurt.*)
P. Hydropiper, L.
P. Bistorta, L.

35. *Empetraceæ.*
Empetrum nigrum, L. (*Krækilýng, Lúsalýng.*)

36. *Callitrichineæ.*
Ceratophyllum demersum, L.
Callitriche aquatica, Sm.

37. *Urticaceæ.*
Urtica urens, L.
U. dioica, L. (*Brennunetla, Notrugras.*)

38. *Amentaceæ.*

Betula alba, L. (*Birki, Björk, Rifhrís.*)
B. nana, L. (*Fjalldrapi.*)
*B. fruticosa, Pall.
*B. intermedia, Thom.
Salix pentandra, L.
S. Caprea, L. (*Selja.*)
S. repens, L. (*Beinvidir.*)
S. Lapponum, L. (*Grávidir, Kotúnsvidir, Tág.*)
S. lanata, L.
Salix Myrsinites, L.
*S. arctica, Pall.
S. reticulata, L.
S. herbacea, L. (*Grasvidir, Kotúngslauf.*)
S. phylicifolia, L.
S. purpurea, L.
*S. myrtilloides, L.

39. *Coniferæ.*

Juniperus communis, L. (*Einir, Einirber*), and var. nana.

b. Monocotyledons.

40. *Typhaceæ.*

Sparganium natans, L.

41. *Naiadeæ.*

Zostera marina, L. (*Markálmr.*)
Potamogeton natans, L.
P. lucens, L., and var. rufescens.
P. perfoliatus, L.
P. crispus, L.
P. pusillus, L.
P. pectinatus, L.

42. *Alismaceæ.*

Triglochin palustre, L.
T. maritimum, L. (*Sandlaukr.*)

43. *Orchidaceæ.*

Orchis maculata, L. (*Gradrót, Vinagras, Brönugrös, Hjönagras, Elskugras, Friggjargras.*)
O. latifolia, L.
O. mascula, L.
O. Morio, L.
*O. angustifolia, Wimm., var. cruenta.
Habenaria viridis, Br.
H. albida, Br.
Corallorhiza innata, Br.
Listera ovata, Br.
Neottia Nidus-avis, L.
*Nigritella angustifolia, Rich.
*Platanthera hyperborea, Lindley.
*P. Kœnigii, Lindley.

44. *Liliaceæ.*

Paris quadrifolia, L. (*Fjögralaufasmari.*)
Tofieldia palustris, Huds. (*Sýkisgras.*)
*Anthericum ramosum, L. (*Iglagras, Sikisgras.*
*Maianthemum bifolium, DC.

45. *Juncaceæ.*

Juncus communis, Mey. and var. effusus.
J. articulatus, L.
J. compressus, Jacq.
J. squarrosus, L.
J. bufonius, L.
J. trifidus, L.
J. biglumis, L., and var. triglumis.
*J. arcticus, Willd.
Luzula pilosa, Willd.
L. campestris, Br.
L. spicata, DC.

46. *Cyperaceæ.*

Carex dioica, L.
C. pulicaris, L.
C. leporina, L.
C. lagopina, Wahlenb.
C. elongata, L.
C. canescens, L.
C. vulpina, L.
C. muricata, L.
C. arenaria, L.
C. saxatilis, L.
C. cæspitosa, L., and var. rigida, Good.
C. rupestris, All.
C. panicea, L., and var. vaginata.
C. acuta, L.
C. atrata, L.
C. montana, L.
C. hirta, L.
C. pallescens, L
C. flava, L.

Carex limosa, L., and var. rariflora.
C. pseudocyperus, L.
C. ampullacea, Gooden.
C. vesicaria, L.
C. incurva, Lightf.
C. capillaris, L.
*C. hyperborea, Drej.
*C. capitata, L.
*C. ornithopoda, Willd.
*C. pedata, L.
*C. fuliginosa, Sternb. and Hoppe.
*C. loliacea, L.
*C. microglochin, Wg.
*C. chordorhiza, Ehrh.
*C. cryptocarpa, C. A. Mey.
Scirpus cæspitosus, L.
S. palustris, L, var. uniglumis.
S. acicularis, L.
S. setaceus, L.
S. lacustris, L.
Blysmus compressus, Panz.
B. rufus, Link.
Eriophorum vaginatum, L.
E. alpinum, L.
E. polystachyum, L., (*Fifa.*) and vars. angustifolium, Roth., and latifolium, Hop.
*E. Scheuchzeri, Hop.
*Kobresia scirpina, W.

47. *Gramineæ.*

Anthoxanthum odoratum, L. (*Reyrgras.*)
Phleum pratense, and var. *nodosum, Willd.
P. alpinum, L. (*Foxgras, Tóngras, Refsheli, Puntr.*)
Alopecurus geniculatus, L.
Agrostis alba, L.
A. canina, L.
*A. alpina, Leyss.
Psamma arenaria, Beauv.
Calamagrostis stricta, Nut.
C. Epigejos, Roth.
*C. montana, Host.
Aira cæspitosa, L., and var. alpina.
A. flexuosa, L., and var. montana.
A. præcox, L.
Nardus stricta, L. (*Tödu-finnúngr.*)
Triticum repens, L. (*Húsapuntr.*)
T. caninum, Huds.
Milium effusum, L.
Elymus arenarius, L.
Festuca ovina, L., and vars. rubra, and duriuscula, and state vivipara.
F. elatior, L., and var. arundinacea.
Poa laxa, Hœnke.
P. pratensis, L.
P. fluitans, Scop.
P. maritima, Huds.
P. annua, L.
P. compressa, L.
P. trivialis, L.
P. nemoralis, L., and var. cæsia.
P. alpina, L., and state vivipara.
Catabrosa aquatica, Beauv.
Sesleria cærulea, Ard.
Arundo Phragmites, L.
Hierochloe borealis, Rœm. and Sch. (*Reisgresi.*)
*Trisetum subspicatum, Beauv.

II. CRYPTOGAMS.

I. Lycopodiaceæ.

Isoetes lacustris, L.
Lycopodium annotinum, L.
L. alpinum, L. (*Jafni.*)
L. clavatum, L. (*Jafni, Isfnabródir.*)
L. Selago, L. (*Vargslappi, Skollafingr.*)
L. selaginoides, L.
*L. complanatum, L.
*L. dubium, Kœnig.

II. Equisetaceæ.

Equisetum sylvaticum, L.
E. palustre, L.
E. limosum, L.
E. hyemale, L. (*Eskigras, Góebitill.*)
E. pratense, Ehrh.
E. arvense, L. (*Elting, Goubitill, Gvindarber, Grombitill, Sætutág, Sultarepli, Skollafótr*), and *var. alpestre.

III. Filices.

Ophioglossum vulgatum, L.
Botrychium Lunaria, Sw. (*Túngl-urt.*)
Polypodium vulgare, L.
P. Phegopteris, L.
P. Dryopteris, L.
Aspidium Lonchitis, Sw.
A. Filix-mas. (*Burn, Burkni, Tóngras.*)
Allosorus crispus, Bernh.
Asplenium Filix-fœmina, Bernh.
A. fontanum, Bernh.
A. septentrionale, Hoffm.
A. Trichomanes, L.
Cystopteris fragilis, Bernh.
Woodsia ilvensis, Br.

IV. Characeæ.

Chara vulgaris, L.
Chara hispida, L.

V. Mosses.

1. *Andrœaceœ.*

Andræa rupestris, L.
A. Rothii, Web. and M.
A. alpina, Dill.

2. *Sphagnaceœ.*

Sphagnum cymbifolium, Dill. (*Barnamosi.*)
S. compactum, Brid.
S. acutifolium, Ehrh.

3. *Bryaceœ.*

(1.) *Acrocarpi.*

Phascum serratum, Schreb.
P. muticum, Schreb.
Gymnostomum curvirostrum, Hedw.
Weissia cirrhata, Hedw.
W. crispula, Hedw.
Dicranum heteromallum, Hedw.
D. squarrosum, Schrad.
D. scoparium, Hedw.
D. subulatum, Hedw.
D. palustre, Brid.
D. cerviculatum, Hedw. β. pusillum, Wils.
D. virens, Hedw.
D. polycarpum, Ehrh., var. strumiferum, Web. and Mohr.
D. crispum, Hedw.
D. Scottianum, Turn.
Leucobryum glaucum, Hampe.
Ceratodon purpureus, Brid.
Pottia truncata, Hedw.
P. Heimii, Br. and Sch.
Anacalypta lanceolata, Röhl.
Distichium capillaceum, Br. and Sch.
Didymodon flexifolius, Hook. and Tayl.
Didymodon rubellus, Br. and Sch.
Trichostomum glaucescens, Hedw.
T. tophaceum, Brid.
Tortula tortuosa, Web. and M.
T. subulata, Brid.
T. ruralis, Hedw.
T. convoluta, Hedw.
Cinclidotus fontinaloides, P. Beauv.
Encalypta vulgaris, Hedw.
E. commutata, Nees and Hsch.
E. ciliata, Hedw.
E. rhabdocarpa, Schwægr.
Schistidium apocarpum, Br. and Sch., and var. strictum, Brid.
S. maritimum, Br. and Sch.
Grimmia pulvinata, Smith.
G. Doniana, Sm.
G. ovata, Web. and Mohr.
Racomitrium fasciculare, Brid.
R. canescens, Brid.
R. ellipticum, Br. and Sch.
R. heterostichum, Brid.
R. lanuginosum, Brid.
R. sudeticum, Br. and Sch.
R. aciculare, Brid.
Orthotrichum affine, Schrad.
O. cupulatum, Hffm.
O. leiocarpum, Br. and Sch.
O. phyllanthum, Br. and Sch.
O. rupestre, Schleich.
Zygodon Lapponicus, Br. and Sch.
Tetraphis pellucida, Hedw.
Diphyscium foliosum, Web. and M.
Pogonatum aloides, Brid.
P. alpinum, Brid., and var. arcticum, Swartz.
P. nanum, Brid.
P. urnigerum, Brid.

Polytrichum commune, L.
P. juniperinum, Hedw., and var. strictum, Brid.
P. sexangulare, Hoppe.
P. piliferum, Schreb.
P. formosum, Hedw.
Oligotrichum hercynicum, DC.
*O. lævigatum, Wg.
Amblyodon dealbatus, P. Beauv.
Aulacomnion androgynum, Schwgr.
A. palustre, Schwgr.
Leptobryum pyriforme, H. and Wils.
Bryum argenteum, L.
*B. Duvalii, Voit.
B. nutans, Schreb.
B. cæspiticium, L.
B. crudum, Schreb.
B. pallens, Swartz.
B. turbinatum, Hedw.
B. Zierii, Dicks.
B. julaceum, Sm.
B. Wahlenbergii, Schwægr.
Mnium punctatum, Hedw.
M. hornum, L.
M. undulatum, Hedw.
M. cuspidatum, Hedw.
Meesia uliginosa, Hedw.
Funaria hygrometrica, Hedw.
Physcomitrium fasciculare, Dicks.
Bartramia fontana, Brid.
B. ithyphylla, Brid.
B. pomiformis, Hedw.
Conostomum boreale, Swartz.
Splachnum ampullaceum, L.
*S. rubrum, L.
S. sphæricum, Hedw.
S. vasculosum, L.
Tetraplodon mnioides, Br. and Sch.
Tayloria serrata, Br. and Sch.
Fissidens taxifolius, Hedw.
F. adiantoides, Hedw.

(2.) *Pleurocarpi.*

Antitrichia curtipendula, Brid.
Climacium dendroides, Web. and M.
Leskea sericea, Dill.
L. moniliformis, Wahlenb.
Hypnum atrovirens, Dicks.
H. abietinum, L.
H. aduncum, L., and var. tenue.
H. cuspidatum, Dill.
H. crista-castrensis, L.
H. cupressiforme, Dill.
H. denticulatum, Dill.
H. filicinum, Dill.
H. illecebrum, L.
H. prælongum, Dill.
H. nitens, Dill.
H. purum, Dill.
H. revolvens, Swartz.
H. splendens, Dill.
H. squarrosum, Dill.
H. Silesiacum, Seliger.
H. tamariscinum, Hedw.
H. triquetrum, Dill.
H. uncinatum, Hall.
H. undulatum, Dill.
H. velutinum, Dill.
H. scorpioides, Dill.
H. molle, Dicks.
H. Schreberi, Dill.
H. sarmentosum, Wahlb.
H. fluitans, Dill.
H. pulchellum, Dicks.
H. lutescens, Dill.
H. cordifolium, Swartz.
H. stellatum, Dill.
H. loreum, Dill.
H. palustre, Dill.
H. rugosum, Dill.
H. molluscum, Dill.
Cryphæa heteromalla, Dill.
Fontinalis antipyretica, L.
F. squamosa, L.
Dichelyma capillaceum, B. and S.

VI. Hepaticæ.

1. *Riccieæ.*

Riccia crystallina, L.
R. glauca, L.

2. *Targionieæ.*

Targionia Michelii, Corda.
β. cuneata, Nees.

3. *Anthoceroteæ.*

Anthoceros punctatus, L.

4. *Marchantieæ.*

Marchantia polymorpha, L.
Preissia commutata, Nees.
*Fimbriaria tenella, Nees.

5. *Jungermannieæ.*

Metzgeria furcata, Nees.
Aneura pinguis, Dum.
A. multifida, Dum.
Pellia epiphylla, Nees.

Blasia pusilla, L.
Fossombronia angulosa, Rad.
Sphagnöecetis communis, Nees.
Alicularia scalaris, Corda.
*A. compressa, Nees v. E.
Madotheca platyphylla, Dum.
Jungermannia albicans, L.
J. bicuspidata, L.
J. divaricata, Sm. Eng. Bot.
*J. pallescens, Schrad.
J. barbata, Schmid.
J. Francisci, Hook.
J. julacea, Lightf.
J. minuta, Crantz.
J. nana, Nees.
J. ventricosa, Dicks.
J. albescens, Hook.
J. trichophylla, L.
J. setiformis, Ehrh.
J. pumila, With.
J. crenulata, Sm.
J. cordifolia, Hook.
J. sphærocarpa, Hook.
Jungermannia laxifolia, Hook.
J. inflata, Huds.
J. porphyroleuca, Nees v. E.
J. connivens, Dicks.
J. saxicola, Schrad.
J. epiphylla, L.
Scapania nemorosa, Nees.
S. compacta, Nees.
S. undulata, Nees.
Plagiochila asplenioides, Nees and Mont.
Gymnomitrium concinnatum, Corda.
Sarcoscyphus Ehrharti, C.
Frullania dilatata, Nees.
Radula complanata, Dumont.
Ptilidium ciliare, Nees.
Sendtnera juniperina, Nees.
Lejeunia serpyllifolia, Lib.
Calypogeja Trichomanis, Corda.
Lophocolea bidentata, Nees v. E.
Chiloscyphus pallesens, Nees v. E.

VII. Algæ.

1. *Diatomaceæ.*

Desmideæ.

Isthmia obliquata, Ag.

2. *Confervaceæ.*

(1.) Palmelleæ.

Coccochloris Grevillei, Hass.
var. botryoides, Hass.

(2.) Nostocheæ.

Nostoc commune, Vauch.
N. verrucosum, Vauch.
*N. lichenoides, Vauch.

(3.) Oscillatorieæ.

Rivularia atra, Roth.
Raphidia angulosa, Hass.
Oscillatoria tenuis, Ag.
O. autumnalis, Ag.
Microcoleus repens, Harv.

(4.) Conferveæ.

Zygnema quininum, Ag.
Z. nitidum, Ag.
Z. deciminum, Ag.
Tyndaridea cruciata, Harv.
Conferva Melagonium, Web. and Mohr.
C. implexa, Dillw.
C. ericetorum, Roth.
Cladophora glomerata, Dillw.
Cladophora flavescens, Kütz.
C. rupestris, L.
C. lætevirens, Dillw.
C. arcta, Dillw.

(5.) Siphoneæ.

Tetraspora cylindrica, Ag.
Ulva latissima, L.
U. Linza, L., and var. lanceolata, L.
U. Lactuca, L.
U. crispa, Lightf.
Enteromorpha intestinalis, Link.
E. compressa, Grev.
Porphyra laciniata, Ag.
P. vulgaris, Ag.

3. *Fucaceæ.*

(1.) Vaucherieæ.

Vaucheria dichotoma, Ag.
Ectocarpus littoralis, Lyngb.
Chordaria flagelliformis, Ag.
Ralfsia verrucosa, Aresch.
*R. deusta, Ag.

(2). Halysereæ.

Sphacelaria scoparia, Lyngb.
S. plumosa, Lyngb.
Dictyota dichotoma, Huds.
Chorda Filum, Lx.
Laminaria digitata, Lx. (*Thaungull, Hrossathaungull.*)

Laminaria saccharina, Lx. (*Beltsthorni, Thamabelti.*)
Alaria esculenta, Grev. (*Muru, Mariukjavni.*)
*A. Pylaii, Bory.
Desmarestia aculeata, Lx.

(3.) Fuceæ.
Fucus vesiculosus, L. (*Beljathang, Thunnathang, Klothang, Boluthang*), and vars. divaricatus, Croal, inflatus, Croal, and spiralis, Lightf.
F. ceranoides, L.
F. serratus, L.
F. nodosus, L. (*Thykkvathang, Ætithang.*)
F. canaliculatus, L., and var. excissus, L.
*F. distichus, L.
Himanthalia lorea, Lyngb.
Halidrys siliquosa, Lyngb.
Cystoseira fœniculacea, Grev.

4. *Ceramiaceæ.*

(1.) Cerameæ.
Callithamnion arbuscula, Br.
C. floccosum, Müll. Fl. Dan.
C. roseum, Roth.
C. plumula, Ellis.
Griffithsia equisetifolia, Ag.
G. corallina, Ag.
Ceramium rubrum, Huds.
C. diaphanum, Lightf.
Ptilota plumosa, Ag.

(2.) Cryptonemeæ.
Iridæa edulis, Bory.
Furcellaria fastigiata, Grev.
Polyides rotundus, Grev.
Phyllophora rubens, Grev.
P. membranifolius, Good. and Woodw.
Chondrus crispus, Lx.
Ahnfeltia plicata, Ag.
*Holosaccion ramentaceum, L.
Gelidium corneum, Lx., and var. cæspitosum, Ag.
Gigartina mammillosa, Good. and Woodw.
Calliblepharis ciliata, Kütz.

(3.) Rhodomeleæ.
Polysiphonia fastigiata, Grev.
P. urceolata, Grev.
Rhodomela lycopodioides, Ag.
R. subfusca, Woodw.
Odonthalia dentata, Lyngb.

(4.) Sphærococceæ.
Cystoclonium purpurascens, Kütz.
Gracilaria confervoides, Grev.
Rhodymenia palmata, Grev., and vars. sobolifera, Harv., and ovina, Croall.
R. laciniata, Huds.
Euthora cristata, Ag.
Sphærococcus coronopifolius, Ag.

(5.) Delesseriæ.
Wormskioldia sanguinea, Spr.
Delesseria alata, Lx.
D. sinuosa, Good. and Wood.
Plocamium coccineum, Huds.

VIII. Lichens.

1. *Lichineæ.*
Ephebe pubescens, Fr. (*Smáulladr Mosi.*)

2. *Collemeæ.*
Collema nigrescens, Ach. (*Svartleitr Mosi.*)

3. *Sphærophoreæ.*
Sphærophoron fragile, Pers. (*Brothættr Mosi.*)
S. compressum, Ach.
S. coralloides, Pers.

4. *Cladoniæ.*
Cladonia endiviæfolia, Fr.
Cladonia gracilis, Fr. (*Veigalítill Mosi.*)
C. pyxidata, Fr. (*Hríngnöbottr Mosi.*)
C. cornuta, Fr. (*Hornmosi.*)
C. rangiferina, Hffm. (*Hreindýra Mosi, Tröllagrös, Mókrókar.*)
C. uncialis, Hffm. (*Greinóttr Mosi, Mókrókr.*)
C. cornucopioides, Fr. (*Hárandr Mosi.*)
C. digitata, Hffm. (*Fíngramosi.*)
C. furcata, Schær. (*Almosi, Mókrókr.*)
C. deformis, Hffm.
C. fimbriata, Fr.

5. *Stereocauleæ.*

Stereocaulon paschale, Fr. (*Fortu Mosi.*)
S. tomentosum, Fr., and *var. incrustatum, Flk.

6. *Siphuleæ.*

Thamnolia vermicularis, Schær.

7. *Usneæ.*

Usnea barbata, Fr., and var. hirta, Fr. (*Strihardr Mosi.*)

8. *Ramalineæ.*

Alectoria jubata, Ach. (*Stálprædilr Mosi.*)
A. ochroleuca, Ehrh., and var. sarmentosa, Ach.
Evernia furfuracea, Mann. (*Skeljamosi.*)
E. prunastri, Ach. (*Pyrnimosi.*)
Ramalina calicaris, Fr., and vars. fraxinea, Fr. (*Oskumosi*), and farinacea, Ach. (*Mjölmosi.*)
R. scopulorum, Ach.

9. *Cetrariæ.*

Cetraria Islandica, Ach. (*Islands Mosi, Fjallagrös.*)
C. aculeata, Fr.
Platysma nivale, L. (*Snjómosi, Mariugraus.*)
P. cucullatum, Hffm.

10. *Peltigereæ.*

Nephromium tomentosum, Hffm. (*Umsnuinn Mosi.*)
Peltigera aphthosa, Hffm. (*Porskamosi.*)
P. canina, Hffm. (*Hundamosi.*)
P. venosa, Hffm. (*Ædamosi.*)
P. rufescens, Hffm.
Solorina saccata, Ach. (*Púngamosi.*)
S. crocea, Ach. (*Saffransmosi.*)

11. *Parmeliæ.*

Sticta pulmonacea, Ach. (*Lûngna Mosi.*)
S. scrobiculata, Ach.
Parmelia physodes, Ach. (*Trèmosi.*)
P. saxatilis, Ach. (*Steinmosi, Litunarmosi*), and var. omphalodes, Ach. (*Lèttr Steinmosi.*)
Parmelia olivacea, Ach. (*Grænmosi.*)
P. stygia, Ach. (*Blákolls Mosi.*)
P. Fahlunensis, Ach. (*Falúnsborgar Mosi.*
P. lanata, Ach. (*Ullarmosi.*)
Physcia parietina, L. (*Veggja Mosi.*)
P. candelaria, Ach. (*Ljósmosi.*)
P. ciliaris, DC.
P. stellaris, Fr. (*Stjörnumosi.*)

12. *Umbilicariæ.*

Umbilicaria pustulata, Hffm. (*Bólumosi.*)
U. polyphylla, Hffm. (*Slèttr Mosi*), and var. deusta, Ach. (*Sviðinn Mosi.*)
U. erosa, Hffm.
U. proboscidea, DC. (*Trjónumosi, Geitnaskóf.*)
U. vellea, L. (*Gærumosi.*)
U. hirsuta, DC.
U. cylindrica, L.

13. *Lecanoreæ.*

Pannaria brunnea, Mass.
P. triptophylla, Ach.
Squamaria gelida, L.
Placodium murorum, DC., and vars. lobulatum, Flk., and miniatum, Ach.
Psoroma hypnorum, Fr.
Urceolaria scruposa, Ach.
Lecanora cinerea, L., and var. calcarea, L. (*Kalkmosi.*)
L. tartarea, Ach. (*Litunmosi*), and var. frigida.
L. parella, Ach.
L. subfusca, Ach. (*Svartleitr Mosi.*)
L. badia, Ach.
L. ventosa, Ach.
L. glaucoma, Ach.
L. sulphurea, Ach.
L. verrucosa, Laur.

14. *Lecideæ.*

Lecidea fusco-atra, Ach. (*Grámosi.*)
L. geographica, Schær. (*Málaramosi.*)
L. sanguinaria, Ach. (*Blódmosi.*)
L. decolorans, Flk.
L. atro-alba, Flot.
L. contigua, Fr., and var. confluens, Schær.
L. arctica, Smrf.

15. *Verrucariæ.*
Endocarpon miniatum, Ach. (*Menjumosi.*)
Endocarpon hepaticum, Ach.
Verrucaria tephroides, Ach.

IX. Fungi.

1. *Agaricaceæ.*
Agaricus campestris, L. (*Ætis-veppr.*)
A. campanulatus, L.
A. ericæus, Pers.
*A. conicus, Schœff., var. citricus.
Boletus bovinus. (*Kualubbi.*)
B. luteus, L. (*Reidikúla.*)
Clavaria muscoides.

2. *Lycoperdaceæ.*
Lycoperdon Bovista—(Bovista gigantea) Nees. (*Gorkûla, Fissipeppr.*)

3. *Helvellaceæ.*
Helvella atra.
Peziza æruginosa, Ball.
P. scutellata, L.
P. cupularis, L.

4. *Mucoraceæ.*
Mucor Mucedo, Bolt.

Appendix.

*Enumeration of Floras of Iceland, or of Publications containing Lists of the Plants of Iceland, consulted by, or known to, the Author.**

1. "Íslenzk Grasafrædi," by "Ó. J. Hjaltalin, Distriktskirurgus: Utgéfin ad tilhlutuhins íslenzka Bókmentafélagi." Copenhagen and Reykjavik, 1830.

2. Flora Islandica of Zoega; contained in vol. ii. of "Vice Larmand Eggèrt Olafssen's og Land-Physicus Björn Povelsen's Reise igjennem Island foranstaltet af Videnskabernes Selskab i Kiobenhavn, 1772." Danish edition. It is also translated into German; Leipzig, 1774–75, 4to, 2 vols.

*3. "Journal of a Tour in Iceland in the Summer of 1809," 2d ed., 2 vols. London, 1813. By Sir W. J. Hooker, K.H., D.C.L., LL.D., &c., Director of the Royal Botanic Gardens at Kew. Contains Zoega's list of Icelandic plants above referred to, with the addition of 50 species, and a reference to the lists of Mohr and Pálsson.

*4. "Travels in the Island of Iceland during the Summer of 1810." By Sir George Stuart Mackenzie, Bart., of Coul, Ross-shire, F.R.S. 4to. Edin., 1811. Chapter on Botany, by Dr Bright. P. 417. Contains the list of plants given in Sir W. J. Hooker's "Journal of a Tour in Iceland." It would appear that the number of plants collected by Sir W. J. Hooker, Sir George S. Mackenzie, and by Pálsson, and not mentioned by previous writers, amount to between 70 and 80. The three works last mentioned, contain many plants not mentioned in Hjaltalin's "Islenzk Grasafrædi."

*5. "An Historical and Descriptive Account of Iceland, Greenland, and the Faröe Islands, with illustrations of their Natural History," forming vol. xxviii. of the Edinburgh Cabinet Library. Edin. 1840, 12mo, p. 376. Chapter on Botany, the data in which are based mainly on Gliemann's list of the plants of Iceland.

*6. "Liste des Plantes que l'on *suppose* exister en Islande, dressée par M. Vahl," at p. 371 of a "Voyage en Islande et au Gröenland, executé pendant les années 1835 et 1836, sur la corvette La Recherche: Publié par ordre du Roi, sous la direction de M. Paul Gaimard, Président de la

* The lists which I have perused and compared, and which are incorporated more or less in my revised list, are denoted by an asterisk.

Commission Scientifique d'Island et de Gröenland ; Minéralogie et Géologie par M. Eugène Robert." First Part. Paris, 1840.

*7. "List of Plants gathered during a short visit to Iceland in 1846," by Charles C. Babington, M.A., F.L.S., &c. Trans. Bot. Soc. Edin., vol. iii., part i., p. 15, 1848.

8. Müller in Nova Acta Nat. Cur., vol. iv. p. 203 and seq., contains, according to the Edinburgh Cabinet Library volume on Iceland, p. 382, the *first published* list of Icelandic plants.

9. Grasafráedi, by Distrikts-Kirurgus Sveinn Pálsson, who wrote about the year 1800, and who lived in the vicinity of the Kötlugjá volcano in the south of Iceland.

10. Gliemann's "Geographische Beschreibung von Island" (Altona, 1824), is said to contain the fullest list hitherto published of Icelandic plants, being chiefly compiled by Mörck, a companion of Kotzebue in his circumnavigation of the globe [according to the Edin. Cabinet Library volume on Iceland, p. 382]. Pp. 136–148 and 171–183. Gliemann's list would appear to exceed that of Zoega, Hooker, and Mackenzie by about 100 species of Phanerogams and as many Cryptogams.

11. A. J. Retzius' "Floræ Scandinaviæ Prodromus," enumerating the plants of Iceland, along with those of Greenland, Sweden, Norway, Denmark, Lapland, Finland, &c.: published at Leipzig, 2d ed.

12. Kœning's "Flora Islandica."

13. Mohr "Forsög til en Islandsk Naturhistorie." Copenhagen, 1786.

14. List of Icelandic Plants (Fishes and Birds), with their Linnæan names, by Olaf Olafsson, in Trans. of 1st Literary Society of Iceland.

15. On the Cultivation of Trees in Iceland, by Jon Petursson, in the above-mentioned Transactions.

16. Economical Travels through the North Parts of Iceland, by Olaf Olafsson, 2 vols., 4to, 1780; contains an essay on the Icelandic "Surturbrand" (which illustrates the *fossil* flora of Iceland). The most recent information regarding this form of lignite may be found in

*17. "Physisch-geographische Skizze von Island, mit besonderer Rücksicht auf Vulkanische Erscheinungen: abgedruckt aus der Göttinger Studien," by Baron Sartorius von Waltershausen. Göttingen, 1847.

18. "Snotru Afhandling om de til Menneskeföde brugelige Tangarter." by Dr júris M. Stephensen.

19. "Grasnytjar," by Sira (Rev.) Björn Haldórsson.

20. Madame Ida Pfeiffer's "Journey to Iceland, and Travels in Norway and Sweden." 8vo. London, 1852.

*21. "Iceland: or a Journal of a Residence in that Island during the years 1814–15." By the Rev. Ebenezer Henderson, D.D., Ph.D., Missionary of the British and Foreign Bible Society. 8vo. Edinburgh, 1818, 2 vols. References will be found to the "Surturbrand" in vol i., p. 195; vol. ii., pp. 11, 80, 104, 113, 116, 125; to present and former forests in vol. i., pp. 10, 137, 224; vol. ii., p. 74; to drift-wood, in vol. ii., p. 130; to agriculture, in vol. i., pp. 11, 122, 136; and to other subjects connected with Icelandic botany in vol. i., p. 161 [Angelica]; vol. i., p. 307. [Melur corn—Elymus arenarius, L.]

The dates of the principal or most important of the foregoing Floras or lists are as follows:—

1. Zoega . .	1772–75	7. Hjaltalin . .	1830
2. Mohr . .	1786	8. Vahl and Robert	1835–40
3. Pálsson . .	1800	9. Edinburgh Cabinet Library . .	1840
4. Hooker . .	1809–13	10. Babington . .	1846–48
5. Mackenzie .	1810–11	11. Lindsay . .	1860
6. Gliemann . .	1824		

On a Rise of the Coast of the Firth of Forth within the Historical Period. By Archibald Geikie, F.R.S.E., F.G.S.

The existence of a series of littoral deposits above the present high-water mark, along the shores of the Firth of Forth, has long been familiar to the geologist. The upraised beds of sand and gravel, with shore shells, which occur at the Friggate Whins, between Leith and Portobello, have been described by Mr Maclaren, as well as other similar strata that fringe the coast westward as far as the mouth of the River Avon. At the Friggate Whins, which may be taken as a kind of typical example, we are presented with a low bluff rising from high-water mark, and then sloping upwards at a scarcely perceptible angle to another and higher cliff, which varies in outline and in its distance from the shore. The first low escarpment consists of various well-bedded alternations of sand and gravel full of the ordinary littoral shells. The nearly level plain between this escarpment and the inner one represents the old beach, while the inner bluff marks the sinuous cliff line against which the waves broke previous to the last upheaval of the land. The base of the inland cliff is somewhere about twenty-five feet above the present sea-level; and the space between its base and high-water mark consists of strata of sand, gravel, and shells, exactly similar to those which are now forming at the base of the outer cliff between tide marks. The inference is therefore incontestable, that, within a comparatively recent geological period, the land here has risen twenty or twenty-five feet above the level of the sea. I propose in this paper to show that this elevation is not only one of the latest geological changes of this district, but that it has actually taken place since man appeared on the shores of the Forth.

In the course of some recent examinations of the alluvial deposits of the water-courses of Mid-Lothian, I had occasion to visit the lower reaches of the Water of Leith. In tracing the alluvial plain of that stream, I found that the raised beach just referred to fringes the banks of the river, as might have been anticipated, and that it extends southward beyond the outskirts of the town of Leith. It has been laid open in an interesting section in the sand-pit on the south side of the Junction Road, close to Bowling-Green Street. The strata here exposed lie about twenty-five feet above high-water mark, and are unequivocally those of the raised beach. They closely correspond to the deposits along the shore between Leith and Portobello. In examining them, I was accompanied by my friend and colleague Dr Young, who has assisted me in nearly all the observations detailed in this paper. We found that, in addition to the ordinary contents of raised-beach deposits, they include others which have not hitherto been observed, and which give a clue to the date of the last rise of the land in this part of Scotland.

The section in the sand-pit presents the succession of strata shown in the subjoined diagram. The lowest bed (1) visible is one of coarse gravel or shingle, the pebbles being all well

Section of Sand-pit, Junction Road, Leith.

rounded, and loosely cemented in a sandy and somewhat ferruginous matrix. (2) Is a bed of fine white sand, about six feet thick. It is full of false bedding, the diagonal stratification being beautifully exhibited by the alternations of darker and lighter coloured layers. Its upper surface is irregular, and is overlaid by a well-marked seam (3) of sand and gravel, which averages about sixteen inches in thickness. Its lower part is gravelly and ferruginous. This stratum is covered by three or four inches of a stiff greenish clay (4), which contains numerous perpendicular (sometimes dichotomous) ferruginous pipes, probably marking the remains of the stems of plants.* This stratum passes up into a bed (5), about six feet thick, of dark silt or sandy clay well stratified, having thin lenticular interlaminations of sand, with occasional oyster-valves, a few stones, and fragments of bones and pottery. The upper part of this bed becomes more sandy, and graduates into the super-incumbent stratum of brown sand (6). The highest bed of the section (7) consists of stratified sand and shingle full of littoral shells, and some of the stones having *balani* still attached. The irregular deposit (marked *h* in the diagram), which rests unconformably upon the edges of the strata just described, is a mass of loose humus, which has been thrown down here at no distant date, perhaps to fill up an irregularity of the surface. It is full of stones, bricks, bones, pieces of earthenware, tobacco-pipes, &c., and its origin is sufficiently explained by a large board a few yards distant—"Rubbish may be laid down here free."

It is with the stratum marked 5 that we have chiefly to deal. But before entering into its details, I would dwell pointedly on the fact that it is a regularly stratified deposit, with thin parallel interlaminations of sand and clay; its oyster-valves and stones lie horizontally, and it passes upward by gradations into brown sand, which is covered by well stratified shell-sand and gravel. It cannot for a moment be confounded with the dark earth *h*, in which no trace of stratification can be detected, and which, moreover, rests on the edges of the other deposits. Whatever may be the contents of this bed of silt, they are undoubtedly of contemporaneous deposition; in other words, all the materials imbedded in the stratum were laid down at the same time with the stratum itself. And that this deposition and arrangement were effected

* I have seen similar pipes produced in the clay below a peat bog, by the decomposition of the salts of iron round the roots of plants, the bark becoming crusted with the oxide, and eventually replaced by it, while the internal woody matter has disappeared, leaving only a set of branching pipes to represent the roots and rootlets. When I first saw the pipes in the sand-pit at Leith, they appeared to me to resemble annelide burrows; but a more careful search showed that they not unfrequently branched, and that they could hardly be of other than vegetable origin. They may have arisen when the stream flowed over the clay, on which a scrubby and semi-aquatic vegetation grew.

tranquilly by the tides, is abundantly manifest from the stratified aspect of the bed as well as from that of the sand which covers it. We see its exact counterpart, indeed, along the shores of the Firth at the present day. The dark sandy mud which covers such extensive flats between tide marks at Leith, if elevated, would give us just such a deposit as that of the sand-pit. At the mouth of the Almond, the same muddy silt is now forming, and there the observer may notice patches of sand blown across the mud after the recession of the tide, and covered with a thin muddy pellicle by the next influx of the mingled water of the sea and the river. Such lenticular sandy layers in like manner represent those which occur in the dark silt of the sand-pit. To complete the parallel, we see along the muddy flats frequent fragments of bone, pottery, and pieces of stone, which are gradually covered over by the alluvial deposits. Similar fragments occur in the sand-pit, and to their nature, and the inference to be deduced from their occurrence there, I shall now advert.

The pieces of pottery found by Dr Young and myself were of two kinds; the first and most abundant were of a pale yellowish-grey colour, from two to nearly six lines in thickness, and of a firm, compact, but somewhat granular clay. They showed no glaze, but had a rough exterior and a rounded form, like fragments of a flagon or urn. All the pieces we obtained occurred in the space of two or three yards, and might have belonged to one vessel. We also found, however, one or two fragments of a thinner and finer kind of pottery of a red colour, and coated with a pellicle of greenish glaze.

Having obtained as many fragments as could be gathered after a careful search during two visits to the sand-pit, we submitted them to Mr M'Culloch, the curator of the Scottish Antiquarian Museum, requesting his opinion before informing him where they had been found. He at once pointed out that they strongly resembled fragments of Roman pottery; and he stated, that if found near a Roman station, he would have no hesitation in pronouncing them to be Roman. He further courteously assisted us to compare them with pieces of undoubted Roman workmanship in the museum. The resemblance was so complete, that one could easily have believed that the fragments from Leith had formed part of one of the broken jars, which, however, had been dug up along with other Roman remains at Newstead, in Roxburghshire. We have no doubt, therefore, that the pieces of pottery embedded in the elevated littoral silt of Leith are of Roman origin.

Along with these remains occurred numerous fragments of the bones of some ruminant, apparently a deer. With the exception of a broken tibia, all the pieces were of small size, like little chips and splinters. There occurred also, as noticed above, a number of ferruginous pipes of irregular size and form, occasionally branching. I have found similar pipes in the clay of the Portobello brick-works, where they are associated with branches of hazel, thorn, oak, beech, &c., and hazel nuts. They arose, probably, from the decomposition of ferruginous soil round the decaying stems of plants, though they sometimes resemble annelide burrows.

I have just shown that the bed of silt in which these remains occur is a truly stratified deposit, formed by water, exactly as a similar silt is being laid down on the shores of the Firth at the present day. The occurrence of stratified shell-sand and shingle above this silt proves that it was a littoral deposit; and the inference is irresistible, that the land here has risen about 25 feet since the deposition of these littoral strata. Further, the existence of fragments of Roman pottery in the silt shows us that the deposition of these upraised strata was going on during the Roman occupation of Britain, and therefore that this rise of the land has taken place since the time of the Romans.

This may seem, indeed, a startling deduction, when we consider the comparatively large increase of land which it demands, the short interval it allows for the process of elevation, and the silence of historians as to any such change of level. But these objections are only negative, and cannot be entertained in the face of the clear positive evidence of the raised beach itself. They are, besides, more apparent than real. The rate of elevation, if spread over 2000 years, would not be half so rapid as the rise of Sweden at the present day. The upheaval, however, was more probably effected during the earlier centuries after the Roman occupation. But even if we suppose that it had been completed by the fourteenth or fifteenth century, and that the land has remained stationary ever since, the rate of rise would then be no more than 2 feet in a hundred years—a rate geologically quite probable, and sufficiently slow to escape observation during the barbarous middle ages. The absence of any record of a change of level could not therefore be used as a valid argument in this question. But the change has really not passed unobserved; and I shall immediately refer to corroborative testimony from the researches of the archæologist.

A more serious objection would be obtained if it could be shown, that, over the area which I assert has been gained from the sea since the time of the Romans, there have been found the undoubted remains of Roman buildings, which seem to have been erected at least above high-water mark. Such an objection, if clearly established, would indeed involve the subject in great difficulty. We should then have to weigh the evidence of the sand-pit against the testimony of the exhumed buildings. And yet, bearing in mind that the operations of nature are uniform and certain, and that those of man may be guided only by his own caprice, we should be compelled to decide in favour of the geological rather than the antiquarian evidence. But no such difficulty really exists. Since the examination of the sand-pit at Leith, I have visited all the localities along the shore where Roman remains are known to have existed, and I have found no authentic evidence that in any way militates against the recent elevation of the land, but, on the contrary, several facts that tend to confirm it.

In thus testing the conclusions derived from the littoral deposits of Leith, by a reference to the actual position of Roman sites, Dr Young has examined with me the shore of the Forth from Inveresk to Cramond, and the line of the Roman Wall from Carriden to Falkirk. At Inveresk, where a Roman town existed, all the remains, so far as we could discover, were found on the ridge 60 or 70 feet above the present high-water mark. The site of Fisherrow must at that time have been a flat of sand and silt, exposed between tide-marks. We can attach no value to a vague tradition of the discovery of a "Roman bath" at that village. The sea at high-water must have washed the foot of the heights of Inveresk, on which the town stood, ascending far up the valley of the Esk, and making the mouth of that river a safe and commodious harbour. Had it not been so, it is difficult to see how the Romans should have made choice of such a shoaling estuary as that of the Esk, and have planted their town on an inconvenient narrow ridge, at some distance from their harbour, when a broad open plain lay along either side of the river, and skirted the shores of the Firth. But we see at once the expediency of the choice, if we allow that in their days the flat plain was covered by the sea at high-water, and that they built their houses along the only space available here—namely, the declivity that overhung the beach, whence they commanded a wide view of the sea towards the north, and of the wild bosky country that stretched southwards towards the Pentland Hills.

From Inveresk the shore westwards must have had a greatly more sinuous outline than that which it exhibits at the present day. The old coast line is still well preserved at several points; and from its remains we can easily see how varied and broken must have been the configuration of the coast, which now presents scarcely any modifications of its long sweeping lines. At Portobello, for example, the sea ran up the valley of the Friggate Burn, and from washing the stiff boulder clay that formed its banks, probably produced the finely stratified clay which now lies along the sides of the valley at the brick-work, and contains trunks and branches of still indigenous trees, with shells of the *Scrobicularia piperata*. A Roman road is believed to have crossed near the mouth of this valley, running by Jock's Lodge, the northern outskirts of Edinburgh, and Davidson's Mains, to the station at Cramond. This road, at its seaward portion, lies above the limit of the gained land.

Passing still westwards we reach Leith, which, at the period of the Roman occupation, seems to have been a muddy flat, only laid bare by the recession of the tide. The extent of ground then covered by the sea must have been great, for the tides rose up the valley of the Water of Leith towards Canonmills. There is no record, however, of this inlet having been used as a Roman port, nor do we encounter any other remains of that period until we reach Cramond, at the mouth of the River Almond.

To one who stands on the rising ground above that village, and looks seaward, it seems as if no more inconvenient part of the coast could possibly have been selected as the site of a port. A wide dreary expanse of mud stretches along the shore, and extends outwards for wellnigh two miles at its broadest part, across which vessels even of light burden can only venture at full tide. The river channel is narrow and shallow, and a little way up becomes rocky and stony. And yet this inlet is recognised as Alaterva, the chief harbour of the Romans on this part of the coast of Britain. We must remember, indeed, that the River Forth is constantly bearing down mud from the higher grounds, depositing it along both shores of the Firth, but especially on the south side. Eighteen centuries must undoubtedly have witnessed some change from the gradual silting up of the estuary. But this process of change is a very slow one. Even allowing the greatest depth of sediment to have accumulated compatible with the small amount carried in suspension in the water, and with the action of the tides and currents of the Firth, the depth of silt which has accumulated since the time of the Romans cannot, I think, have been by any means so great as to have converted what appears to have been the most commodious inlet along the coast into a difficult and dangerous shoal. But be this as it may, there can be no doubt that the mouth of the Almond would be greatly improved as a harbour if the sea rose in it to a greater height. If we admit that the land here was 20 feet lower when the Romans occupied the country, then we cannot fail to see that they were fully justified in making it their chief port, for it would unquestionably be the best natural harbour along the whole of the south side of the Forth.

The coins, urns, sculptured stones, and other remains which have been found so numerously at Cramond, fully attest its ancient importance. The remnant of a harbour has also been detected here. It is greatly to be regretted, however, that in these, as in other instances of archæological discovery along the coast, no record appears to have been kept of the exact spots on which the remains were found. We only know that the quays which the Romans built along the sea-margin have been found on what is now good dry land. No relic of the Roman period is now visible here. A rock, indeed, called the "Eagle Rock," or "Hunter's Craig," is shown with the alleged effigies of an eagle carved on its eastern front, a little above high-water mark. Antiquaries have grown eloquent at the sight of this relic of the creative genius of the old legionaries. But the carving has really about as much claim to be considered Roman as the famous Prætorium of Jonathan Oldbuck. In a niche of the soft sandstone crag stands a rude figure, as like that of a human being as of an eagle, with a very short stump by way of legs, surmounted by a long and not very symmetrical body, on one side of which an appendage that may be an arm, hangs stiffly down, while the corresponding one shoots away up at an uncomfortable angle on the other side. Like other carvings on the shores of the Forth (as the figure near Dysart, and Queen Margaret's footstep at South Queensferry), it must take rank among the handiworks of idle peasants or truant schoolboys.

The next point westwards where we meet with traces of the Roman occupation is the commencement of the Wall of Antoine at Carriden. From this point the line of the wall runs on the summit of the high bank that overlooks the Firth westwards to beyond the village of Polmont. Its position at the Kerse toll-bar was pointed out to us by a farm-labourer who dug through the soil in a level field on the upper edge of the great Carse, and showed the position of the large flat stones which formed the foundation of the wall. From this locality the wall again ascended to the higher ground, passing westwards by Falkirk and Camelon, and then receding from the shores of the Forth.

From Falkirk seawards, the ground forms a great expanse of flat alluvial land, called the Carse. No one can doubt that this tract has been gradually gained from the sea, and that the tides must at a comparativly recent period have washed the heights on which Polmont and Falkirk stand. One antiquary even asserts his belief that this tract may have been formed since the days of the Romans. He alleges, in support of this opinion, that near Camelon, on the banks of the Carron, at the inner edge of the Carse, the remains of the Roman Portus ad Vallum, consisting of walls, houses, and docks existed down to the last century, and that an anchor was dug up in the same locality.*

This independent testimony corroborates in the most satisfactory manner the geological inference already stated in this paper. I visited the site of the ancient Camelon, and found it lying at the foot of the old coast line—a wavy line of bold bluffs, similar to but considerably higher than those of the Friggate Whins. It required no force of imagination to picture the sea rising to the base of these cliffs, and ascending the valley of the Carron, with Roman galleys winding up the estuary, or anchored in the harbour of the long forsaken and forgotten Portus ad Vallum.

Having shown that the coast at Leith has risen 25 feet or so since the Roman invasion, it by no means follows that the coast along other portions of the Firth of Forth, and of the east of Scotland generally, has been elevated to the same amount. Nor is it necessary to the truth of the conclusions of this paper, that the west coast of Scotland—as for instance at the termination of the Wall of Antonine—should be proved to have experienced any elevatory movement at all.

Such movements are local in action and variable in amount, so that geologically there is no reason why the amount of rise may not have lessened towards the west, until in the Firth of Clyde it ceased altogether. No one can examine the shores of our country without becoming convinced, that they have been raised, not by equal and uniform elevations, but by a general upheaval which varied greatly in amount in different localities, and was even interrupted by long intervals, during which the land appears to have remained stationary. Hence the raised beaches occur at different levels above the present shore, and even the same line of upheaved littoral deposits may be proved to be actually higher at one point than at another.†

* Stewart's "Caledonia Romana," p. 177.

† It is a curious fact, that during the oscillations which accompanied the deposition of the carboniferous rocks in central Scotland, a great inequality ap-

In conclusion, as some of the more widely known geological researches of the last two or three years have been directed to the history of primæval man, every additional fact that tends to place in a clearer light the relations of our race to the later physical changes of the land acquires at present a peculiar significance. The object of this paper has been to show that the last elevation of part of Britain has not only taken place since the island was inhabited by man, but even since it was invaded by the Romans. The extent of this upheaval has been at one locality as much as 25 feet—a large amount of change to have taken place quietly and unobserved during a period of less than eighteen hundred years. In the centuries that preceded this elevation other changes of equal or even higher magnitude may have been going on, possibly with a still greater rapidity, after man had become an inhabitant of these islands. Some caution therefore is needed, lest the extent of the geological changes which he has witnessed should lead us to assign to man, as an inhabitant of Britain, a higher antiquity than he can justly claim.

On Natro-boro-calcite and another Borate occurring in the Gypsum of Nova Scotia. By Henry How, Professor of Chemistry and Natural History, King's College, Windsor, N.S.

About three years and a half ago, I showed the existence of Natro-boro-calcite in the gypsum of Windsor, N.S.* I was not aware at that time that Dr Hayes of Boston, U.S., had announced his conviction† that the soda which had been attributed to this mineral was an impurity, and had given, as the true expression of the composition of the pure mineral, the formula $CaO\ 2\,BO_3 + 6\ HO$. Had I known this, I should have adverted to the probability of his mineral

pears to have existed between the rate of submergence in the east of the country and that in the west. During the Lower Carboniferous period (as I have shown elsewhere), the area of the Lothians probably subsided several thousand feet more than the district now occupied by the counties of Lanark and Ayr. —See *Quart. Journ. Geol. Soc.*, vol. xvi. p. 312.

* Edin. New Philosophical Journal, July 1857. Silliman, Sept. 1857.

† Silliman, Nov. 1854, p. 95.

(Hayesine, Dana) constituting a distinct species from Natro-boro-calcite, whose existence seems to be sufficiently established by the repeated finding of not very dissimilar quantities of soda in analyses of specimens from two of its three localities, as seen in the following list, which contains all the analyses I have been able to find :—

	BO_3.	CaO.	HO.	NaO.	KO.	SO_3.	NaCl.	Sand.	
Peru, .	46·11	18·89	35·00						Hayes*
Tuscany, .	51·135	20·85	26·25						Bechi*
Peru, .	49·50	15·90	25·80	8·8					Ulex†
,, .	49·50	17·70	26·00	8·8					,, †
,, .	45·46	14·32		8·22	0·51	1·10	2·65	0·32	Dick*
,, .	43·70	13·11	35·67	6·67	0·83				Ramm.‡
,, .	47·25	15·98	25·46	9·88		0·45		0·98	Anderson§
Nova Scotia,	41·97	13·95	34·39	8·36		1·29	MgO	0·04	H. How*
,,	44·10	14·20	34·49	7·21					,,

In the account of the analysis by Anderson, the quantities of soda and sulphuric acid, as given above, are reversed ; from the conclusion drawn by the author, this is evidently a typographical error. As regards the amount of water present, no mention is made, in any case but my own, as to the temperature at which the substance was dried ; in my analysis the mineral was air-dried. The soda, it will be observed, is a constant ingredient, in pretty uniform amount, in all but the first two analyses ; and in my, examination as stated at the time, the mineral was washed, for the second analysis, with cold water till all sulphuric acid was removed.

From the preceding data the following formulæ have been deduced :—

$CaO\ 2\ BO_3 + 6\ HO$ . . . . Hayes ;
$NaO\ 2\ BO_3 + 2\ CaO,\ 3\ BO_3 + 10\ HO$. Ulex ;
$NaO\ 2\ BO_3 + 2\ CaO,\ 3\ BO_3 + 15\ HO$. H. How ;
$NaO\ 2\ BO_3 + 2\ (CaO\ 2\ BO_3) + 18\ HO$. Rammelsberg ;

all referring to a mineral found in rounded masses, consisting of interwoven fibres, opaque, snow-white, and of a silky lustre.

The mineral to which I would now draw attention was found in the same quarry as the preceding, at a distance of about 100 yards, and at about 20 feet lower level, and also associated with glauber-salt, which, it is worthy of notice, is generally met with here, according to the quarrymen, in narrow seams at the line of junction of the

* Dana's Min., 4th ed., p. 394.
† Liebig und Kopp's Jahrb. 1849, p. 780.
‡ Silliman, Sept. 1856, 3d Supt. to Dana's Min., p. 6.
§ Proc. Phil. Soc. Glasgow, Feb. 1853.

" hard plaster " (anhydrite) with the " soft plaster " (gypsum). I detected it in the form of an opaque white substance without lustre, and, to the naked eye, devoid of crystalline structure, in cakes and somewhat rounded masses, varying in size from that of a small pea to that of a bean; these masses lay between gypsum and crystals of glauber-salt, taking shape from the crystals of the latter on the side next to them, and, when detached from them, leaving their faces, as it were etched, and sometimes the crystals were penetrated to a considerable depth by the imbedded borate. The mineral is very soft, H = 1, but coherent, tasteless, slightly tough between the teeth, fuses readily before the blowpipe to a clear bead, insoluble in water, soluble in hydrochloric acid. As found, or very soon after being brought home, it lost by exposure to the air,—

Water = 18·36 per cent.,

and the air-dried substance gave the following results on analysis; the water was determined by ignition; the lime, magnesia, and sulphuric acid in one portion of the so dried residue, and the soda in another, after its treatment with fluor-spar and sulphuric acid for elimination of boracic acid, which was, of course, estimated by deficiency:—

	I.	II.
Lime,	14·21	
Soda,	7·25	
Sulphuric acid,	3·98	
Magnesia,	0·62	
Water,	19·96	20·78
Boracic acid,	53·98	
	100·0	

The quantity of mineral obtained did not permit me to make more than one analysis and retain a little as a specimen for identification; but these results, as well as the characters already mentioned, and the crystalline structure to which I shall presently advert, are, I think, sufficient to show that it is specifically distinct from Natro-boro-calcite (see analyses, p. 429). On the assumption that the magnesia and sulphuric acid are accidental, and that the latter is combined with the former, and with a quantity of soda equivalent to that of the acid not required by the magnesia, I have calculated the preceding results (I.) after making these deductions, and at the same time taking away the amount of water necessary to render the $MgO\ SO_3 = MgO\ SO_3 + 7$ aq. (the hydrated sulphate of soda would of course, become anhydrous on exposure to dry air); the results then become :—

	Oxygen.		Ratio.	Calculation.		
Lime, . .	15·55 =	4·44	3·08	3 CaO	84	15·46
Soda, . .	5·61 =	1·44	1	NaO	31	5·77
Water, . .	19·72 =	17·52	12·16	12 HO	108	20·11
Boracic acid, .	59·10 =	40·47	28·10	9 BO_3	314·1	58·48
	99·98				537·1	100·00

—corresponding to the formula,

$$NaO, 3\ CaO, 9\ BO_3 + 12\ HO.$$

I am very well aware that it is unsafe to base a formula upon a single analysis, especially of a mineral substance, and most especially after making deductions as above, and I cannot, in this case, insist on the one brought out, but it is not anomalous. We find rather complex combinations both in the natural and artificially formed compounds of boracic acid; thus,

Hydroboracite,* = 3 CaO, 4 BO_3 + 3 MgO, 4 BO_3 + 18 HO, and
Larderellite,* = NH_4O, 4 BO_3 + 4 HO ;

while Laurent describes† a salt = 5 NaO, 24 BO_3 + 52 HO, and Rose one‡ = 3 CaO, 5 BO_3 when ignited; and it is a little curious that the formula given above includes the soda compound corresponding to Larderellite and the salt of Rose—

$$NaO, 4\ BO_3 + 3\ CaO, 4\ BO_3 + 12\ aq.$$

I mentioned that the mineral presented no appearance of crystalline structure to the naked eye. Not having at hand, at the time I was at work upon it, a sufficiently good microscope, I sent a portion of the mineral to Professor Robb, of the University of New Brunswick, at Fredericton, with a letter stating my results and my doubt as to the substance being crystalline. I received this answer—" In spite of your odd formula, the mineral just as I got it, untouched and unwashed, is perfectly crystalline in every particle. A good power is required; but with a magnifying power of about 350 diameters there is no difficulty, the form comes out as sharp as possible. The crystals are excessively thin translucent tables or plates. They have a rhombic outline, and the angles probably = 80° or more,

* Dana's Min., 4th ed., 394, 395.
† Liebig und Kopp's Jahresbericht, 1849, p. 226.
‡ Ibid., 1842, p. 313.

Owing to their excessive thinness I could not say whether they could be called right or oblique rhombic prisms ; I suspect the latter from analogy. By care the 'Tiza' (Natro-boro-calcite) can be shown to consist of very fine prisms, sharp, angular, and long, but too fine for me to state their form. The diameter was less than ·00118 of an English inch. The long prismatic needles of the Tiza are in great contrast to the broad tables of the recent mineral in your last letter ; of that the plates are about ·0048 of an inch from side to side, but some are a little larger, others a little smaller. In some you see regular cleavage—that is, a small rhomb chipped out of one side. As far as form goes, therefore, it would seem to be a distinct and definite species. I presume it was formed in a dry place, for the angles were quite sharp. The connection between these borates and sulphates of lime and sulphate of soda is very curious."

I may state that I had subsequently the opportunity of appreciating the great accuracy of this description of the appearance of the two minerals.

Arguing from the chemical composition, which, however, may not be quite established, and the crystalline structure, I conceive the mineral in question to constitute a new species, and I propose for it the name of Cryptomorphite (*κρυπτος* occultus, and *μορφη* forma), in allusion to its microscopic crystalline structure.

The truth of the last sentence in Professor Robb's letter is very apparent. In my former paper on the subject, I adverted to the existence of Natro-boro-calcite in the gypsum here, as confirming Dawson's theory of the origin of the rock from the action of volcanic waters on carbonate of lime. It is interesting to observe that Bechi* found the same (?) mineral, with other borates, in the lagoons of Tuscany. The hydrated condition of both the borates found here, and of the associated sulphate of soda, shows the action of water ; but that of ordinary sea-water would not account for the presence of boracic acid. As regards the soda, the sulphate and borate of lime were probably the substances originally present, and chloride of sodium in water being introduced might remove part of the calcium as chloride, and furnish borate and sulphate of soda. It is confirmatory of this view that a small quantity of rock-salt in crystalline grains has recently been found in the gypsum.

* Dana's Min., 4th ed., pp. 394, 395.

On Gyrolite occurring with Calcite in Apophyllite in the Trap of the Bay of Fundy. By Henry How, Professor of Chemistry, &c., King's College, Windsor, Nova Scotia.

The mineral gyrolite was first described by Professor Anderson of Glasgow,* as a new species from the Isle of Skye; it is stated by Greg and Lettsom† to occur without doubt at two localities in Greenland, and according to Heddle at Faröe. The only other notice of it that I am acquainted with is by L. Sæmann, who mentions‡ that he examined a specimen—no locality being given—mixed or interlaminated with pectolite, and suggests that this mineral, losing its alkali, becomes gyrolite, and, losing its lime, becomes okenite. No other analysis than the original one of Professor Anderson has, I believe, been published; the following account of its occurrence among the minerals of Nova Scotia shows it in such associations as affords a mode of explaining its origin by change in apophyllite.

I met with it in Annapolis Co., N.S., some 25 miles S.W. of Cape Blomida, between Margaretville and Port George, on the surface of fractured crystalline apophyllite, and, on further breaking the mass, a good many spherical concretions of pearly lustrous plates were observed in the interior, of sizes varying from that of a pin's head to nearly half-an-inch in diameter; their outline was well defined, and the external characters, as given by Anderson, were recognised on examination; it afforded the following results on analysis:—The mineral was ignited for water, and the residue treated with hydrochloric acid, the resulting dried silica was weighed, and then fused with carbonated alkali, and the weight of the small quantities of alumina, &c., so separated, was deducted from that of the first silica. I place my numbers by the side of those of Professor Anderson, and give the calculated percentages for his formula:—

	H. H.	Anderson.	Calculation.	
Potass, . .	1·60			
Magnesia, .	0·08	0·18		
Alumina, .	1·27	1·48		
Lime, . .	29·95	33·24	32·26	2 CaO =56
Silica, . .	51·90	50·70	52.18	$2\,SiO_3$ =90·6
Water, . .	15·05	14·18	15·35	3 HO =27
	99·85	99·78	99·99	173·6

* Trans. Roy. Soc. Edin., and Phil. Mag. Feb. 1851.

† Manual of Mineralogy, p. 217.

‡ First Supp. to Dana's Mineralogy, p. 9; Silliman, May 1855.

and a general accordance is observed sufficient to show the identity of chemical composition in the minerals examined; the small quantity of potass present in my specimen probably modified the blowpipe characters a little, as I found it not to exfoliate completely, and it fused without any difficulty, and even with some boiling.

Some of the numerous cavities in the apophyllite were empty, some entirely filled with gyrolite, and in others separate plates of this mineral were standing edgewise, leaving vacant spaces, while, upon and by the side of the plates were in some cases rhombohedral crystals, which proved to consist of calcite, and were sometimes present alone in the cavities, which varied from being quite shallow to half-an-inch in depth. It is mentioned by Anderson that gyrolite occurs associated with stilbite, laumonite, and other zeolites, and is sometimes found coating crystals of apophyllite.

The difference in chemical composition between apophyllite and gyrolite is very well seen on comparing the respective theoretical percentages of their constituents; thus,

	$Si{\cdot}O_3$.	CaO.	KO.	HO.
Apophyllite,	=52·70	26·00	4·40	16·70+HF variable;
Gyrolite,	=52·18	32·26		15·50;

and the existence of the calcite in the cavities seems clearly to show, that the gyrolite is formed from the apophyllite by the action of the water which deposited the carbonate of lime, reacting on the silicate of potass, and dissolving out at the same time the fluorine or fluoride of calcium;* trial was made for fluorine on two fragments of the gyrolite, and no evidence of its existence obtained.

REVIEWS AND NOTICES OF BOOKS.

The Quadrature of the Circle: Correspondence between an Eminent Mathematician and James Smith, Esq.

This is a beautiful book, both inside and out. It is a goodly octavo volume, printed in a type which does infinite credit to the Liverpool press; and the binding, too, is mauve,—such a pretty colour! On opening the volume, and beginning at the beginning, we found page 1 occupied with conveying the information that "The right of translation is reserved." This circumstance induced us to believe that the work was intended to be a serious essay. But, on reading a few pages of the introduction, some-

* Dana's Mineralogy, i. p. 332, 333.

thing seemed to be wrong with the writer or with the reader. We were gravely told at page ix., that "in every circle the circumference is exactly equal to three and one-eighth times its diameter, and the area exactly equal to three and one-eighth times the area of a square described on its radius." Now we fancied we remembered having read that Archimedes had *proved* that the circumference is less then $3\frac{1}{7}$, but greater than $3\frac{10}{71}$ of the diameter; so, to relieve our minds, we hastened to turn up Archimedes' Works. Sure enough, in Prop. 3 of Commandine's translation, it is so set down. But as this is only a translation, which may misrepresent the original, and as it is a Latin translation, which is not the simplest imaginable vehicle for expressing fractions, we admitted the possibility of its being wrong, or of our incapacity to read it aright, and resolved to appeal to a much more simple and accessible work—Playfair's Geometry. In that treatise we found the matter stated plainly enough. There can be no mistake. The circumference of a circle lies between $3\frac{1}{7}$ and $3\frac{10}{71}$ times the diameter. It cannot, therefore, by any possibility be equal to $3\frac{1}{8}$ times the diameter. If, indeed, any one shall succeed in proving that a place which is known to be situated between Edinburgh and Aberdeen has a greater north latitude than Inverness, then may it be admitted to be possible to prove that the circumference of a circle is exactly $3\frac{1}{8}$ times its diameter. The cases are precisely parallel; and yet the author tells us, quoting the words of one of his correspondents, that this "is one of the great truths of nature, which can admit of no doubt, and which it is not in the power of any man living to subvert." There must be some egregious blundering somewhere, we argued. What can be the meaning of it all? In great perplexity we turned over the leaves of the new book, and it happened (as it has happened in matters of deeper moment) that our very tossings brought us relief, and added the pleasant reflection that "the great truths of nature" remain unchanged, and that our distress was simply the offspring of our own folly; for it happened that we stumbled on page xxv, which closes the introduction, where we were presented with a key to the whole enigma. On that page the author dates his work, "Liverpool, April 1, 1861"—*All-Fools' day*. "Ho, ho!" shouted we, "we have it now; a very pleasant practical joke for the 1st of April!"

And here we are sorely tempted to write three philosophical essays; 1. On Practical Jokes; 2. On the Commercial Prosperity of England in General, and of Liverpool in Particular; and 3. On the Quadrature of the Circle. But as the editors inform us their readers are not likely to tolerate such essays, we will content ourselves with two remarks. The first is, that the work before us is a most expensive *jeu d'esprit*, proving better than the Great Eastern and the builders' strikes that there is a plethora of riches in certain quarters. We have on our table a treatise (or rather a series of treatises) printed in Calcutta in 1858, of which the title is, "*The Moon is the Image of the Earth, and is not a Solid Body.*" We were wont to regard this as a masterpiece in its way, but it pales before Mr Smith's work. Perhaps this may be explained by the fact that the author of the treatise on the moon is evidently serious; and we know that truth, although it may be stranger than fiction, is not nearly so attractive. Besides, the author of the shadow-moon may be right. No one has climbed up so high as to touch the moon, to convince himself that it is a substantial solid body, and no shadow. The green-cheese theory is certainly losing supporters. After all, it *may* be but an image; but the circle is not in the same predicament: we can get at it, and measure it too; at any rate with sufficient accuracy to be in a position to render it a difficult task for him to execute who undertakes to cheat us into the admission that its circumference is exactly $3\frac{1}{8}$ times its diameter. Hence arises the great attractiveness, the elaborate getting-up, of the work before us.

Our second remark is, that the search after unattainable results has in past times been productive of much good. Who can say how much chemistry owes to the philosopher's stone—to the transmutation of metals? Who can count the discoveries which have had their germ in perpetual motion? Who can estimate the influence which the quadrature of the circle has exercised on the progress of geometry? But these are fruits reaped by generations long passed away;—the problems are sadly out of date now. We would advise any gentleman who has plenty of spare money to invest it in some newer chimera. We would venture to suggest the great sea-serpent as the subject for the next first of April. Well, let this suffice. We have no sympathy with those who frown hard on the perpetual-motionists and the squarers of the circle. We have learnt to admire the perseverance and self-denial of men who can give up their time and their money for the pursuit, misdirected though it be, of abstract truth. They are usually simple, single-hearted men, with no worldly motives to influence them. We retain an affectionate remembrance of a gentleman who did us the honour to dedicate his treatise on the quadrature of the circle to ourselves.

To be sure, we had on one occasion to deal with a man of a different stamp. A poor, half-starved, half-witted fellow had taken the trouble to travel on foot all the way from Yorkshire to Edinburgh, to lay before us his discovery; and when he had gone through his story about segments and sectors, cosines and versed sines, and all the rest, to which we paid the same respectful attention that we would have done to him who should assure us he had performed the well-known feat of jumping down his own throat,—when he had emptied himself of his science, we perceived that, like Pandora's box, he had still something sticking within. It came out in the form of a suggestion that the discoverer of the quadrature of the circle was entitled to a reward of £10,000, and that he trusted he should get it; and that if he did get it, it would make a man of him. The last words were enough. We saw clearly that the thing was impossible, and made our bow.

We trust Mr Smith will excuse our having taken the liberty of cautioning our readers against the *results* of his labours. That the book contains many ingenious arguments, and much that will interest those who are curious in such matters, we have no doubt. To such persons we recommend the book, not to the vulgar. The unwary student, on opening it, may find himself in the position of the unfortunate hill farmer when he added to his scanty library Mr Ruskin's volume on Sheepfolds.

The Mathematical Works of Isaac Barrow, D.D., Master of Trinity College, Cambridge. Edited for Trinity College, by W. Whewell, D.D., Master of the College. 1860.

Dr Isaac Barrow was the first Lucasian Professor of Mathematics in the University of Cambridge. He held the professorship only six years, and was succeeded by Isaac Newton. On the elevation of Dr Pearson to the see of Chester in 1673, Barrow became Master of Trinity College. We find him thus exhibited, in conjunction with a great mathematician on the one side, and a great divine on the other. And the mathematician and the divine, each judging from Barrow's labours in his own department, acknowledge themselves to be linked with a man worthy of the position.

The characteristic of the writers of the age in which Barrow lived was *exhaustiveness.* The habit of thinking then in vogue led men to the very roots of a subject. It is not simply the exhibition of erudition that strikes one in the writings of such men as Pearson and Barrow; it is the manifestation of that peculiar habit of casting about the mind to reach and ransack every corner and cranny of a subject, to take every step cautiously and slowly, even painfully, lest when some high point should be reached the foundations might be found to shake. The writers of that age did not consider it to be sufficient to state and discuss everything which might fairly be said on both sides of the question; they were not satisfied with the annihilation of their opponents' arguments and the exhibition of their own; it behoved them to rake up the ashes of every forgotten adversary, and to recount the triumphs of every insignificant supporter; it behoved them to look forward to the probable issue of future controversies, and to imagine or invent new objections, the removal of which would exhibit the position which they maintained in a clearer light;—in a word, they aimed at acquiring the character which Charles the Second gave to Barrow: "that he was not a fair man; he left nothing to be said by any one who came after him."

There are a host of cotemporaries who, each in his own way and in his particular department, aimed at the same thing—the witty South; the learned, pious, imaginative, but impulsive Jeremy Taylor, now dazzling you with gorgeous imagery described in soothing cadences and harmonious rhythms, now dashing in your face a stream of authorities, and overwhelming you with the profusion of his learning; the able but inelastic Owen, whose theological writings filled seven volumes in folio, twenty in quarto, and about thirty in octavo; and other men like these.

This tendency of the age in which Barrow lived—to exhaustiveness of treatment and copiousness of expression—must not be lost sight of by those who would form a just estimate of the lectures to which we are anxious to direct attention. The reader must not approach them with the expectation of finding anything corresponding with the Leçons of Langrange and Cauchy, or the Astronomical Lectures of Airy. He will not do well to judge them by comparison with the present Lucasian lectures, excellent though these are. He will appreciate them if he apply the standard of Sir William Hamilton of Edinburgh rather than that of Sir William Hamilton of Dublin; admirable both, but with this marked characteristic difference, that the latter refers only to what a thing is, the former deals also with what other minds have made of it, what other readers have thought of it:—the latter treats of the matter as a point in philosophy; the former views it as a question for philosophers.

Barrow's mode of treating a subject leads to a display of learning which borders on pedantry. In discussing the name and excellence of mathematics, he perfectly dazzles his reader with quotations from the classics. Now an alumnus of the modern school is apt to wince under the weight of these authorities. He has been taught to be cautious how he receives any dogma. The errors of the so-called Aristotelian teaching which preceded Bacon have been so triumphantly paraded before him, that he is apt to suspect any reasoning which appeals to the old thinkers. But is he altogether justified in this course of proceeding? May not the opinions of the great men who laid the foundations have some value, at least in the abstract sciences, where the materials out of which the structure is raised undergo no change from age to age? The opinions of judges learned in the law are the capital of the lawyer. In matters of fact, the opinion of the judge is not asked; but in matters of right and wrong, it is all-powerful. And thus, too, relative to the phenomena of nature, it matters little what were the theories of Plato and Aristotle; but in a question of abstract truth,—their opinions are valuable in proportion to the massiveness of their intellects, and the attention they bestowed on the subject. Hamilton, in his remarkable review of Dr Whewell's "Thoughts on the Study of Mathematics as a part of a Liberal Education," exemplifies the use of such opinions; and the value which he himself attached to them may be inferred from the labour and research which he bestowed in their collection. Take one example, in the original essay (*Edinburgh Review*, January 1836) he had quoted from the Life of Descartes the opinion of that philosopher, extracted from his Fourth Rule for the direction of the mind on the subject of the utility of the mathematical sciences. In subsequently turning up Descartes' own words, Hamilton perceived that they contained an allusion to the well-known statement that Plato had inscribed on the vestibule of his study the injunction, "Let no one unacquainted with geometry enter." And it must have struck him that the word attributed to Plato, ἀγεωμέτρητος, was far more definite in its meaning than the word *mathesis* which Descartes had employed, and was not to be so easily explained away as applying to something very different from the ordinary geometry of Euclid. This consideration, if admitted to take effect, would suffice to destroy the argument. Accordingly, Hamilton boldly questions the genuineness of the tradition, and sets to work to trace it to its rightful authority. For some years he followed the opinion of Fuelleborn, that the inscription had no higher authority than that of Bessarion in the seventeenth century, It was however pointed out to him in the jingling rhymes of Tzetzes, a Greek writer of the twelfth century; and when in 1852 he published his collected "Discussions on Philosophy," &c., he referred to it as a "fable, the oldest recorder of which flourished some sixteen centuries subsequent to Plato" (p 271). Another year revealed to him the fact that it was some centuries older still. Accordingly, in the second edition of the "Discussions," published in 1853, he remarks in a note (p. 278) "Fuelleborn, I may observe, questioned the antiquity of this story. . . . . The oldest testimonies which I have noticed are Ammonius Hermiæ (or Philoponus) and David the Armenian. Ammonius and David flourished towards the conclusion of the fifth century; they were both scholars of Proclus. Are there any earlier authorities?" Now we would ask the mathematician who takes up these lectures of Barrow's, whether he considers this question put by Sir William Hamilton to be worth answering or no. On his reply will depend, we think, the pleasure he will derive from a perusal of these lectures. Those who hold that the opinions of antiquity are worthless on mathematical questions, will require some training before they can reach a position from which Barrow's display of erudition will appear other than an empty tossing about of words. But to those who have learnt to desire to see a matter thoroughly sifted and examined from every conceivable point of view, these lectures will afford ample gratification.

The "Mathematical Lectures" are twenty-three in number, and may be divided into three parts—1. Ten lectures on First Principles. 2. Three lectures on the Foundation of Geometry, or rather on that feature of it which sets forth the true meaning of Geometric Equality; and, 3. Ten lectures on Ratio and Proportion.

Of the first part it is only necessary to say, that it bears evidence of the indefatigable perseverance of the author in the search after testimonies from ancient and modern writers. In the second part, the question whether the foundation of geometry can be better laid than on what is known as the 8th Axiom of Euclid, is discussed in a masterly way, and decided in the negative. We know of no exercise better fitted to develop the powers of a student than these three lectures. The lynx-eyed author has searched into every cranny for reasons, for opinions, for objections. He has handled the subject with the grasp of a giant. Only one point, so far as we know, escaped him. In the second part of Prop. 2, B. 6, Euclid proves that two triangles are equal. But in what way can their equality be referred to the 8th Axiom, "Magnitudes which coincide are equal?" They are not proved to be congruous whole by whole, or part by part, or by any process of transmutation or succession. Their equality rests on the fact, that if any multiple of the one exceed any magnitude, the same multiple of the other does the same; and if any multiple of the one falls short of any magnitude, the same multiple of the other does so likewise. Now, this fact establishes congruity only subject to the same objections which are raised against the application of the axiom, that equals taken from equals leave equals. And the objections are not easily removed; Barrow has not even alluded to them. Perhaps he had intended to discuss this species of equality when he came to Proportionality, but we can find no indication of such intention. We should like to have had the opinion of the learned editor of the present edition on the whole of this question. There are few men besides himself whose opinion on such a subject would be entitled to much weight. Mathematical studies have taken a turn in the present day, which leads them, after the first stage, too much into the byways of mental training. We hope to see them brought back. Dr Whewell has done much for the improvement of the studies of the University of Cambridge, and the edition before us is proof that he is still engaged on the right side.

The third part of the "Mathematical Lectures" is occupied with the subject of Ratio and Proportion. As an instance of the copiousness of treatment to which we have alluded, we may mention that one whole lecture (Lect. 14), is occupied with the different acceptations of the *word* measure, whilst the subject of Mensurability fills another complete lecture. In discussing this word Measure, the author quotes St Paul, Plato, Aristotle, Ptolemy, Proclus, Apollonius, Cicero, Juvenal, Lucan, Hobbes, and Wallis. The remaining nine lectures are occupied with the definitions of Euclid's fifth book. We are glad to see from the title-page to this edition, that it has been prepared *for* the College. It is to be hoped that this implies that the College intend to encourage the reading of it Now, we are pretty secure in saying, that no one will think of reading through these ten lectures on the method employed by Euclid in his fifth book, who has no desire to master that method, or no object in endeavouring to do so. We consider the fifth book of Euclid to be the most perfect work which has come down to us from antiquity, and the most beautiful example ever produced of reasoning on an abstract definition, or, indeed, of reasoning at all; and it is matter of surprise that this book should be virtually ignored in Cambridge. For the ordinary degree, it is absolutely and formally excluded; and it is to be presumed, that candidates for honours will take the hint to pass it over, unless their attention is strongly directed to it. We accept this edition of Barrow's Works, edited by the Master of Trinity for the College, and published, as we infer from the preface, at the expense of the University, as a protest against such omissions, and a pledge of their ceasing to exist.

It is right to notice, that the present publication embraces not only the Mathematical, but the Geometrical and Optical Lectures. These last will find few readers in the present day. Dr Whewell modestly states in his preface, that he does not himself pretend that he has, in all cases, gone through them to his satisfaction. We fear they will not only find few readers, but will hang as a dead-weight upon the circulation of the "Mathematical Lectures."

It is right to notice, too, that the "Mathematical Lectures" have been translated into English, and that copies are frequently to be met with. The translation is so badly executed, according to Dr Whewell, that it cannot be of use to any one. We do not altogether subscribe to this opinion. We happen to possess two copies of the translation, one of which bears the name of Baron Maseres, and both have been well thumbed. Our readers will perhaps prefer a specimen of the copious (shall we call it pleonastic?) style of Dr Barrow, extracted from the translation, humble as it is, to the infliction of the original Latin. The passage occurs in the 13th Lecture, and is the author's mode of apologising for being about to dwell a little longer on Congruity, in place of at once passing on to Proportionality :—

"But shall I never extricate myself from these quirks and trifles? Shall I always spend my time in examining what is of no value? In so plentiful a harvest, so rich a vintage, so great a store of most important disquisitions, why do I only glean the scattered ears, search the neglected boughs, and gather the fallen grapes? When a chase after the more important and difficult things in the mathematics is offered,—a chase so full of variety, so pleasant, and so certain,—wherefore do I dwell so long upon those little questions, like one hunting after flies? I shun things of consequence, sport in serious, am gravely ridiculous, studiously seeking after, and nicely repeating and inculcating, even the slightest matter. Shall I then incessantly follow so many distant byways, so many uncouth turnings; and shall I never return again into the beaten path of the king's highway? Shall I grow old in these outer courts of general matters? Shall I perpetually tarry in the entrance of the sciences? shall I always stick in the threshold? Shall I only knock at the doors of the mathematics, and never enter within the walls of the house, nor penetrate its more sacred recesses? Shall I ever be upon the parley, ever skirmish at a distance, and never engage hand to hand or come to a decisive battle? What do I but raise mists and doubts, sow strifes and contentions, raise storms and tumults, in that science which promises, which boasts of nothing but what is clear and evident, certain and tried, calm and serene? And by disputing more freely, and bringing many things to the scrutiny, I seem to detract and derogate from the certitude and evidence of the mathematics, which is so contrary to jarring and contentions. Thus am I wont to upbraid myself, and perhaps also others do the same, at least not without some seeming cause or appearance of justice.

"Notwithstanding I am able to allege something in my own excuse to wipe away those reproaches; and since so much of the time destined for this lecture is now passed over, contrary to expectation, so that I am unable, though not unwilling, to enter upon another new subject, I humbly beg of you to pardon this, and indulge me with a little of your patience, while I am in some sort defending these trifles, and explaining the reason of the design I have hitherto gone upon. As to these little niceties, I answer that these things are not always small which seem so, since the stars appear very small, and the sun not great; we are therefore to have a thorough knowledge from whence the appearance of a thing beheld comes, and whither it tends, before its magnitude can be judged of. Those things which are small in bulk are sometimes endued with vast strength; and those which contain nothing in them notable, do often draw after them very great consequences. The origins of the greatest things are almost always small: the largest stocks grow from small seeds; immense rivers swell from small fountains. And the nature of truth and error is most remarkably fruitful: a vast light is, on every side, diffused from small sparks of truth, and a huge crop of errors springs from the least root of falsehood. In the sciences especially, from slender threads are suspended the greatest weights, nor are the least things contemned without the greatest damage. As a whole machine perishes and becomes unfit for use by the misplacing of one wheel, and a huge elephant often perishes by the breach of a little vein; so sometimes one only notion, which may seem small and barren, if ill placed and badly understood, will, from a fruitful offspring of consequences, derive upon any science a vast confusion, a gross darkness, and a manifold mass of error. Aristotle (who also maintains his own accuracy and strict diligence in some most minute things) has wisely observed, in the words most worthy of notice which are extant in the fifth chapter of his first book *de Cœlo*, 'Any little wandering is presently increased and multiplied to ten thousand times greater by such as recede from the truth,'' &c., &c.

Should the reader desire to see other specimens of the copiousness of Barrow, we would refer him to his theological writings. They are full to overflowing, but broad and deep as they are full. It may seem to be something like an example of the *reductio ad absurdum* to speak, as Barrow did, for eight mortal hours on the *government of the tongue*, it is nevertheless true that his discussion of that subject fills eight sermons. That their delivery occupied only eight hours is more than we dare affirm. In the pulpit, Barrow was wont on occasions to weary his hearers. When he preached before the Lord Mayor, he is said to have gone on for three hours and a-half. It is maliciously suggested that he had not been invited to the dinner which was to follow hard upon the sermon, and that he took this ingenious mode of revenging himself for the neglect. We do not believe this. It was not like Barrow. What we do believe, on the testimony of his most intimate friend, is, that he had but one fault—he was a little too long in his sermons. Preaching in Westminster Abbey on a week day, the attendants finding him still in the midst of his subject when the time for showing the cathedral to strangers had arrived, set the organ to play against him, and so blew him out. Barrow was certainly not a popular preacher. His discourses were far too massive for ordinary hearers. Nor do we imagine that he succeeded much better on secular subjects. He began his public career as Professor of Greek in the University in 1660. He appears to have lectured to empty benches. "There I sat," he says, "in the professorial chair like Prometheus fixed to his solitary rock, or muttering Greek sentences to the naked walls like an Attic owl driven out from the society of all the other birds of the air." And we have no reason to believe that his Lucasian lectures proved generally attractive. It must be remembered that mathematical studies had not at that period begun to assume the importance at Cambridge which they have since acquired, partly through Barrow's writings, partly through those of Newton. Long after these lectures had been published, Barrow had heard only of two persons having read them through, Slusius and James Gregory, and it is probable that, like the "Principia," they made their way slowly. But they are now established as part of the standard literature of the country. We trust they may again find their way into the hands of youth. We trust, at any rate, that this edition may find many readers, and allure some kindred spirits into the paths which Barrow trod so well.

Attractions, Laplace's Functions, and the Figure of the Earth. By JOHN H. PRATT, M.A., Archdeacon of Calcutta. Second Edition.

We have great pleasure in introducing this little work to our readers, both for its author's sake and its own. Archdeacon Pratt is one of those persons who have succeeded in devoting themselves heartily, and with full efficiency, at the same time, to the duties of a working clergyman and to the extension of science. When appointed to the chaplaincy of the late Bishop of Calcutta, about four and twenty years ago, he resolved to make his mathematical pursuits the main elements of relaxation, arguing that the overworked mind recovers its elasticity better from change than from want of occupation. Wisely confining himself mainly to one branch of the science, he has steadily devoted his recreation hours—not *horæ subsecivæ*, as our friend Dr Brown calls those he has snatched from sleep (?)—to the examination of the subject of which this volume treats. Papers from the author were read before the Royal Society in 1855–58–59 and 1860, which will be found amongst the Transactions of that Society. In these papers he has examined the effect of the Himalayas, and the mountain ranges beyond them, on the plumb-line in India. He has examined also into the consequences of the fact, that whereas in the north there is an excess of dense mountain matter, in the south there is a corresponding deficiency, as the ocean stretches away from Cape Comorin to the south pole. He endeavours to explain the difficulty which those calculations have brought to light—namely, that the amplitudes of the arcs from Kaliana to Kalianpur, and from Kalianpur to Damargida, determined geodetically, were so little in excess, as they proved to be of the same amplitudes determined astronomically—by attributing to the Indian arc a curvature different from that corresponding to the mean meridian of the earth (*Proceedings of the Royal Society*, x. 648). In the present work, the author has arrived at a different conclusion—namely, that the explanation is geological rather than geographical; that the phenomena are due, not to change of the outer form of the earth in the neighbourhood of the arc, but to a peculiarity in its interior structure; that Kaliana is not required to be 7000 feet nearer the centre than it would be in the mean ellipse, but that the density of the crust of the earth near the middle of the arc is very wide of the mean density.

This is one of the problems worked out in the clear, concise, and comprehensive treatise before us. The basis of the reasoning employed in the work is Laplace's analysis. The author deduces the principal properties of Laplace's functions in a highly satisfactory manner. He then proceeds to apply them to attractions generally, and concludes with the application of the whole to the determination of the figure of the earth. The last division of the subject he treats in three chapters. In the first he deduces the figure of the earth, considered as a fluid mass; in the second, he deduces it on the sole hypothesis of the surface being a surface of equilibrium, and nearly spherical; and, in the third, he discusses the results of geodetic operations, especially those carried on in India. The author has endeavoured to grapple with every difficulty connected with the subject. For example, he examines the argument adduced by Mr Hopkins, to prove from precession that the crust of the earth is not a mere skin, like the rind of an orange, covering up a fluid mass, but is at least 1000 miles thick. To this conclusion he gives his assent.

If anything can add to the pleasure with which we welcome this little volume, it is the fact that the author dates his preface "Calcutta, 1861," thereby assuring us that it has been written in the midst of his labours in that higher field which Archdeacon Pratt has so long and so usefully occupied.

The Past and Present Life of the Globe, being a Sketch of the World's Life System. By DAVID PAGE, F.G.S. Blackwood & Sons. 1861.

The discussions which have lately been raised by Darwin's "Origin of Species," and the discovery of implements of human manufacture in the Post Tertiary Drift, from their peculiar bearing on the origin of our own race, have enlisted the sympathies of many who otherwise take little interest in natural history science. To such recruits the above little work will be of great value, as by its perusal they can master sufficiently well for this purpose the leading principles of the complicated and all-embracing science of Palæontology. Even the special student may read this book with profit, as it presents a more vivid picture to the mind of the present state of geological opinion than can be obtained by the study of detailed works alone. Having been written for oral delivery, the style is clear and inviting, yet always marked by the same logical acumen which renders our author's "Handbooks" so useful to the beginner in the science. In the first six chapters of the work before us, Mr Page has, very properly, confined himself to the exposition of what is firmly established in the minds of most advanced geologists, giving all the latest and most comprehensive views, in the form of a sketch of the Fauna and Flora of the present epoch, followed by a summary of their distribution in time, often combined with admirable descriptions of the physical circumstances of the different geological formations, as a specimen of which we quote the passage that brings us down to the current epoch.

"This ungenial period, generally known in geology as the 'Glacial,' 'Northern Drift,' or 'Boulder Clay' epoch, is lithologically characterised by its superficial mounds and masses of drift-sand and gravel, by thick tenacious clays, interspersed indiscriminately with water-worn blocks of all sizes, from mere pebbles to boulders many tons in weight, and by the polished, rounded, and striated surfaces of the subjacent rocks, as if they had been subjected to the long-continued friction of water or ice-borne material, and scratched and furrowed by the passage of the harder and heavier fragments. In Europe, Asia, and North America, down to the 44th or 42d parallel of latitude, and up to the altitude of 2000 feet, these appearances present themselves, and are inexplicable, unless on the ground of the gradual submergence of the northern hemisphere to that extent, and its subjection to a boreal climate which engendered glaciers on its hills, and drifted, during a brief summer, icebergs laden with rocky *debris* over its waters. The glaciers smoothing, rounding, and grooving the rocks of the higher grounds—the icebergs grinding their way through firth and strait, dropping their burden of mud, sand, and gravel on the sea-bed, or stranding themselves on its shores—complete the necessary arrangements for the production of the geological phenomena of the period. For ages the pliocene lands must have slowly subsided, each step gradually narrowing the boundaries of vegetable and animal life, and driving the surviving species, under the rigours of a deteriorating climate, to higher and higher regions. Race after race would succumb: first the more limited and local, next the more cosmopolitan, and ultimately few of the old flora or fauna would survive, except the more elastic in constitution, and those that had, step by step, retreated into more southern latitudes.

"How long these conditions continued we have no means of determining in centuries; but, judging from the amount of denudation, the extent and nature of the heterogeneous deposits, as well as from the slow rate of elevation and submergence now going on in known regions, vast periods must have elapsed during the manifestation of this glacial epoch. At length the downward tendency of these northern latitudes come to a close; submergence stops and elevation begins. Slowly, and for long under a rigorous climate, the lands of Europe, Asia, and North America emerge from the waters. Glaciers still envelop the higher elevations; icebergs, summer after summer, drift over the waters; and the sea, attacking the soft emerging shores, re-assorts and re-deposits the sands, gravels, and clays of the older glacial epoch. By-and-by the deposits become fossiliferous, showing that the ocean was tenanted by shell-fish, seals, whales, and other creatures, whose habitats are now the icy regions of the arctic circle. Upward, still upward, the land emerges, evincing in its old water-lines and raised beaches the successive steps of its uprise, till ultimately the continents of the northern hemisphere assume, within appreciable limits of current mutation, the configuration and climatology they now present. As the continents emerge and the land surfaces augment, as new atmospheric and oceanic currents are established, and as the post-tertiary epoch advances, the boreal races retreat farther to the north, some of the old pliocene families again return and spread over European latitudes, and other and newer forms, in the course of creation, begin to appear."

The last chapter of the work, which our author has entitled "The Law," consists of a group of short but pithy essays on the different questions of vital import to the science, on which opinion is still divided. Although the reflections embodied in these are often highly suggestive, and indicate the author's grasp of mind, yet the effect of the whole, when read in succession, is very confusing, as they are frequently contradictory; so that, being like a mass of jottings made at different times when the mind has been influenced by a variety of impressions, the reader is left at a loss to understand exactly what has been established. Among the subjects treated of in this chapter, Darwin's hypothesis of course figures largely; but it is painful to notice that our author's desire to take a decided ground on this question has led him to forsake that calmness of judgment and breadth of treatment which marks the other parts of his task. Even those most opposed to Darwin's views, who have mature opinions on the subject, will feel annoyed at such vigorous partisanship, founded on obvious misconceptions of what has been urged in behalf of the agency of natural selection. Mr Page has evidently failed to distinguish between the views of the author of the *Vestiges* and those of Darwin; and, in consequence, often imputes to the latter the arguments used by the former, and to this must be attributed several slips he makes in his treatment of the subject. Thus, after quoting a passage from Darwin's work, he says, "Here, then, according to his own showing, inheritance, external conditions, use and disuse, struggle for life, and natural selection are all fulfilling their parts as co-factors in one great law; and it is strange that, in the face of this admission, he should *labour to ascribe to one cause* what would have been more philosophically and satisfactorily ascribed to the many" (p. 211). Now, this is a mere assumption regarding Darwin's object, for in the introductory chapters to his work, we find him stating, "*that natural selection has been the main but not exclusive means of modification*" (Darwin's *Origin of Species*, p. 6, 5th 1000).

Then, again, with reference to the controlling power of the Deity, he has misrepresented Darwin by saying, that he "appeals throughout his argument to chance and nature for all subsequent development, as if these blind duties were aught without the direction of the same original life-breathing impulse" (p. 211). And again still more strongly, in a foot note to p. 197, when, along with Lamarck and the *Vestiges*, he refers "to the whole tone and tenor of the *Origin of Species*, in which there seems to be a studied non-recognition of any higher influence than chance, external conditions, nature, law, and other kindred activities." But if we again turn to Darwin's own statement, we find that he says, "*To my mind it accords better with what we know of the laws impressed on matter by the Creator, that the production and extinction of the past and present inhabitants of the world should have been due to secondary causes, like those determining the birth and death of the individual*" (p. 489). Here we have a distinct and most philosophical recognition of a supreme controlling power, which our author assumes that Darwin denies.

From the general tone of the work before us, we would not have expected that Mr Page would attempt, however vaguely, to wield the *odium theologicum* in arguing against Darwin's or any other person's views. To use his own words: "In the organic, as in the inorganic world, the Creator often operates through secondary causes, and the discovery of these causes, in the spirit of true philosophy, is to human reason a duty as well as a privilege" (p. 208). Why, then, should he treat Darwin with the least approach to acrimony for making the attempt to perform this duty?

We have not space to enter into any discussion on the subject; but we believe that if all those arguments which he misdirects against the theory of natural selection were withdrawn, the general tenor of the book would greatly outbalance the few rightly directed shafts that remained, and show our author to be much more of a *Darwinite* than he appears to suspect himself.

Before concluding our short notice of this on the whole capital little work, which, by the way, is got up with great taste and finish, we would call attention to the theory (mentioned at page 191), that successive cycles of cold and warmth are indicated by the alternating character of formations, and which was advanced some years ago by the author to a Philosophical Society at St Andrews. It is ingenious, but is clearly dependant on the geographical areas in which we group the formation.

PROCEEDINGS OF SOCIETIES.

Royal Society of Edinburgh.

Monday, 4th March 1861.—Professor CHRISTISON, Vice-President, in the Chair.

The following Communications were read :—

1. Memoir of the late Rev. Dr John Fleming. By Alexander Bryson, Esq.

2. On Zoological Classification, and the Parallelism of the Mammal, Marsupial, and Ornithic Classes. By Professor Macdonald.

Monday, 18th March 1861.—The Hon. LORD NEAVES, Vice-President, in the Chair.

The following Communications were read :—

1. On the Properties of the Secretion of the Human Pancreas. By William Turner, M.B. (Lond.), Senior Demonstrator of Anatomy, University of Edinburgh.

The author obtained the pancreatic secretion at a *post mortem* examination which he made of the body of a patient of Mr Spence, who had died with a medullary tumour in the head of the pancreas, which, by compressing the biliary and pancreatic ducts, had produced dilatation of the ducts of the liver and gall-bladder, as well as dilatation of the ducts and lobules of the pancreas. The secretion was contained in the dilated parts of the gland last named, from which it was drawn off by means of a pipette. The fluid thus obtained was of an orange-yellow colour, and well-marked viscid consistency—sp. gr. 1·0105; appearance slightly turbid, owing to the presence of small white flakes, which a microscopic examination proved to consist of groups of small spherical, colourless cells, resembling, and most probably consisting of, the epithelial lining of the vesicles of the gland. Reaction faintly yet decidedly acid; heat, alcohol, corrosive sublimate, and bichloride of platinum threw down copious yellowish-white precipitates, consisting of the peculiar albuminous constituent of the secretion. No reduction was effected by boiling the fluid with freshly precipitated blue oxide of copper, showing the absence of sugar or any corresponding deoxidizing substance. The absence of sulpho-cyanide of potassium was shown by no reaction being given with a solution of perchloride of iron; thus affording a well-marked distinction between the composition of the human saliva and pancreatic juice. A partial emulsionizing effect was produced by rubbing some of the fluid with a little oil. With another portion of the secretion, starch was converted into dextrine. The action of the fluid upon albuminous substances was also tested, but a negative result was obtained. It should be stated, however, that but a small quantity of the secretion was now left, and that a day had elapsed between its withdrawal from the body and the application of this test. The author then adverted to the accounts which have been given by various physiologists of the pancreatic fluid obtained from the different domestic animals which it is usual to experiment on when samples of this secretion are required, and concluded by showing in what respect the secretion of the human pancreas agreed with, or differed from, that of these animals.

2. On the Acrid Fluid of the Toad (*Bufo vulgaris*). By John Davy, M.D., F.R.S. Lond. and Edin., &c.

The author first adverts to the conflicting opinions respecting the nature of this fluid, and especially to one of the latest, that entertained by MM. Gratiolet and S. Cloez, that it is an active poison.

He next describes some experiments he has made for the purpose of testing their conclusion, the results of which are in opposition to theirs, and confirmatory of certain ones of his own, showing that the fluid is a simple acrid irritant, and as such well adapted to protect an animal otherwise defenceless, and, from its sluggish habits, peculiarly exposed to danger.

Incidentally, he makes some remarks on the toad of Barbadoes, which, brought from Dominica only a few years ago, has so multiplied as to abound in every part of the island. Its comparative rareness in Britain he attributes to two causes: one, the circumstance of the very young toad being, as he believes, destitute of the acrid fluid; another, the intolerance of the toad of all ages of severe cold, and in consequence, its liability to perish if the winter temperature be unusually low.

In a foot-note, he expresses the opinion, founded on one observation, that the female toad during the breeding season is without the protecting acrid fluid, the male at that time having it in more than ordinary abundance, and, from position, whilst the ova are *in transitu*, probably defending his mate.

3. On Gyrolite occurring with Calcite in Apophyllite in the Trap of the Bay of Fundy. By Henry How, Professor of Chemistry and Natural History, King's College, Windsor. Nova Scotia.

(This paper appears in the present number of this Journal.)

4. On Natro-boro-calcite, and another Borate occurring in the Gypsum of Nova Scotia. By Henry How, Professor of Chemistry and Natural History, King's College, Windsor, N.S.

(This paper appears in the present number of this Journal.)

5. On some Derivatives from the Olefines. By Frederick Guthrie, Professor of Chemistry and Physics in the Royal College, Mauritius.

This paper is supplementary to, and forms the sequel of, a series of papers which have been published in the "Quarterly Journal of the Chemical Society of London."

In continuing the examination of the behaviour of the olefines towards compound halogens, certain compounds previously described have been submitted to a test of homogeneity, of which the following is the principle:—

"If a body be partly dissolved in a solvent, and if the dissolved part and the undissolved part, or the dissolved part and the whole, or the undissolved part and the whole, have the same composition, then the body is a simple one."

Examined in this manner with regard to the solvent alcohol, the bisulphochlorides of ethylen and amylen were shown to be true chemical compounds.

The bisulphochloride of ethylen was submitted to the action of chlorine, whereupon a body was formed identical with that got by the action of chlorine upon the bisulphochloride of chlorethylen or upon the bisulphide of ethyl—namely, the chlorosulphide of bichlorethylen or sulphide of terchlorethyl

$$C_4\ H_2\ Cl_3\ S.$$

Further, the same body $C_4\ H_4\ S_2\ Cl$ was submitted, in alcoholic solution, to the action of hydrate of potash, which converted it into

$$C_4\ H_4\ S_2\ OHO.$$

Again, the body $C_{10}\ H_{10}\ S_2\ Cl$ (whose equivalent of chlorine has been shown to be replacible by O and by OHO), on treatment with cyanide and sulphocyanide of potassium in alcoholic solution, exchanges its chlorine for cyanogen or sulphocyanogen respectively, giving rise to

Bithiocyanide of amylen, $C_{10}\ H_{10}\ S_2\ Cy$
and Bithiosulphocyanide of amylen, $C_{10}\ H_{10}\ S_2\ S_2\ Cy$
respectively.

From these and analogous reactions previously described, the conclusion is drawn that the bodies $C_4\ H_4\ S_2\ Cl$ and $C_{10}\ H_{10}\ S_8\ Cl$ behave towards chlorine like the sulphides of chloriniferous radicles,

$$C_4 \left.\begin{matrix}H_4\\Cl\end{matrix}\right\} S_2 \qquad C_{10} \left.\begin{matrix}H_{10}\\Cl\end{matrix}\right\} S_2;$$

while towards metallic oxides, hydrated oxides, cyanides, and sulphocyanides, they behave like chlorides of sulphuriferous radicles,

$$C_4 \left.\begin{matrix}H_4\\S_2\end{matrix}\right\} Cl \qquad C_{10} \left.\begin{matrix}H_{10}\\S_2\end{matrix}\right\} Cl.$$

The bisulphide of amylen,

$$C_{10}\ H_{10}\ S_2,$$

was produced by the withdrawal of the chlorine from $C_{10}\ H_{10}\ S_2\ Cl$ by means of metallic zinc—a reaction analogous to the reduction of kakodyl from its chloride.

The bichloride of amylen,

$$C_{10}\ H_{10}\ Cl_2,$$

could not be formed by the direct union of chlorine and amylen, but was produced by the action of amylen upon the pentachloride of phosphorus.

The binitroxide of amylen,

$$C_{10}\ H_{10}\ 2NO_4,$$

which is formed in small quantity when nitric acid and amylen react on one another, was formed in abundance when NO_4 was led into amylen. This reaction shows how completely NO_4 obeys the laws of the halogens, and leads to its being called nitroxine. The same property is again illustrated by the conversion of the latter body into bicyanide of amylen,

$$C_{10}\,H_{10}\,Cy_2 + 5Aq,$$

by the action of cyanide of potassium in alcoholic solution, the nitrite of potash or nitroxide of potassium KNO_4 being formed at the same time. The five equivalents of water are feebly combined. An experiment to procure the pimelate of potash from the bicyanide of amylen by the action of caustic potash was without result.

By the action of nitric acid upon the bisulphochloride of amylen the nitroxisulphide of nitroxamylen is formed,

$$C_{10}\,{}^{H_9}_{NO_4}\;SNO_4,$$

together with a conjugate sulphur acid.

Finally, when zinc-ethyl and bisulphochloride of amylen are brought together in ethereal solution, the chlorine of the latter body is replaced by ethyl, and a body formed having the constitution and properties of the bisulphide of œnanthyl—

$C_{10}\,H_{10}\,S_2\,C_4\,H_5$ Bisulphethide of amylen,
or $C_{14}\,H_{15}\,S_2$ Bisulphide of œnanthyl.

A list is given of the compounds hitherto obtained by the action of certain compound halogens upon the olefines ethylen and amylen.

The use of the terms Recomposition, Isotype, Idiotype, are explained, and a method given for determining the specific gravity of small quantities of liquids, which are heavier than and insoluble in water.

Monday, 1st April 1861.—Dr CHRISTISON, Vice-President, in the Chair.

The following Communications were read :—

1. On the Molecular Theory of Organization. By Professor Bennett, M.D., F.R.S.E., &c.

Parodying the celebrated expression of Harvey, viz., *Omne animal ex ovo*, it has been attempted to formularise the law of development by the expression *omnis cellula e cellula*, and to maintain "that we must not transfer the seat of real action to any point beyond the cell."* In the attempts which have been made to support this exclusive doctrine, and to give all the tissues and all vital properties a cell origin, the great importance of the molecular element, it seemed to the author, had been strangely overlooked. It becomes important, therefore, to show that real action, both physical and

* Virchow, Eng. Trans. p. 3.

vital, may be seated in minute particles, or molecules much smaller than cells, and that we must obtain a knowledge of such action in these molecules if we desire to comprehend the laws of organisation. To this end the author directed attention: 1*st*, To a description of the nature and mode of origin of organic molecules; 2*d*, To a demonstration of the fact that these molecules possess inherent powers or forces, and are present in all those tissues which manifest vital force; and 3*d*, To a law which governs the combination, arrangement, and behaviour of these molecules during the development of organised tissue.

2. Notices of Early Scotch Planting. By Prof. Cosmo Innes.

The common opinion that Scotland was at one time closely wooded, is at least questionable, and some circumstances lead to an opposite belief: as, the careful stipulations found in the most ancient deeds, about giving or withholding a limited use of wood for building and fuel. The use of foreign timber for our greater buildings, when to be had; thus, Norway timber used for building the Abbey of Arbroath, in the 15th century. The importation of bow-staves and spear-shafts, such long straight timber not being procurable at home.

The trees found in peat-mosses, for the most part small and few, and confined to narrow spaces, by no means prove a general covering of wood in ancient times.

One reason of the common error is the change of meaning which the word *forest* has undergone. From its etymology, the word has no connection with wood, and of old, and especially with old lawyers, it meant merely land privileged for the chase; but many people, meeting the word in old charters and descriptions of estates, suppose it to mean as at present, wood-land. It is clear, however, that there has always been some wood, even timber, in Scotland.

The earliest Christian churches were of timber, probably in all countries; and the building of churches of stone was considered a novelty at the beginning of our acquaintance with church architecture in Scotland.

The forts built in inland lakes and morasses, which the Irish have taught us to call *cranogues*, of great antiquity, perhaps the most ancient extant dwellings except caves and burrows, are found often built on piles of oak of moderate size, and sometimes with beams of birch for the cross timber.

Sometimes beside these forts, but often apart, are found the shells of rude but large canoes, bespeaking a high antiquity, each hollowed out of a single oak.

Within the period of history (A.D. 1249), the Earl of St Pol and Blois, preparing for the Crusades, had a wonderful ship (*navis miranda*) built at Inverness.

The Bishop of Caithness, Chancellor of Scotland, and a friend of Edward the First, being engaged (A.D. 1291) in putting a roof on his cathedral of Dornoch, obtained from the king a grant of 40 oaks, fit for timber, to be taken out of the wood (*bosco*) of Darnaway, in Moray.

The Bishop of Brechin granting (A.D. 1435) a lease of the Kirkdavoch of Strachan for three lives, took the tenant bound to deliver, not periodically, but once only, oak laths enough for roofing 20 perches of the cathedral, or the Bishop's palace—*tantas vulgariter dictas lathis bonas et sufficientes de quercu.*

Two centuries later (1606), Alexander Davidson, styled tymberman in St Andrews, agrees with "the honest man that has bocht the wod of Drum, for als mekill tymber as will big ane bark." The timber was to be floated down the Dee, "how soon the water growis." This was evidently fir-timber. Nine trees were bought from the woodmen of Drum (1612–13) to make a sluice for one of the town of Aberdeen's mills, for the price of £27. These may have been oak. The presumption seems very strong, from the present appearance of the ground, and all circumstances, that the timber in all these transactions was not planted, but of native growth.

From all the evidence we have, old historical Scotland,—Scotland of the 14th to the 17th century, both included,—in regard to wood was very much as at present; making allowance, however, for the effect of cultivation which has curtailed it a little, and plantation, which has immensely increased its quantity in the last century. Speaking generally, the levels were cultivated, or bare moorland or swamp; the upland pastures, whether green or heathery, were bare of wood, except where the steep and rough glens, ravines, and water-courses, sheltered and protected from cattle a fringe of native wood—hazel, birch, or oak—the latter of small size. There are, and always have been, districts more or less willing to send up a native growth of timber—as Braemar; the upper part of Strathspey; the upper part of the valley of the Beauly; parts of Glenmoriston, and Loch Arkeg in Lochiel.

To remedy the defect of wood, some of our old codes of criminal practice appointed a form of procedure against trespassers and destroyers of wood; and the parliamentary records of Scotland are full of ordinances to encourage planting of wood, and even broom, in minute quantities; and for the repression of offences against it.

Following out the intention of the Legislature, the great proprietors made some efforts at planting in the 15th century. The Abbot of Cupar (A.D. 1473) set in lease the lands of Balmyle, in Strathmore, and bound the tenants to "put al the land to al possibil policie in biggin of housis, plantacioun of treis—*eschis*, *osaris*, and *sauch*, and froit-treis—gif thei ma."

From that time downwards, there are documentary proofs of some attention bestowed upon planting in Scotland; and, in a few, widely-scattered instances, we find places bearing marks of culture and planting that carry us back to that century; but all of these mark, also, that the effort was confined to the planting of a few trees near the mansion-house and the houses of the greater tenants.

In the next century (16th), but rather towards the end of it, considerable progress was made in the creation and embellishment of country houses. William, first Earl of Gowrie, who built a gallery, and decorated it with pictures, was a zealous planter, and was fond of the chestnut and walnut. In 1586, James, Lord Ogilvy, is found corresponding with Sir David Lindsay of Edzell, about their plantations, and writes to him—"Your thousand young birkis shall be richt welcom."

At the same period the Campbells of Glenurchy were creating the place of Balloch, now Taymouth, enforcing the planting of single trees amongst their tenants, and using vigorous measures for protecting wood. Probably similar operations were carried on in that century at Seaton, Winton, Lethington, and other places; and some remains of still older cultivation are to be found about the seats of the old Church lords, as at Newbattle, Ancrum, Pinkie, and a few others.

It seems very doubtful whether any tree planted before the Reformation is now growing in Scotland. The date of the sycamore at Kippenross is not well vouched; and, to judge from appearance, neither it nor those at Newbattle can be ranked so old as 300 years. The chestnut at Finhaven was certainly much overrated when said in 1760 to be 500 years old.

Some ancient yews, especially the yew of Fortingall, come under a different category. It would appear that successive trees grow up in the bark and round the stem of the decayed yew, and may go on decaying and reproducing indefinitely.

About the period of King James's accession to the English throne (A.D. 1603) was the era of a great effort for improving and beautifying our country mansions, as shown in the Aberdeenshire castellated mansion, and others of the same taste all over Scotland. That period of fine taste was marked by great attention to planting, chiefly in the manner of avenues of ash and sycamore, with a timid intermixture of chestnut and walnut. During "the troubles" of Charles's reign and the Commonwealth, there was a cessation of progress; but yet even in that time we find the Earl of Lauderdale sending to Taymouth for fir seed, and the Marchioness of Hamilton expressing her own interest, and that of several of her relations, in young firs grown from Breadalbane seed, and boasting that she had four or five hundred of her own planting. "Believe me," says she, "I think mair of them nor ye can imagin, for I loue them mair nor I dou al the froit-treis in the wordil." The Restoration (1660) brought a great change. Crowds of young men, virtually exiled during the Usurper's reign, then returned from wandering over the Continent, where they had learnt to admire the taste of the Italian villa and the French chateau. Evelyn tells us how universal the passion for rural embellishment and magnificent country houses was among the English nobility,* and he himself helped to extend the public attention to restoring and planting wood.

Scotland kept pace as much as her poverty allowed. The botanical garden of Edinburgh was founded (1670). Country-seats were built or restored, and planting was carried on in many places where we can yet find trees to be ascribed to that period—still chiefly in the limited style of straight avenue and hedgerow. This was the date of a great enlargement—almost new modelling—of Taymouth, Hatton, Inverary, Drumlanrig, Hamilton, Hopetoun, Panmure, Kinross, Yester, Arniston, with a long *et cetera.*

The Revolution (1688) may be said to have renewed the impulse given by the Restoration. Again, a crowd of Scotch gentlemen whom the unhappy courses of the last Stuarts had driven abroad, returned to their own country, imbued with the taste of cultivation they had acquired in Holland and Flanders. Among these were Hume of Marchmont, the Dalrymples, Lord Haddington, Dundas of Arniston, Argyll, Hyndford, &c.

About this time a style of planting became fashionable, breaking a little from the formal straight avenue, and which was known as "the wilderness." The Earl of Mar at Alloa, his brother Lord Grange at Preston, Lord Haddington, and the First President Arniston, adopted this style; and at Arniston is preserved a plan of "the wilderness" as it was in 1726, which can still be distinctly traced on the lawn to the west of the house, and shows how little the original formality impedes the picturesqueness of the grown wood. There was a wilderness also at Blair-Atholl.

Lord Haddington remarks that planting was little understood in Scotland till the beginning of the 18th century (1700), and, of planting in masses, the remark is nearly correct. He himself was among the first who planted on the great scale, and with method and discrimination. But a little before his time (A.D. 1680) Andrew Heron was planting at Bargally, in the stewartry of Kirkcudbright, which Loudon considered "the most interesting place in Scotland with respect to the introduction of foreign trees and shrubs." Dukes John and Archibald of Argyll followed, bringing their English experience to bear on Scotland. Lord Haddington and his wife made the noble wood of Tyningham out of a rabbit-warren. The Earl of Bute, Lord Loudoun, and Lord Hyndford, were planters in the most favourable situations of Scotland. The Earl of Panmure

* Evelyn, Silva or a discourse of forest-trees. London, 1768–79.

planted endless beech avenues at Panmure, which within memory were grand and growing trees, and proved how the East Coast may be made to produce fine timber.

It has been said by old foresters that Panmure and Yester were the two places where beech was first planted largely. The taste spread rapidly. It was from Lord Tweeddale that the first President Dundas brought a present of thirty beech plants and one elm, which were carried in his portmanteau, on his servant's horse, to Arniston. The beeches are still standing and flourishing in the south avenue. They bear the marks of having been headed down in transplanting —a practice of that time.

Next came the taste for larch, which must have been introduced in several places as soon as at Dunkeld, though the story of the Duke's two flower-pot larches (A.D. 1727) may be true too.

A few giant larches at Arniston may be as old, and one or two in the "Paradise," by the river side at Monymusk, are apparently coeval, as they are coequal, with the finest trees at Dunkeld.

In the north country the Duchess of Gordon (the Mordaunt Duchess) was a great improver, and planted to some extent both at Gordon Castle and in Strathspey. Sir William Gordon of Invergordon planted and drained extensively; and other improvers and planters of that time were Ross of Balnagown, the Grants of Monymusk, Scott of Scotstarvet, Hope of Rankeillor, Lord Cathcart, Sir Francis Kinloch, Sir John Dalrymple, Wauchop of Edmonston, Sir James Dick of Priestfield, Sir James Stewart of Goodtrees, the Duchess of Buccleuch, Sir James Cunninghame, Lord Livingston.

Reid's "Scots Gardener," published in 1683, shows the taste for wood already begun. Sir Archibald Grant of Monymusk has left us a brief but interesting account of the planting and other improvements begun by him in 1716. The Earl of Haddington published, in 1733, a minute account of his planting operations. At Arniston are preserved original accounts and contemporary documents showing the extent and manner of planting there during almost the whole of last century, and also a narrative detailing the results made up from such materials, written by the Lord Chief Baron Dundas. An anonymous writer in 1729 (believed to be Mr M'Intosh of Borlum) mentions a good many improvers, enclosers, and planters, in Scotland at that time. Mr Walker, Professor of Natural History at Edinburgh, in his "Economical History of the Hebrides and Highlands," and his collected "Essays," gives the results of his own observations of trees through Scotland, from about 1760, for twenty years. Sang's "Planter's Calendar;" Dr Patrick Graham's "General Report of Scotland;" Monteith's "Forester's Guide;" Sir Thomas Dick Lauder's edition of "Gilpin," furnish a considerable mass of information of the state of wood in Scotland during a century past. And Loudon, in his most laborious and valuable "Arboretum et Fruticetum Britannicum," arranges and digests much of these materials. One important use served by the authors named is to enable us to compare the present condition and size of trees with what they were at ascertained distances of time previous; while the collection of returns of remarkable trees now making to the Highland Society, will serve as a foundation for such measurement and comparison in future times.

Monday, 15th April 1861.—The Hon. LORD NEAVES, Vice-President, in the Chair.

The following Communications were read :—

1. Additional Observations on the Chronology of the Trap-Rocks of Scotland. By Archibald Geikie, Esq., F.G.S.

In a communication made to the Society last session, the author stated the results of a series of explorations among the trap-rocks of Scotland, and showed that, at successive periods, during the deposition of the Lower Silurian, Old Red Sandstone, Carboniferous, Oolitic, and Tertiary formations, there were contemporaneous eruptions of volcanic material. During the year 1860, the investigation was continued across the Highlands into the Inner Hebrides, and throughout a large part of the central counties southward to the Cheviot Hills. The author was now able to fill in more fully what had only been sketched in outline in the previous paper, and to prepare a series of maps to illustrate the volcanic areas of Scotland during the successive geological periods. He showed that, in the Scottish Highlands, no distinct trace existed of any igneous rock erupted contemporaneously with the deposition of those Lower Silurian strata which are now metamorphosed into gneiss, mica-schist, clay-slate, &c. The greater part of his observations during the past year had been devoted to the elucidation of the chronology of the igneous rocks belonging to the period of the Old Red Sandstone, and he found that, in central Scotland, that formation exhibited a copious series of contemporaneous felstones and ash-beds in its lower and upper members; the former being exemplified in Forfarshire and Perthshire, and the latter in Fife and in the Pentland Hills. Several additional facts had also been observed among the Carboniferous trap-rocks, tending to make the series more complete, and to show how with volcanic movements there were associated certain risings and sinkings of the land, whereby the fauna and flora of the Carboniferous period were locally modified. Reference was also made to the remarkable series of greenstone and basalt dykes which traverse Scotland from N.W. to S.E., and enter the northern English counties. From observations made at either end of the series, the author deduced the inference that these dykes are later than the Lias, and probably belong to the period of the Middle or Upper Oolite.

2. Notes on Ancient Glaciers made during a brief Visit to Chamouni and its neighbourhood in September 1860. By David Milne-Home, Esq. of Wedderburn.

(This paper appears in the present number of this Journal.)

Monday, 29th April 1861.—Professor ANDERSON, in the Chair.

The following Communications were read:—

1. On the Aqueous Origin of Granite. By Alexander Bryson, P.R.S.S.A.

In this paper the author referred to the labours of Dr William Smith, who published his "Tabular View of the British Strata" in 1790, and remarked that since that period geology had been studied mainly in the direction of Palæontology. Physical, chemical, and dynamic geology, were left almost unregarded by the great masters of the science, who generally accepted the speculations of Hutton and the experiments of Hall, as demonstrating the igneous origin of the primary rocks.

The author stated that the Huttonian theory was most ably attacked, and, in his opinion, overthrown by Dr Murray in his "Comparative View of the Huttonian and Neptunian Systems of Geology," a work most unaccountably overlooked. Since that time it had suggested itself to the sagacious mind of Davy, that the occurrence of fluids in the cavities of crystals seemed to point to an aqueous origin. He also alluded to the writings of Brewster, Sivewright, and Nicol, in the same field; also to Becquerel, Fuchs, Bischoff, and Delesse, who have taken up the subject of the aqueous origin of rocks from a chemical point of view. The author then laid before the Society the result of ten years' experimental investigation into the structure of rocks relative to their formation, more particularly granite. While examining microscopically the various pitchstone veins abounding in Arran, he was much struck with the similarity of their structure, and the marked difference they exhibited when compared with sections of granite and its various mineral constituents. On extending his observations to obsidian, marekanite (a volcanic glass from Lake Marekan in Kamtschatka), and also to the well-known glassy obsidian of Bohemia, he found they all exhibited a structure analagous to the pitchstones of Arran. He further found that sections of glass slags, where the heat had been long continued, combined with slow cooling, all presented the same appearances as the sections of pitchstone.

This structure, peculiar to igneously formed substances, he found usually to radiate in a stellate form; and though many slags showed large stars visible to the naked eye, the stellate structure is more easily observed by the aid of the microscope. The character is so marked that no one whose eye is tutored to microscopic observation can fail to recognise at once a mineral substance of igneous origin.

In granite, on the other hand, the structure, as seen by the microscope, is as persistent as in pitchstone, glass, and obsidian, but totally different.

In the many experiments which the author had tried with granites from various localities, he had never succeeded in obtaining one instance of stellate structure, while the constant occurrence of cavities containing fluids convinced him that, if pitchstone and glass are types of igneous-formed substances, granite must be of aqueous origin. In the fluid cavities so abundant in topaz, Cairngorum, beryl, tourmaline, and felspar, all constituents of granite, he found the same appearance prevailed. These cavities are seldom entirely filled with fluid, an air-bubble usually occupying more or less of the cavity. After many hundred experiments on such cavities, the author found that when exposed to a temperature of 94° Fahr., the bubble disappeared, the fluid entirely filling the cavity, and at the temperature of 84° the bubble reappeared with a singular ebullition, showing that the air had formed an atmosphere round the fluid. He was thus led to infer that those cavities could not have been filled at a temperature above 84°, and certainly not above 94° of Fahrenheit.

As another proof that these cavities could not have been filled when the temperature of the surrounding rock was higher than the temperature above indicated, the author drew attention to the fact, that the bubble of air occupied always a much smaller portion of the cavity than the fluid, a condition which could not obtain, if, as other writers hold, the fluids were enclosed under intense heat and pressure.

For the purpose of accurately determining the temperatures at which the bubble vanished and reappeared, the author constructed an apparatus which he exhibited and described. It consists of a microscope with a hollow iron stage, having a tube in the centre to admit light from the reflector. At one side, and inserted into the stage, is a small tin retort with a stopper; at the other side, a tube is inserted and attached to a reservoir of water, from which the hollow stage and retort are filled. On applying heat to the retort, by means of a spirit-lamp, any required temperature under the boiling-point of the water may be obtained in the stage and retort.

Above the stage is placed an iron saucer, in the centre of which an iron tube is rivetted, through which the light is admitted; this vessel is filled with mercury, and in it is placed an upright thermometer, with the bulb shielded with cork or any other good non-conductor; by this means it indicates the actual temperature of the mercury bath. The cavity to be observed is cemented with Canada balsam to a plate of glass 3×1 inch, and is floated on the surface of the mercury, so that the glass and mercury are in absolute contact. When the temperature is raised until the bubble nearly disappears (which is seen by its contraction), the spirit-lamp is withdrawn, and the vanishing point carefully watched, and the temperature noted. The stopper of the retort is then withdrawn, and the stop-cock of the reservoir of water opened, so that the temperature of the stage and mercury bath is soon reduced, and the ebullition or reappearance of the bubble takes place, when the temperature is again recorded. By this method the author felt confident that his results were correct, as they always were consistent when observing the same cavity. By means of this instrument the author had found fluid cavities in the trap tuffa of Arthur's Seat, the greenstone of the Crags, and the basalt of Samson's Ribs. He had also found that the porphyry of Dun Dhu in Arran, which most geologists assumed as of igneous origin, was full of fluid cavities contained in the doubly acuminated crystals of quartz for which this remarkable porphyry is distinguished. He also showed doubly acuminated crystals of quartz in the saliferous gypsums of India, both of which were full of fluid cavities, and the quartz impressed with the gypsum; and as no geologist would hold that this formation was of igneous origin, but that the quartz, if not contemporaneous with the gypsum, must have been subsequent, and as the same phenomena were presented by the porphyry of Dun Dhu, he was forced to the conclusion that it was as much aqueous in its origin as the saliferous gypsum of India. The author exhibited a specimen of quartz which contained a crystal of iron pyrites, to which was attached a crystal of galena and also a small massy zinc blende, while over these three metals was laid a covering of gold. From this specimen he argued, that as all these metals were fusible at a much lower temperature than quartz, they must have aggregated during a gelatinous condition of the quartz; and further, that as the sulphides of the three metals were in chemically combining proportions, any heat which would have fused the quartz would have made an alloy or a slag in which chemical combining proportions could not occur.

He also exhibited specimens of schorl which he had obtained in the granite of Aberdeen, and drew the inference that schorl, which crackles and splits with a very small increment of temperature, could not have been present during a molten condition of the quartz; and that it was crystallized prior to the solidifying of the latter, as proved by the schorl impressing the quartz. The author, from a careful examination of the schorls in the quartzite of Aberdeen, was led to believe that the quartz, while in the process of crystallization, expanded one twenty-fourth of its bulk, a force which appeared to him to be sufficient to cause all the upheavals and disruptions which had led geologists to account for such phenomena by a molten condition of the primary rocks. If this view is correct, and if the highest peak is granite, as the lowest is known to be granite, the author calculated that as the highest mountain is only $\frac{1}{571}$ part of the radius of the earth, a thickness of the crust of 168 miles is quite sufficient to yield expansive force to raise the highest peak of the Himalayan range. He further stated that the cause of the temperature at which the fluids were confined being higher than the normal one, depended on the rise of temperature which takes place during solidification.

The author, in conclusion, trusted he would soon be in a position to confirm these views when he had finished the investigation of the trap rocks with which he is now engaged.

2. Notes of Excursions to the Higher Ranges of the Anamalai Hills, South India, in 1858 and 1859. By Hugh Cleghorn, M.D., F.L.S., Conservator of Forests, Madras Presidency.

The southern ranges of the Anamalai (*i.e.*, Elephant Hills) having been little explored, and only known through the manuscript report of Captain J. Michael, 39th N.I., formerly of the Forest Department, the author was induced to project an excursion to these heights, in concert with Dr D. Macpherson, Inspector-General of Hospitals, and the Collector and Engineer of the Coimbatore District (Messrs Cherry and Fraser). The arrangements were made under the auspices of the Right Hon. Lord Harris, Governor of Madras, and His Excellency Sir P. Grant, complied with the request that Major Douglas Hamilton, 21st N.I., should accompany them as artist, to delineate the characteristic features of the country. (This officer's sketches, seventeen in number, some of them panoramic, were exhibited. A selection will appear in the Transactions). Notwithstanding the unfavourable state of the weather, the result was not without interest, much additional information having been obtained, which elucidates Col. Fred. C. Cotton's narrative of an expedition over the Anamalai mountains (northern range). (See "Madras Journal of Literature and Science," vol. ii. p. 80. 1857.)

The main results of the excursion were extracted from his Diary, beginning 15th Sept. 1858. "Teak occurred on some undulating knolls, two or three miles before reaching the village (Punâchi), and on the slopes of the basin leading to the river (Torakadu). The teak tree is not of superior dimensions, but is thickly scattered, forming nearly half of the forest. Many of the trees would yield second-class logs, and they increased in size as we descended the gorge. Being in flower, the white cross-armed panicles formed a striking feature in the landscape. There was much fallen and decaying teak within three miles of our huts. I inspected the jungle both in going and returning, and walked across in different directions to estimate approximately the number and size of the trees, and came to the conclusion that the value of standing wood might be 50,000 rupees, and of fallen timber at least 5000 rupees, a sum which could easily be realised, if there was easy transport. We saw, farther up the valley, much Vengé (*Pterocarpus marsupium*) and blackwood, which became more abundant, as the elevation increased. These trees seem to prefer an altitude somewhat greater than teak, whilst the Vella Nâga (*Conocarpus latifolius*), of great size, occurs with the teak, or prefers a lower range. The sholas (glades) near Punâchi, between 3000 and 4000 feet above the sea, are very dense and rich in their flora. The following are a few remarkable forms observed, a new species of *Jenkinsia* (Wallich), *Solenocarpus Indicus*, a tree called by the Kaders Palli-illi, the leaves of which are eaten. *Elœocarpus Monoceros*, a new species of *Cookia* (Mur Kuringi), with a delicious fruit. *Glycosmis pentaphylla*, *Pierardia macrostachys*, with an edible fruit. *Cleidion Javanicum* (Wall); *Mesua*, with very large fruit; *Calophyllum*, a species with narrow lanceolate leaves; *Orophea*, two new species; *Unona pannosa*, *Guatteria coffeoides*, *Cyathocalyx zeylanicus*; *Garcinia*, *Pterospermum obtusifolium*, *Sterculia guttata*, *Machilus*, *Casearia*, a new species; *Euonymus*, two apparently new forms, one with downy leaves, and the other much like a lime tree. *Agrostemma*, two species, *Ophioxylon*, a new species, with falcate bracts; and *Othomorphe subpeltata*. *Acranthera zeylanica*, *Nephelium erectum*, a very gorgeous species of *Pachycentria*, and two rare Euphorbiaceous trees, *Dimorphocalyx glabellus*, and *Desmostemon zeylanicum*, lately described by Mr Thwaites.

"Many of the trees in the dark sholas are covered with beautiful epiphytes, especially the *Hoya pauciflora*, *Æschynanthus zeylanicus*, and *Sarcanthus filiformis*. The dripping rocks are adorned with *Klugia* (two species), *Epithema*, &c. Cardamoms with rich aroma, and the true ginger plant, abound in these sholas. The rocks in the bed of all the rivers, from 3000 to 4500 feet, are quite covered with a showy orange-coloured Balsam (*Impatiens verticillata*). It often forms a fringe at the line of watermark, or appears in patches between the forks of a cascade. At a higher elevation, other species seemed to take its place, especially the "*Impatiens*

Tangachee" (Beddome). A truly aquatic fern, a new species of *Pleopeltis*, grows in great abundance on rocks at the bottom of the Torakadu river.

"The *Rhododendron arboreum* was first seen at an elevation of about 5000 feet."

Mr Beddome has favoured me with the following note of his ascent:—"The rocky Akka Mountain, which is probably upwards of 8000 feet, is quite covered near its summit with several new species of *Impatiens*. The only other new form observed on this mountain was a curious Crassulaceous plant with fleshy peltate leaves, growing in sheltered moist nooks of the rock. Balsams are very abundant on these hills. *Impatiens Balsamina, dasysperma, Hensloviana, maculata, Campanula, chinensis, tomentosa, verticillata, oppositifolia, Kleinii, filiformis, tenella,* and *rivalis*."

"Some of the herbaceous plants observed adorning the higher hill-side pastures were:—*Flemingia procumbens, Phaseolus Pulniensis, Anemone Wightiana, Lysimachia Leschenaultii* and *deltoidea, Utricularia, Ranunculus reniformis, Gentiana pedicellata.* This list might be extended, but the examples are sufficient to show the similarity of the Flora to that round Utakamand."

The general appearance and character of these high lands resemble much the Nilgiri Hills. Here are the same rounded eminences and dense sholas, extending continuously for miles, their edges fringed with *Strobilanthes*, and ceasing abruptly; the hills are conical, and the slopes covered with short, rich grass, abounding with such plants as *Exacum bicolor*, and *Ophelia elegans:* the woods contain *Hymenodyction excelsum*, and other species of the Cinchona family. Heavy rains, evidently the breaking up of the south-west monsoon, fell continuously during the period of our stay in these upper regions. The want of shelter, and the difficulty of procuring supplies, prevented us from proceeding to the highest parts of the range, which appeared to be about twelve miles in a south-east direction from the extreme point the party reached. We therefore reluctantly returned to the low country without fully attaining our object, having been absent eight days. Three distinct tribes inhabit the Anamalai hills; they are denominated Kâders, Paliars, and Malsars. The Kâders perform no menial labour; as their name implies, they are the lords of the hills; they will carry a gun, and loads also as a favour, and are expert at stalking game, but are deeply offended if they are called coolies. They are a truthful, trustworthy, and obliging tribe, and exercise some influence over the Paliars and Malsars. Small in stature, their features resemble the African; they have curly hair tied in a knot behind, and file the four front teeth of the upper jaw to a point, as a marriage ceremony. The upper ranges are in undisturbed possession of wild beasts; we saw a large herd of bison, with samber and ibex in numbers, and also traces of wild elephants.

The soil on the summit of these fine mountains is deep, and covered with good pasture. Streams of water are numerous, and flow throughout the year. From the extent of forest, the resemblance of the Flora to that of Ceylon and the corresponding altitude, these hills seem suitable for the cultivation of coffee on a large scale, and for colonisation of small communities of Englishmen.

3. On the Contractions suffered by Sulphuric Acid on being mixed with Water. By Dr Lyon Playfair, C.B.

4. On the Constitution of Anthracene or Paranaphthaline, and some of its Products of Decomposition. By Professor Anderson.

Royal Physical Society.

27th February.—James M'Bain, M.D., R.N., President, in the Chair.

The following communications were read :—

1. *Observations on British Zoophytes and Protozoa. On Atractylis coccinea* (new species). By T. Strethill Wright, M.D.

(1.) On *Atractylis coccinea.*—The subject of this notice was found at Inch-Garvie, in August last, growing on the roots of *Laminaria saccharina.* The polypary consists of an open network of milk-white fibres which closely invest the branches of the root. From this network the polyp-stems are given off, each about a quarter of an inch in length, of a rich pinkish-cream colour, and bearing at its summit a single crimson polyp with a double row of transparent, colourless tentacles. The body of the polyp is spindle-shaped, sometimes nearly cylindrical, and consists of an endoderm, having its cells laden with granules of a deep rich carmine colour, covered by an ectoderm of transparent white. The polyps, like others of this class, have the habit of turning themselves inside out, when the internal surface of the deep-coloured velvety endoderm is readily observed. On such occasions, masses of crimson granular matter are frequently ejected, which are composed of small globules filled with deep coloured fluid. These globules, which in other zoophytes are variously coloured in tints of brown, vermilion, orange, purple, and green, have had various functions assigned to them, as being the rudiments of a biliary element, nutritive centres, &c., but nothing is certainly known of their nature. The tentacles are eight in number, four of which are long, and held nearly erect, and alternate with the rest, which are shorter and much more expanded. The thread-cells of the tentacles are inconspicuous.

(2.) On *Rhizopod* structure.—One of the most interesting and important questions of the day to the comparative physiologist is that of the constitution of Rhizopod structure. The Foraminiferous or Rhizopod animals are before our microscopic eye every day. We see their beautifully chambered shells imitating some of the most graceful objects of nature and art,—the living streams of nearly fluid sarcode, of which they are composed, flowing forth from the almost invisible pores of their shells, uniting with each other, and forming glairy masses, and reticulations, and expansions, which absorb animal matter coming in contact with them,—single and compound animals building their aggregated homes in the most graceful lines and spirals,—single dwellings and populous towns slowly moving along, of which the inhabitants are but patches of transparent slime,—vast Polythalamian cities, where the huge primordial Rhizopods reign, surrounded by the multitudes of their dwarfed descendants, in widening circles and triple tiers. Such is Rhizopod life. At present, no true generative elements have been recorded as discovered in the Rhizopods, though Carpenter and Schultze have noticed bodies which they have suspected to be ova. In the autumn of 1859, I was preparing a number of specimens of Hydractinia for the microscope. They were first soaked in whisky for several weeks, then immersed in dilute nitric acid to remove them from the crab's shell, and finally washed in strong spirit, and put up in Canada balsam. On examining one of these preparations under the microscope, it was found that two specimens of Truncatulina had been accidentally prepared at the same time. The development of Truncatulina commences with a single cell; this multiplies by gemmation in series until a colony of animals is formed, each larger than its predecessor, arranged in a spiral, somewhat resembling the shell of the nautilus. In the nautilus, the last chamber of the shell only is occupied; but in Truncatulina every chamber contains its tenant, while the whole colony are united by a band of sarcode, which passes from chamber to chamber along the inner curvature of the shell. All the cells or houses in this Rhizopod town are full of minute pores, from which the inhabitants protrude their delicate arms of slime in search of prey, or to move the assemblage from place to place. When the Truncatulina is treated as before mentioned, the shell is removed, and the separate zooids appear united by their connecting band. One of the two Truncatulinas, when examined by aid of the microscope, was found to consist entirely of homogeneous matter; but the other presented a far different appearance. Its segments or zooids, and their connecting bands, all appeared to be inclosed in a well-defined membrane. Each segment was nearly destitute of sarcode, and contained a highly refractive body, in which appeared, with the utmost distinctness, a germinal vesicle or spot. I can regard this body only as a true egg, which has been developed at the expense of the sarcodal element of the segments, in all of which the reproductive process is occurring simultaneously. Yet it may be objected that the ova in the larger segments are greatly larger than the young or original animals of Truncatulina. In some animals, however, as in Spongilla, Gregorina, &c., many individuals are produced from a single egg; and it is not improbable that a process of great division of the egg or swarming may take place in Truncatulina, by which a great number of animals are produced from each segment.

2. Mr R. H. Traquair exhibited some specimens of *Trilobites* from the Carboniferous Limestones of Fifeshire.

3. *Note on the exposure of the Liberton Old Red Sandstone Conglomerate Bed, in a quarry recently opened near the Grange House, Newington.* By Andrew Taylor, Esq.

4. *On the occurrence of the Argentine, Anchovy, and other Fishes, on the Coast of Caithness; with a note on the termination of the Vertebral Column in the tails of the Salmon tribe.* By Charles W. Peach, Esq., Wick.

5. *Specimens of the Glaucous Gull and Bewick's Swan* were exhibited by P. A. Dassauville, Esq. and J. A. Smith, M.D.

Wednesday the 27th March.—Thomas Strethill Wright, M.D., President, in the Chair.

The following Communications were read:—

1. *Note on the occurrence of Vanessa polychloros and Cheimatobia boreraria* in Edinburghshire. By R. F. Logan, Esq.

2. *Remarks on some Comparative Anatomical Distinctions between the Skull of the Manatus Senegalensis and that of a Manatee,* from the Bay of Honduras. By James M'Bain, M.D., R.N.

Having pointed out the anatomical modifications between the two skulls, Dr M'Bain stated that it appeared to have been from the American species that Daubenton, Cuvier, Gray, and others, had adopted the dental formula of the genus Manatus. In the British Museum Catalogue for 1850, the number of grinders in the genus Manatus is said to vary according to the age or state of the specimens, but when complete to be M. $\frac{9-9}{9-9}=36$. Dr M'Bain said there was no skull of the African species mentioned in the Catalogue as existing in the British Museum, and that there was none described in the Catalogue of the Royal College of Surgeons of London; and at a meeting of the British Association, held at Cheltenham in 1856, Professor Owen stated that he had not then had an opportunity of examining the dentition of the known African Manatee. Dr M'Bain concluded by stating that the difference in the number of the molar teeth in these two distinct species corresponded with the difference in the length of the alveolar portion of the palate, and with other corresponding modifications which had been shown to exist between the two skulls. He was indebted to the kindness and liberality of Professor Rogers of Glasgow for an opportunity of comparing the skull of the *Manatus australis* with that from the west coast of Africa; and the result of that anatomical comparison appeared to him to confirm the necessity for adopting M. $\frac{11-11}{11-11}=44$, as the normal number of the dental formula for the genus Manatus, which were found to have been present in the skull of the Manatee inhabiting the rivers of Old Calabar.

3. *Historical Review of the State of our Knowledge respecting Metamorphism in the Mineral Kingdom, with special regard to certain recent researches.* By John S. Livingston, Esq.

Wednesday the 24th April 1861.—Alexander Bryson, Esq., President, in the Chair.

The following Communications were read:—

1. *Some statements in Cuvier's* "Natural History of Fishes," *as to the Herring, shown to be erroneous.* By J. M. Mitchell, Esq.

2. *Observations on British Zoophytes and Protozoa.* By T. STRETHILL WRIGHT, M.D.

(1.) *On Dendrophrya radiata, a new dendritic Rhizopod.*—The animal I have now to describe is not new to me, at least I have seen it repeatedly attached, to all appearance, as a small calcareous patch, to the fronds of Algæ and Flustras. It was only while examining these fronds for the smaller Rhizopoda that I began to suspect its true nature, but it was some time before I could make out the truth of my suspicions. Its general appearance is that of a small shelly mass, from the borders of which radiates a system of blanched membranous tubes, more or less coated with fine grains of sand or other matter. In young specimens the central shell is as yet absent, and the animal merely presents the appearance of an irregular system of branches radiating from a centre. The shape of the adults is very various and irregular. They attain sometimes a diameter of nearly a quarter of an inch, though generally much smaller. The shell is not acted on by acids, and is therefore siliceous. Occasionally, especially when the animal is attached to the under surface of stones, the branches rise from the surface, and we can then see the arms, or pseudopodia, like delicate, straight, or forked lines, protruded from their extremities. The animal itself, which is doubtless a mere mass of semi-fluid sarcode, is never seen, being concealed within its central stronghold of finely cemented flint, and the complicated system of earthworks surrounding it.

(2.) *On the Reproduction of Ophryodendron.*—I have now to give to the Society another chapter in the history of *Ophryodendron abietinum.* In my first account of this creature I figured one or two globular bodies in its interior. Professor Claparede, to whom I showed the figure, thought I must be mistaken as to these structures, as he had never observed anything similar. Within the last few weeks, I have again found many Ophryodendra loaded with these globules, and have, by cautious pressure, succeeded in bursting the body of the parent, and, by this somewhat "meddlesome midwifery," liberated the young. At an early stage, the young consist of ovoid bodies of higher refractive structure than the body of the parent, and contain olive-brown corpuscles, shaped like the chlorophyll of *Hydra viridis*. At a later stage, when the wrinkled trunk of the parent hangs lax and dead, the young larvæ assumes a slightly pyriform shape, flattened on their inferior surface. This surface is also marked with longitudinal striæ, carrying short, soft, slowly-moving cilia. The young Ophryodendron, when first attached, is an irregular sac, from which arises a short, stumpy, unwrinkled proboscis, surmounted by three or four tentacles. As development proceeds, the neck gradually loses its granular character, acquires the power of elongating itself, and puts forth other tentacles, until it becomes the magnificent appendage of the adult.

(3.) *On Lecythia elegans.*—This animal is found not unfrequently on the polypidoms of zoophytes. It is exceedingly minute, and requires the highest microscopic powers and most careful adjustment of the light for its accurate definition. The body is flask or caraffe-shaped, mounted on a long, thin, rigid pedicle, and enclosed in a closely fitting envelope or cell. The summit is dilated, and furnished with a variable number of long, slender, diverging tentacles, which appear to correspond to those of Actinophrys, or to the pseudopodia of the Rhizopods. When the tentacles are contracted, they assume the form of a bossed coronet. These animals sometimes occur in immense numbers, forming a dense mass over the surfaces to which they grow; in these cases it is impossible to make anything of them. It is only when we catch a single individual alone, under favourable circumstances of position and light, that we can persuade him to give a satisfactory account of himself.

(4.) *On the Reproduction of the Rhizopoda.*—Since the last meeting of the Society, I have discovered the occurrence of *spermatozoa* in Gromia. Schultze has observed the occurrence of living young in Rotalia, and I have confirmed the same fact in Spirulina, which had been observed by Ehrenberg, but was doubted by Williamson. It is a question whether these young are gemmæ or the product of ova.

3. *Notes of Deep-Sea Soundings.* By E. W. Dubuc, M.D., R.N. Communicated by Mr J. B. Davies.

4. *Further notice of the Herring and Sprat Fishery of the Firth of Forth.* By George Logan, Esq., Convener of the Society's Committee on Marine Zoology.

Mr J. M. Mitchell exhibited several specimens of the garvie herring, *Clupea sprattus*, with well developed milt and roe. These fish were taken above Queensferry about the end of March.

A Specimen of the Æquoreal Pipe-Fish, taken at Inchkeith, was exhibited by William S. Young, Esq.

Dr J. A. Smith exhibited a specimen of the Spotted Crake or Rail (*Crex porzana*) in beautiful plumage. It was shot near Bathgate on the 17th of March.

Botanical Society of Edinburgh.

14*th March* 1861.—Professor Balfour, V.P., in the Chair.

The following Communications were read :—

1. *Notes on Horticultural Experience at Russelconda, South India.* By Dr William Traill. Communicated by Dr Cleghorn.

The author described the difficulties of forming a garden in the wilds of Orissa, the peculiarities of climate, and the results of his experience, which showed how much can be done by a zealous horticulturist in a rather wild country at a small cost. Many Cape and Australian plants, chiefly *Acacieæ* and other *Leguminosæ*, appear to have grown well, and many British specimens, as *Viola odorata*, *Bellis perennis*, &c. With a little care, many annuals ripened their seeds abundantly, nearly as well as in England, such as mignonette, larkspur, &c. A variety of English vegetables, as beetroot, knolekole, cabbages, and onions, were successfully cultivated. Bombay onions from Bellary seeds attained the size of 10½ inches in circumference, and weighed 8¼ oz. He grew tomatos of 7¼ oz. in weight. Cabbages formed solid hearts, and, stripped of the outer leaves, measured 3 feet 4 inches in circumference. The seeds were obtained from the Nilgiris, and proved excellent. On the whole, the author believes Gumsur to be an admirable climate for horticulture, and it seems important that similar observations should be made and recorded at the different stations of our vast Indian empire.

Tabular list of Annuals, &c., sown at Russelconda in 1858 *and* 1859, *showing their time of germination, flowering, &c.*

Name of Plants.	When Sown.	When up.	When in Flower.	Remarks.
Mignonette	Oct. 23	Oct. 29	Dec. 27	
Do.	Nov. 8	Nov. 13	Jan. 3	Ripened many seeds.
Do.	— 11	— 16	— 4	
Sweet Peas	— 5	— 11	— 31	Ripened a few good seeds.
Do., another parcel	— 5	— 22	... ...	Did not flower.
Poppy (red)	Oct. 25	. . 4	Feb. 5	Ripened many seeds.
Centaurea Cyanus ...	— 25	— 1	Jan. 17	Ripened many seeds.
Do. ...	Nov. 11	— 14	— 15	
Centaurea depressa....	Oct. 23	— 2	— 23	Ripened very few seeds.
Larkspur, purple and pink	— 23	— 4	— 8	Ripened many seeds.
Antirrhinum majus, of mixed colours .	— 25	— 6	Feb. 10	Do. do.
Ten-week Stocks	Nov. 11	— 15	Jan. 15	Do. do.
Hollyhock	— 17	— 20	Mar. 9	Do. do.
Tropæolum majus	— 11	— 22	Jan. 6	Ripened a few seeds.
Nolana prostrata	Oct. 25	— 3	Dec. 25	Ripened many seeds.
Do. do.	Nov. 26	Dec. 3	Jan. 15	
China Pink.............	— 11	Nov. 16	Feb. 15	Do. do.
Sweet William	— 11	— 17	Mar. 6	Ripened a few seeds.
Globe Amaranth, orange coloured	Oct. 27	— 20	Jan. 6	Ripened many seeds.
Geranium, Scarlet	— 23	Oct. 29	March	Do. do.

2. *Description of a new species of* Cladophora *from the river Ouse in Sussex; with additions to the local distribution of British Marine Algæ.* By Mr Robert Brown of Campster.

3. *On the varieties of Mango Fruit* (Mangifera Indica) *in Southern India.* By Dr Cleghorn.

The author remarked—The Mango-tree is one of the most common in India, and is generally cultivated throughout the warm parts of Hindostan, yet there is no full account of the varieties produced in gardens. Dr Roxburgh (*Flora Indica*, i. p. 640) has given a good description of the tree; and Sir William Hooker published an excellent figure in the *Botanical Magazine*, tab. 4510.

There are many varieties of the fruit in cultivation, differing remarkably in size, shape, colour, smell, and flavour. Some are large, fleshy, and luscious, while others are so stringy and terebinthaceous that they have been compared to " a mouthful of tow soaked in turpentine." The fine varieties, free from turpentine flavour, should be the objects of special culture.

A series of forty varieties, delineated by Walter Elliot, Esq. and Dr Cleghorn, in various parts of South India, was exhibited, including the best kinds obtained from carefully grafted stocks.

The fruit assumes different shapes; some are kidney-shaped, while others are roundish and compressed with a point at the apex or at one side. The absence of the peak or point in a graft mango usually indicates a fine variety. The weight of the mangoes examined varied from

$13\frac{3}{4}$ oz. to $3\frac{1}{2}$ oz. When the fruit attains a large size, the flavour is generally inferior.

Horticulturists propagate this fruit-tree by layers and grafts. The natives generally are acquainted with the system of layering, but not of grafting, which perpetuates the flavour of the parent stock. In the different horticultural gardens, a great number of mango grafts are taken from the choicest kinds, and are annually distributed over the presidency.

The Alphonzo and Mazagon varieties are preferred, from their honey-flavour and the absence of fibres; the former, which is distinguished by its russet rind and deep orange mesocarp, is known at Madras as the Petre pasand, from the circumstance of its having been introduced from Bombay by a former governor, Mr Petre. Other kinds are highly esteemed, as Ramani (after Rama), Dil pasand (Delight of the Heart), Shah pasand (Delight of the King), &c. Some have a slightly acid taste, and the mesocarp varies in colour from orange to nearly white.

Mangoes of very fine quality are produced in the Chittur, Salem, and Bangalore districts of the Madras Presidency.

Report of the Flowering of Plants in the Botanic Garden.
By Mr M'Nab.

Symphytum caucasicum,	Feb.	24	Scilla bifolia-alba, .	Mar.	9
Muscari botryoides .	—	26	Hyoscyamus Scopolia,	—	9
Anchusa sempervirens	—	28	Rhododendron Nobleanum	—	10
Orobus vernus .	Mar.	4	Pulmonaria mollis, .	—	12
Narcissus pumilus, .	—	6	Corydalis nobilis, .	—	12
Arabis albida, .	—	6	Primula nivalis, .	—	12
Primula denticulata,	—	7	Erythronium Dens-canis,	—	14
Scilla bifolia, blue, .	—	7	Puschkinia scilloides,	—	18
„ sibirica, .	—	8			

Thursday 11th April.—Dr W. H. Lowe, President in the Chair.

The following communications were read:—

1. *The Flora of Iceland.* By W. Lauder Lindsay, M.D., F.R.S.E., F.L.S., &c.

(This paper appears in the present number of the Journal.)

2. *On the species of Dioscorea* (yams) *occurring in South India.* By Dr Cleghorn.

The author adverted to the great importance of these tropical esculents, which are of such value in eastern countries, particularly in seasons of famine like the present, when the rice crops have failed and the suffering population resort to the forests in quest of yams and other indigenous roots. The *Araceæ* and *Dioscoreaceæ* yield starchy tubers, which are much more wholesome than the *Cucurbitaceous* fruits so extensively used by the natives. The former contain a large amount of nutriment, and when roasted or steeped in cold water are deprived of their acridity; but the latter are a fruitful source of diarrhœa and mischief. A good conspectus of the genus is still a desideratum. The best description of the Asiatic species was given forty years ago by Roxburgh, who cultivated seventeen species in the Botanic Garden, Calcutta, the roots having been transmitted to him from different districts of Bengal. Of these, thirteen species are now recognised in the public gardens. The student will find representations of these in Wight's "Icones," and in Rheede's "Hortus Malabaricus." The growth of some of the yam tribe is very remarkable. A tuber of *Dioscorea alata*, 1lb in weight, was planted at Madras in

June, and lifted at the end of nine months, when the weight was found to be 27½ lbs. The best known and most esteemed kinds are *D. aculeata*, "Goa potato;" *D. Batatas*, "Chinese yam;" *D. purpurea*, "Pondicherry potato;" and *D. fasciculata*, "Tenasserim yam." Besides these, *D. globosa* and *D. alata*, with *Arum campanulatum*, are much cultivated; whilst *D. bulbifera*, *pentaphylla*, and *oppositifolia* are common species in the jungles.

3. *Effect of the late Winter on the Coniferæ and other Trees and Shrubs at Belstane.* By Mr P. S. Robertson.

4. *Report on the effects of the Frost on the Trees at Borthwick Hall and Vicinity, the Property of* Charles Lawson, Esq. By Mr W. Gorrie.

Thursday, 9th May.—Dr W. H. Lowe, President, in the Chair.

The following Communications were read:—

1. *Observations on some hitherto undescribed Plants from New Zealand.* By Dr Ferdinand Mueller, Melbourne. Communicated by Professor Balfour.

Amongst a considerable number of living plants forwarded by Th. H. Hulke, Esq. from the vicinity of New Plymouth, to the Botanic Garden of Melbourne, and also in a fine collection of dried botanical specimens, which the Melbourne Phytological Museum owes to the zeal and liberality of Julius Haast, Esq., of Nelson, I had the gratification of observing several plants which appear to me novel and deserving special notice. In making these plants known through the medium of the Edinburgh Botanical Society, I avail myself of the opportunity thus afforded of publicly recording the services rendered by their discoverers in promoting our knowledge of the New Zealand Flora, the foundation of which has been so well laid by Dr J. D. Hooker, in the justly celebrated *Flora Novæ Zealandiæ*. Whilst the misfortune of one of the above gentlemen, who saw in the northern island a flourishing estate and garden establishment annihilated by the hordes now waging war against British sovereignty, calls for our deep sympathy; we cannot but with the utmost pleasure turn to the southern or middle island, where, under the shelter of peace, an ardent geographical and geological explorer finds leisure and exhibits a desire to bring within the range of his observation forms of vegetation which are yet replete with novelty.

Veronica Hulkeana.—Shrubby; branches very finely downy, cylindrical; leaves opposite, subcoriaceous, rather distant, long-stalked, subcordate-ovate, coarsely and almost doubly crenate-serrate, soon glabrous; spikes distant, terminal, simply paniculate; bracteoles deltoid-ovate, shorter than the calyx, as well as the ovate lobes of the latter ciliolate; corolla glabrous; its lobes considerably longer than the tube; capsule obcordate-roundish, turgid; seeds few, curved-ellipsoid. In mountain-forests towards New Plymouth.—Th. H. Hulke, Esq.

The specimen cultivated in the Melbourne Botanic Garden forms a small shrub. Leaves generally from 1″ to 1½″ long, shining on both surfaces, paler beneath, strongly one-nerved, with thin pinnately spreading veins. Spikes many, opposite, usually with conspicuous special peduncles, 1″ to 1½″ long; the lowest supported by a diminutive leaf. Segments of the calyx almost equal, nearly 1‴ long. Corolla about 2½‴ long; three of its lobes rhomboid-orbicular, the fourth orbicular ovate. Anthers ovate, with bilobed bases about ½‴ long. Style capillary, hardly longer than 2‴. Stigma minutely bilobed. Capsule not seen in a matured state; already, when young, somewhat longer than the calyx.

Gingidium Haastii (sect, Aciphylla).—Stem erect; vaginæ blunt; radical leaves long-stalked, in circumference rhomboid-ovate, tripinnati-sect, plurijugate; general and special raches jointed; pinnæ plurijugate; segments small, crowded, narrowly lanceolate-linear, almost flat, acute, entire, pellucidly one-nerved, without streaks, veinless, terminated by a short capillary bristle; peduncles, with exception of the base, leafless; general involucre few-leaved; leaflets of the involucella several, shorter than the umbellula, as well as those of the involucre linear and acuminate; styles capillary, rather long, finally recurved; fruits short-pedicelled, oblong, more attenuated upwards; mericarps usually equal, each acutely five-ribbed.

On the subalpine summit of the "Black Hill," the middle island of New Zealand, at an elevation from 4000 to 4500 feet. Julius Haast, Esq.

This species differs from *Gingidium procumbens* (*F. M. Fragm. Phytogr. Austr.* i., 15; Jos. Hook. *Flor. Tasm.* ii., 363), in erect taller growth, larger, much more divided leaves, more elongated and slender styles, and longer fruits. *G. antipodum* and several other allied species differ in the want of the bristles, which terminate the lobes of the leaves in *G. Haastii.*

Senecio Traversii.—Herbaceous, perennial, stemless; leaves radical, ovate-oblong, on elongated downy petioles, blunt at the base and apex, slightly crenulated, emitting a stalked gland from between each notch, above sparingly hispid from short rigid hairs, beneath finely downy, and when old glabrescent; scape hardly extending beyond the leaves, as well as the petioles, clothed with an imperfect toment and with scattered articulated hairs, bearing a few remote broad-linear bracts and two flowers; special peduncles longer than the flowerhead, provided with a few linear tomentose bracteoles; involucre almost campanulate, outside glandulous and hispidulous downy, consisting of 10 to 12 scales, not sphacelate at the apex, with exceedingly few bracteoles at the base; discal flowers somewhat longer than the involucre; ligules 11 to 13, their lamina oblong-linear, longer than the involucre; anthers exserted; achenes glabrous.

Alps, near Nelson—Julius Haast, Esq. The only specimen seen by me is about a span high. Petioles emerging from a long soft tomentum, nearly as long as the leaves. The latter herbaceous, 3″ to 4″ long; their mid-rib, lateral nerves, and netted veins, more conspicuous beneath. Bracts less than 1″ long. Scales of the flower-bearing involucre about 2½‴ long, green. Ligules usually three-toothed. Corollæ of disk hardly longer than 2‴. Setæ of pappus white, forming several rows, slightly scabrous, at least in a young state not quite so long as the corresponding corolla. Achenia, before being perfectly ripe, 1‴ long.

This very distinct species is allied to *S. primulifolius* (F. M. in *Transact. Vict. Inst.* ii., 69; J. Hook. *Flor. Tasm.* ii., 365). We have distinguished it with the name of the Honourable Judge Travers of Nelson, an acute and zealous observer of the New Zealand Flora.

Dr Mueller has requested me to add a note to the above descriptions, expressing my belief that they refer to hitherto undescribed species.

Jos. D. Hooker.

Kew, *April* 20, 1861.

3. *Account of a Botanical Trip to Ben Ledi, with Pupils, in July* 1860. By Professor Balfour.

On Saturday 21st July 1860, at 6.30 A.M., a party of about 100 met at the Scottish Central Railway Station, and proceeded to Callander. After breakfasting at Mr M'Gowan's inn they walked towards Ben Ledi, a mountain which rises to the height of 2863 feet above the level of the sea, and which lies on the junction of two formations—the clay slate and mica slate—being a true mica slate on the northwest, and a clay slate, or rather greywacke, on the south-east declivity. After leaving Callander the party crossed the river in the Pass of Leny, and proceeded towards Loch Lubnaig. On the way they gathered *Corydalis claviculata*, *Hypericum humifusum*, *Galium Mollugo*, *G. boreale*, *Lysimachia Nummularia*, *Carex irrigua*, which was observed by Mr A. Bell, as well as *Vaccinium Oxycoccus*. In Loch Lubnaig, *Isoetes lacustris*, *Lobelia Dortmanna*, *Subularia aquatica*, were gathered. *Lysimachia vulgaris* was also met with. From Loch Lubnaig the party ascended Ben Ledi: they proceeded by the side of a stream which has cut out a deep passage for itself, and they examined especially the rocks near the summit on the northern side. The best plants were found on the mica slate soil. Among the interesting plants gathered were the following:—*Thalictrum alpinum*, *Draba incana*, *Silene acaulis*, *Alchemilla alpina*, *Rubus saxatilis*, *R. Chamæmorus*, *Sibbaldia procumbens*, *Epilobium alpinum*, *Sedum anglicum*, *Saxifraga aizoides*, *S. hypnoides*, *S. nivalis*, *S., oppositifolia*, *S. stellaris*, *Meum athamanticum*, *Cornus suecica*, *Antennaria dioica*, *Hieracium alpinum*, *Saussurea alpina*, *Vaccinium uliginosum*, *V. Vitis-idæa*, *Armeria maritima*, *Oxyria reniformis*, *Polygonum viviparum*, *Salix herbacea*, *Gymnadenia albida*, *Habenaria chlorantha*, *Listera cordata*, *Tofieldia palustris*, *Juncus supinus*, *J. triglumis*, *J. trifidus*, *Rhynchospora alba*, *Carex rigida*, *Poa montana*, *Botrychium Lunaria*, *Allosorus crispus*, *Asplenium viride*, *Hymenophyllum Wilsoni*.

4. *Letter from Dr Kirk of the Zambesi Expedition, dated 2d December* 1860. Communicated by Professor Balfour.

SCIENTIFIC INTELLIGENCE.

GEOLOGY.

1. *On the Geology of the Country between Lake Superior and the Pacific Ocean (between 48° and 55° parallels of latitude), explored by the Government Exploring Expedition under the command of Captain J. Palliser* (1857–60). By James Hector, M.D. Communicated by Sir R. I. Murchison, V.P.G.S.—This paper gave the geological results of three years' exploration of the British Territories in North America along the frontier line of the United States, and westward from Lake Superior to the Pacific Ocean. It began by showing that the central portion of North America is a great triangular plateau, bounded by the Rocky Mountains, Alleghanies, and Laurentian axis, stretching from Canada to the Arctic Ocean, and divided into two slopes by a watershed that nearly follows the political boundary-line, and throws the drainage to the Gulf of Mexico and the Arctic Ocean. The northern part of this plateau has a slope, from the Rocky Mountains to the eastern or Laurentian axis, of six feet in the mile, but is broken by steppes, which exhibit lines of ancient denudation at three different levels; the lowest is of freshwater origin; the next belongs to the Drift-deposits, and the highest is the great Prairie-level of undenuded Cretaceous strata. This plateau has once been complete to the eastern axis, but is now incomplete along its eastern edge, the soft strata having been removed in the region of Lake Winipeg. The eastern axis sends off a spur that encircles the west shore of Lake Superior, and is composed of

metamorphic rocks and granite of the Laurentian Series. To the west of this follows a belt where the floor of the plateau is exposed, consisting of Lower Silurian and Devonian rocks. On these rest Cretaceous strata, which prevail all the way to the Rocky Mountains, overlaid here and there by detached tertiary basins. The Rocky Mountains are composed of Carboniferous and Devonian limestones, with massive quartzites and conglomerates, followed to the west by a granitic tract which occupies the bottom of the great valley between the Rocky and the Cascade Mountains. The Cascade chain is volcanic, but the volcanoes are now inactive; to the west of it, along the Pacific coast, Cretaceous and Tertiary strata prevail. The description of these rocks was given with considerable detail on account of their containing a lignite, which for the first time has been determined to be of Cretaceous age. This lignite, which is of very superior quality, has been worked for some years past by the Hudson Bay Company, and is in great demand for the steam-navy of the Pacific station, and for the manufacture of gas. Extensive lignite-deposits in the Prairie were also alluded to; and, like those above mentioned, were considered to be of Cretaceous age; but, besides these, there are also lignites of the Tertiary period. The general conclusion was that the existence of a supply of fuel in the Islands of Formosa and Japan, in Vancouver's Island, in the Cretaceous strata of the western shores of the Pacific, but principally within the British territory, and in the plains along the Saskatchewan, will exercise a most important influence in considering the practicability of a route to our Eastern possessions through the Canadas, the Prairies, and British Columbia.—*Proc. Geol. Soc., Lond.*

METEOROLOGY.

2. *On the Prevalence of certain forms of Disease in connection with Hail and Snow Showers, and the Electric condition of the Atmosphere.* By Dr Thomas Moffat, F.G.S.—In 1852, while deducing results from the meteorological observations of the two previous years, the author observed that an intimate connection existed between falls of snow and hail and diseases of the nervous centres, such as apoplexy, epilepsy, paralysis, and vertigo; and the results of eight more years bear out the truth of the observation. A table formed from two hundred and thirty-six cases of the above diseases, and upwards of one thousand observations of the electrometor, is given, showing the percentage of hail and snow showers, the cases of diseases of the nervous centres, and the times that the air was positive and negative with each wind. From this table it appears that with the wind from the N., N.E., E., and S.E. points, which the author calls the *snow* points, the percentage of hail and snow showers is 23·2; of cases of apoplexy, &c., 36·7; of positive electricity, 27·0; and of negative electricity, 34·1; while with the wind from the *hail* points, S., S.W., W., and N.W., the percentages are respectively 76·6, 65·7, 72·6, and 67·5, thus showing that the number of cases of disease increases with the frequency of hail and snow showers, and the consequently increased frequency of the alternations of positive and negative electricity. All observers agree that the air is negative on the approach of great storms, and negative, or alternately negative and positive, in unsettled weather; and the author remarks, that such storms are almost invariably accompanied by convulsive diseases, or diseases of the nervous centres in some form; and in support of his statement he quotes many cases from his notes of the storms of the last twelve months, but more particularly the succession of gales which occurred from the 21st to the 30th of October 1859 (in one of which the "Royal Charter" was lost), the gales of the 25th, 26th, and 27th, of May last, which were accompanied with frequent hail-showers; and those of the

24th of August and four following days. Other forms of disease accompany these atmospheric conditions, such as premature uterine action, epistaxis, and diarrhœa, with vomiting and cramps; and cases of this class are quoted by the author from his notes; and he remarks that it would thus appear that negative electricity plays an important part in the above atmospheric conditions and morbid actions. After describing the electrical phenomena of continued heavy rains, and of thunder storms and heavy showers of hail and snow, the author observes that as the electrical tension of the clouds which produce these storms and showers is always strong, it must have a coercive force upon all bodies at the earth's surface; and that as, according to our notions of electrical action, the moment the influence of the *inducing* body is removed, a re-arrangement of the electricities in the *induced* body takes place, we cannot well avoid the conclusion that during the period of induction, and when the re-arrangement—the rebound—the *back stroke* occurs, some important action must take place in the organic forces, such as the nervous and the muscular. Cases are quoted in illustration; and the author then remarks that from a long series of observations it would appear that there is an intimate connection between hail and snow showers, stormy weather, atmospheric electricity, and certain forms of disease; and he ventures to add that hail and snow are formed under the influence of opposite electrical conditions, and concludes by suggesting the means of putting this opinion to the test of experiment.—*Proceed. of Lit. and Phil. Society of Manchester.*

Tweeddale Prize for Meteorological Observations.—Much yet remains to be done by meteorologists ere we can predict what is to be the nature of the weather during any season. Dr Lindley justly remarks, "For ourselves, we venture to think that meteorology is too much in its infancy to afford sufficient data on which to ground predictions of future weather with such a degree of accuracy as to make them of any great practical use. Situated as we are in the midst of the ocean, at so comfortable a distance from the tropics, whence moisture is brought over in a moment, without any particular wind, or apparent cause, it seems to be peculiarly difficult, if not impracticable, to predict weather many hours before its occurrence."

By country people many meteorological phenomena have been observed from generation to generation, which give indications of weather. To some of these the Marquis of Tweeddale has recently called attention in the following circular:—

"The observers intending to compete for the premium offered by the Marquis of Tweeddale, on temperature affecting exposed self-registering thermometers, are requested by his Lordship to pay attention to, and record the dates of, the following phenomena, for the observing of which no aid by instruments is required, and which are expected to be recorded only when any marked change takes place in the weather following the occurrence of any of the phenomena enumerated. These phenomena are:—

"*Clouds*, whether singly or in combination, their kinds—and especially, whether a convergence of cirri or cirro-cumuli clouds (commonly called 'mares' tails,' or 'mackerel sky'), at opposite points of the horizon, is followed in about twelve hours, in winter by snow, and in summer by rain; and whether the line of such convergence is always at right angles to the direction of the wind.

"*Sunrises* and *Sunsets*—especially, whether, when the sun rises in red, and the colour or clouds subside behind him, it will be fair weather; and whether, when they rise before him, it will be rain.

"*Rainbows*—especially, whether single rainbows, and in the afternoon, are indicative of fair weather, and double rainbows, and a rainbow in the morning, foretell rain; and also, whether stubs or pieces of rainbow foretell storms and rain.

"*Aurora Boreales*—especially, whether a brilliant aurora, in early autumn, is followed in forty-eight hours by a storm of wind and rain which lasts two or three days.

"*Haloes*, *Coronas*, and *Parhelia;* whether they are all indicative of rain in connection with the sun and moon—and especially, whether, when a break is observed in a corona round the moon, the wind will ultimately blow from that quarter.

"*Thunder* and *Lightning*—especially, whether a severe storm of thunder and lightning at the end of May or beginning of June is followed, for six weeks or more, by a low temperature; and whether flashes of sheet lightning in the night indicate snow in winter, and rain in summer.

"*Meteors* or *Fire Balls;* whether they certainly predict a storm of wind and rain.

"*Falling Stars*, and their effects—and especially, whether the wind will chop round quickly in the direction to which the star falls.

"*Stars*—when visible very near the moon, whether they predict rain.

"*Mists* and *Fogs*—especially, whether, when the mist is seen going up the hill-side and passing away behind the hill, it is followed by fine weather; and whether, when the mist descends the hill-face, it is followed by rain; and what follows a fog in frost, and an eastern fog from the sea in spring—whether these are signs of wet or dry weather.

"*Distant Objects*—when apparently nearer, or with better defined outlines than usual—whether a sign of rain, and how soon after.

"*Rain* and *Drought*, their duration and effects—and especially, whether, when a slight shower of rain falls in the morning, and but for a short time, the weather will be fine for the rest of the day; and whether, when rain begins to fall heavily about midday, it will continue to fall until dark or afterwards.

"*Seed-time.*—First sowing of seed in spring, specifying the kinds.

"*Harvest.*—First day and last day of harvest.

"*Trees.*—Whether, when the oak puts forth its leaves before the ash, the following summer is wet or dry.

"*Hoar-Frost.*—Whether the arrangement of the crystals of hoar-frost on the margin of the leaves of evergreens is always the same on the same kind of plant, and different on different kinds of plants.

"*Animals.*—Whether the actions of animals—such as sheep making their lair in a sheltered place, pigs carrying straw in their mouth—are indicative of a change of weather.

"*Birds.*—The cries of birds—as the whistling of the curlew, the call of the partridge, the scream of the peacock, the drumming of the snipe in the air—whether they indicate any change.

"The flocking of birds in large numbers, and its effects.

"The first and last appearance of the swallow, specifying the different kinds.

"*Sounds.*—The roaring of the ocean, the hearing of distant sounds, and their effects.

"Any other phenomena which the observers have noticed, would be desirable to have noted down.

"It would be also desirable to have the opinion of the observers as to the cause or causes of the phenomena they observe and record.

"A collection of the popular sayings in regard to the weather, from shepherds, ploughmen, fishermen, and seamen, would be a valuable acquisition for the Meteorological Society, in order to their being corroborated or refuted."

Stephens on Meteorological Phenomena.—Mr Henry Stephens (the well-known author of the "Book of the Farm"), in a letter to Professor Balfour, remarks :—" When Noah's ark, or the boat, as it is called by the country people—I don't know its scientific name—occurs, a fall is indicated. The ark consists of a convergence of clouds towards a point on each side of the horizon, and the line between the points is always at right angles to the wind for the time being. When the clouds consist of the cirri, which they usually do, the fall will occur in twelve hours, snow in frost, and rain in summer. I had a confirmation of this result, which I never saw fail, while visiting Lord Wharncliffe this Christmas at Wortley, near Sheffield. The ark appeared distinctly in the heavens, with a clear sun, on Monday afternoon, and a heavy fall of snow took place on Tuesday, Christmas-day, and which I predicted firmly on the Monday.

" Another certain indication is, that when a severe thunder storm occurs in May or early in June, cold weather will follow for six weeks. This was verified to the letter this season.

" Another indication is, that when a bright aurora borealis occurs in autumn, and for the first time in the season, a heavy rain and storm will be sure to come in forty-eight hours, and for two or three days together. This has been repeatedly verified by Dr Christison, from whom I obtained the information.

" I may mention, that while at Wortley I placed the self-registering thermometer in the snow, a slight shower of which had fallen before I went to that part of the country, from where it usually stood in front of a large hedge of Portugal laurels, and it there showed a difference of 7° during the course of the twenty-four hours, and on Christmas morning it marked 2° below zero. This shows how important it is to know the position of a thermometer before you can judge of its indications.

" From this circumstance, I am persuaded that the Marquis of Tweeddale's prizes for ascertaining the temperature as affecting the thermometer when exposed as the crops are, will reveal some curious and important results; for to take the temperature constantly in the shade, is equivalent to taking it only in a cloudy day, in so far as the heat from the sun is concerned.—I am yours sincerely, HENRY STEPHEN.

On the Temperature of the Earth's Crust, as exhibited by Thermometrical Observations obtained during the sinking of the Deep Mine at Dukinfield. By W. FAIRBAIRN, LL.D., &c.—During the prosecution of researches on the conductivity and fusion of various substances, an opportunity occurred of ascertaining by direct experiments, under favourable circumstances, the increase of temperature in the crust of the earth. This was obtained by means of thermometers placed in bore-holes, at various depths, during the sinking of one of the deepest mines in England, namely, the coal mine belonging to F. D. Astley, Esq., at Dukinfield, which has been sunk to a depth of 700 yards. The increase of temperature in descending, shown by these observations, is irregular; nor is this to be wondered at, if we consider the difficulties of the enquiry, and the sources of error in assuming the temperature in a single bore-hole as the mean temperature of the stratum. At the same time, it is not probable that the temperature in the mine-shaft influenced the results. The rate of increase has been shown in previous experiments to be directly as the depth, and this is confirmed by the experiments. The amount of increase is from 51° F. to $57\frac{3}{4}$°, as the depth increases from $5\frac{3}{4}$ to 231 yards, or 1° in 99 feet; but, in this case, the higher temperature is not very accurately determined. From 231 to 685 yards, the temperature increases from $57\frac{3}{4}$° F. to $75\frac{1}{2}$°. This is a mean increase of 1° in 76·8 feet, which does not widely differ from the results of other observers. Walferdin and Arago found an increase of 1° in 59 feet; at Rehme, in an Artesian well 760 yards deep, the increase was 1° in 54·7 feet; De La Rive and Marcet found an increase of 1° in 51 feet at Geneva.

Other experiments have given 1 in 71 feet. The observations are affected by the varying conductivity of the rocks, and by the percolation of water. The author has exhibited upon a diagram, in which the ordinates are depths, and the abscissæ temperatures, the results obtained between the depths of 231 and 717 yards. The strata of the mine are also shown in section. Additional to these, the author gave a table of similar results in another pit at the same colliery, taken between the depths of 167½ and 467 yards, and showing an increase of temperature of 1° in 106 feet of descent. Assuming as an hypothesis, that the law thus found for a depth of 790 yards, continues to operate at greater depths, we arrive at the conclusion that at 2½ miles from the surface a temperature of 212° would be reached, and at forty miles a temperature of 3000°, which we may suppose sufficient to melt the hardest rocks. The author then discusses the effect of pressure and increased conductivity of the rocks in modifying this result. If the fusing point increased 1°·3 F. for every 500 lbs. pressure, as is the case with wax, spermaceti, &c., the depth would be increased from 40 to 65 miles before the fluid nucleus would be reached; but as the same increase is not observed with tin and barytes, the influence of pressure on the thickness of the crust cannot yet be determined. Again, Mr Hopkins has shown that the conductivity of the dense igneous rocks is twice as great as that of the superficial sedimentary deposits of clay, sand, chalk, &c. And these close-grained igneous rocks are those which we believe must most resemble the strata at great depths. Now, if the conductivity of the lower rocks be twice as great as that of the strata in which the observations were made, correcting our former estimate, we should probably have to descend 80 or 100 miles, instead of 40, to reach a temperature of 3,000°, besides the further increase due to the influence of pressure on the fusing point. On entirely independent data, Mr Hopkins has been led to conclude that the minimum thickness of the crust does not fall short of 800 miles, in which case the superficial temperature of the crust would have to be accounted for from some other cause than an internal fluid nucleus.—*Proc. Lit. and Phil. Soc. Manchester.*

MISCELLANEOUS.

On the Alleged Practice of Arsenic Eating in Styria. By Dr H. E. Roscoe.—Dr Roscoe being anxious to obtain further definite information respecting the extraordinary statements of Von Tschudi, quoted by Johnston in his "Chemistry of Common Life," that persons in Styria are in the habit of regularly taking doses of arsenious acid, varying in quantity from 2 to 5 grains daily, was supplied, through the kindness of his friend Professor Pebal, of Lemberg, with a series of letters written by seventeen medical men of Styria, to the Government medical inspector at Grätz, concerning the alleged practice. After reviewing the opinions of Dr Taylor, Mr Kesteven, and Mr Heisch, upon the subject, and having mentioned the results and conclusions arrived at by those who had previously interested themselves with the subject, Mr Roscoe stated that all the letters received from the medical men in Styria, agree in acknowledging the general prevalence of a belief, that certain persons are in the habit of continually taking arsenic in quantities usually supposed sufficient to produce death. Many of the reporting medical men had no experience of the practice; others describe certain cases of arsenic eating, which have not come under their personal notice, but which they have been told of by trustworthy people whose names are given; whilst others, again, report upon cases which they themselves have observed. Professor Roscoe proceeded to bring forward, in the first place, evidence bearing upon the question,—Is, or is not, arsenious acid, or arsenic in any other form, well known to, and distributed amongst the people of Styria? He said that he had received 6 grms. of a white substance, forwarded by Professor Gottlieb, in Grätz, accompanied by a certificate from the district judge of Knittelfeld, in Styria, stating that this substance was brought to him by a peasant woman, who told him that she had seen her farm-labourer eating it, and that she gave it up to justice to put a stop to so evil a practice. An accurate chemical analysis showed that the substance was pure arsenious acid. Extracts from many of the reports of the medical men were then read, all stating that arsenious acid, called "Hidrach" by the Styrian peasants, is well known and widely distributed in that country. The second question to which Mr Roscoe sought to obtain an answer was, whether arsenic is, or is not, regularly taken by persons in Styria in quantities usually supposed to produce immediate death? The most narrowly examined, and therefore the most interesting case of arsenic eating, is one recorded by Dr Schäfer. In presence of Dr Knappe of Oberzehring, a man thirty years of age, and in robust health, eat, on the 22d February 1860, a piece of arsenious acid, weighing 4½ grains; and, on the 23d, another piece, weighing 5½ grains. His urine was carefully examined, and shown to contain arsenic; on the 24th he went away in his usual health. He informed Dr Knappe that he was in the habit of taking the above quantities three or four times each week. A number of other cases, witnessed by the medical men themselves, of persons eating arsenic, were then detailed. Dr Holler of Hartberg says that he and other persons, named in his report, guarantee that they are together acquainted with forty persons who eat arsenic; and Dr Forcher of Grätz gives a list of eleven people in his neighbourhood who indulge in the practice. Professor Roscoe did not think it necessary to translate the reports *in extenso;* he gave extracts containing the portions immediately bearing upon the two questions at issue, and deposited authentic copies of the original reports with the Society, for the purpose of reference. He concluded, that decisive evidence had, in his opinion, been brought forward, not only to prove that arsenic is well known and widely distributed in Styria, but that it is likewise regularly eaten, for what purpose he did not at the moment investigate, in quantities usually considered sufficient to produce immediate death.—*Trans. of Manch. Lit. and Phil. Soc.*, 1860.

Dr Livingstone and his Researches.—The following letters from Dr Livingstone, addressed to Sir Roderick Murchison, were read at a meeting of the Royal Geographical Society in London:—

"SESHEKE, *Sept.* 10, 1860.

"MY DEAR SIR RODERICK,—Feeling in honour bound to take the Makololo back to their own country, and disliking the idea of coming to a stand-still while waiting for news of a real steamer, we started on the 16th of May from Tete, and in three months accomplished a distance of some 600 miles.

"Our route lay along the north bank of the Zambesi, crossing the mountain mass in which Kebrabasa lies, and the Loangua and Kafue at their confluences; then along the fine fertile valley in which the Zambesi gently flows (being new ground) for about 100 miles; then turning westward, in lat. 17. 18. S., up a sandy river (the Zongue) till we saw the source of the fragments of coal strewed on its bed. Ascended about 2000 feet above the Zambesi, or 3000 feet above the level of the sea, to the base of Tabacheu; breathed for a short time the clear, cold, reviving air on the highlands, and actually saw hoar frost and a little ice; then descended into the great valley of the Makololo. When within 20 miles of Victoria Falls, we could see the columns of vapour with the naked eye, and there I could not resist the temptation of acting the showman to my companions, Dr Kirk and Mr C. Livingstone, though by diverging from our straight course to Sesheke we added some 40 miles to our tramp. The hippopotami had eaten all my trees, so henceforth we shall have war with them to the knife. They are good food, half beef and half pork, and lots of fat, that serves as butter. This is part of the *casus belli.* By the way, our good friend Professor Owen and the gastronomic committee will stand very much in their own light if the she-giraffes die a natural death. If they praised the eland so, which we consider but so-so, a dinner off she-giraffe will leave them all lying on their backs.

"Our plan of returning is to pass Victoria Falls, and buy camels at Sinamanes; then drop down the stream, so as to be at the sea in November. This goes by an elephant-hunter, whom we met at the Falls, to Mosilikatze, and thence to Kuruman.

"We found Sekeletu labouring under a skin disease, believed to be leprosy, the effect, of course, of witchcraft; and several headmen had been executed for the alleged crime. Many influential men had died of fever, and the tribe is altogether in a shaky condition. They are anxious generally to go to the highlands, and were much disappointed at my not bringing Mrs L——; for all believe that she, or any member of Mr Moffat's family, would be a protector to them against Mosilikatze. During our month's sojourn here, we have been treated to tea, American biscuits, and preserved fruits daily. We have tried to cure Sekeletu's complaint, and he is recovering; but time and patience are required for the cure. It is probably an obstinate skin disease, and not leprosy.

"But I must tell you that we were saddened by the loss of a party of London missionaries, as we suppose by fever, at Linyanti; six out of nine Europeans perished in three months. By a remedy first tried on my own children at Lake Ngami in 1850, we, at a lower and more unhealthy part of the Zambesi, cured severe cases of the complaint in Europeans so quickly that our march was rarely interrupted more than a day or two; a man stricken prostrate was sometimes able to resume his march on foot a day after the operation of the remedy, and this while those good people were helplessly perishing. The proper medicines, too, for its composition were found by me in the waggon, which has been carefully guarded for seven years, within a few hundred yards of their grave. I think it is mentioned near the end of the "Missionary Travels" which you made me write; but I am now anxious that it becomes generally known, and there is great difficulty in the matter. Medicines so often deceive people; panaceas in one hand, and nonentities in another. I have, however, never failed to cure during ten years.—I am," &c.

"David Livingstone."

"Tete, *Nov.* 26, 1860.

"My dear Sir Roderick,—We unfortunately missed the opportunity of sending overland by the elephant hunters, so I open the letter written at Sesheke to insert some further particulars. The river was so low we could easily see the bottom of one-half of the fissure which forms Victoria Falls; and, indeed, people could wade from the north bank to my Garden Island, to form a stockade for fresh seeds. The depth is not 100 feet, but 310 feet—probably a few feet more, as the weight attached to the line rested on a slope near the bottom. The breadth from bank to bank is not 1000 yards, as I conjectured in 1855, but between one statute and one geographical mile—we say 1860 to assist the memory, but it is a little more, yet not quite 2000 yards. The lips of the crack at Garden Island may be more than 80 feet, as we could not throw a stone across, but the sextant gave that. Now, come to the other, or south-eastern side of the crack, and the fissure, which from the upper bed looks like the letter L, is prolonged in a most remarkable zigzag manner. The water, after leaping sheer down 310 feet, is collected from both ends to the upright part of the letter as the escape, and then flows away on the zigzag part. The promontories formed thereby are flat at the top, and of the same level as the bed of the river above the Falls. The base of the first on the right is only 400 paces from the Fall fissure, and that on the left about 150. Their sides are as perpendicular as the Fall, and you can walk along among the trees, and by a few steps see the river some 300 or 400 feet below, jammed in a space of some twenty or thirty yards, and of a deep green colour. As a whole, the Victoria Falls are the most wonderful in the world. Even now, at extreme low water, or when it is two feet lower than we ever saw it, there are 800 feet of water falling on the right of Garden Island. And the two columns of vapour, with the glorious rainbows, are a sight worth seeing. A fall called Momba or Moamba, below this, is interesting, chiefly because you look down it from a height of some 500 feet. It is really nothing after Mosloatunya.

"We visited the river twice on our way down to Sinamanes, and found it in a very deep crack. The boiling point gives 1600 of descent from the Falls of Sinamanes. Mr Moffat informs me that all the rivers in Mosilikatze country run N.W. or N.N.W. They enter Zambesi above Sinamanes, and above a remarkable mountain which possibly was the dam that shut in the waters of the ancient lake, before Mosloatunya was made. They are therefore not where, from oral information, they have been put in the map. The whole country below and around the Falls has been the scene of comparatively recent volcanic operations. Some parts look as recent as Eden; some are of frothy lava, and all present a burnt appearance. A conjecture that the calcareous tuffa of Sesheke valley was emitted from a volcano like that which covered the cities of Pompeii and Herculaneum does not account for the roots of reeds therein, nor the bidental saurians of the ancient lakes; and I question if a volcano ever threw mud over 200 miles square, as this lake has done. Wherever we have had igneous action in this country, we have had large quantities of tuffa bearing water after it. I cannot account for the enormous quantity of gravel and shingle below the Falls. The bed of the river and country generally are covered with it to a considerable depth. There is none above the Falls, and none below Chicova.

"We purchased canoes and dropped down stream in order to examine all at low water. Kansalo is no difficulty. Kariba, a few miles below it, is a basaltic dyke stretched across the stream; but it has a wide opening in it, dangerous for canoes, the gunwales of which were only six inches above the water. At Varumas there is a rapid of about 100 yards in length, which runs at six knots an hour. This is the most rapid part we have seen in the whole river. We measured the most rapid part below Chicova on our way up, and found it to be under four knots; but a fall of about fifteen feet before our return developed several dangerous rapids and even cataracts, which were quite smooth when we passed Chicova. There seemed from the shore to be a trap dyke across the stream, like Kariba, but it had two openings. We passed through either the one or the other without observing the dyke, but we saw a large seam of fine coal in the bank. There is another in the bank at Manyerire Hill; and besides seeing fragments of the minerals in many rivulets on both banks, we verified the existence of the coal-field, not to Zumbo only, as I formerly pointed out, but to nearly Sinamanes, below Victoria Falls. The only real difficulty in the river is Morumbua, and that could be passed in full flood, for a rise of 80 feet must smooth it over.

"On arriving here two days ago, we had travelled from Linyanti and back, some 1400 miles—the greater part on foot. We have thus kept faith with the Makololo, though we have done nothing else. We were swamped once; but the men behaved admirably, leaping out and swimming along-side till we got into smooth water. In another place one canoe was up-set and property lost. We then abandoned the canoes and came home on foot, thankful to say 'all well.'"

The Victoria Falls.—Letters have been received from Dr Livingstone, dated January 19, 1861, and from other members of the expedition down to the beginning of February, giving an account of a second visit to the Victoria Falls. The following is Mr Livingstone's description of this remarkable cataract:—"On reaching the foot of the island, the singularly unique character of this magnificent cataract becomes apparent. A deep cut in the basaltic rock of the bed extends from the east to the west bank of the stream, here running nearly from north to south. This gash is but a few yards longer than the river is broad, the latter being by measurement 1860 yards. We tried to sound its depth by letting down a line, to the end of which was attached a weight with more than a foot of white calico. When 310 feet had been paid out, the weight rested upon some projecting rocks near the bottom, and the calico seemed no larger than a crown piece. There were no means of measuring the width of the cleft, which may be 70 yards at its narrowest and 100 at its broadest points. Into this yawning chasm, of more than twice the perpendicular depth of the Niagara Falls, the Zambesi leaps with a deafening roar, constituting the Victoria Falls of Mosloatunya. The waters of the Falls near the east bank now run in an exceedingly narrow channel along the bottom of the chasm, exactly at right angles to their previous course, or nearly west, for about 600 yards; at which point they meet the waters of the Falls from the west in a fearful boiling whirlpool. The Zambesi, now apparently not more than 20 yards wide, rushes out of this furious caldron, rolling south through the narrow escape channel for some 150 yards. Here the volume of water enters a second chasm somewhat resembling the first, and nearly parallel to it. Abandoning the easterly third of this gorge to the growth of large trees, the confined river turns off to the west, leaving behind it a jutting promontory on either side of the escape channel. The westerly one is 1200 yards long, with a breadth of 400 yards at the base, and 150 at the head; the easterly one is about half the length. The stream now winds round the head of a second promontory, flowing back again towards the east through a third chasm; afterwards gliding past a third point, and away west down another rift in the rock. We could see in the distance that it rounded another headland, and returned once more towards the east. At the point of the third promontory the river was about 500 feet beneath the land, which, below the Falls, is about the same general level as above. Our whole party walked forth on the promontories, and looked down with dizzy heads to the green and narrow stream far, far beneath. From Garden Island the spectator commands a good view of the great chasm of the western promontory with its evergreen trees, and, above all, of the brilliant rainbow resting on the face of the vast, unbroken, perpendicular rock opposite, with occasionally a second, and even a third, fainter and more faint, above the grand iris. Just, however, as at Niagara (with which Mr Charles Livingstone was able, from personal observation, to compare the scene) one has to go to the Canada side in order to behold the great Horse-shoe Fall, so here we had to cross over to Mosilikatze's, or the west side, to gain the finest view of the two chief falls of Mosloatunya. By far the best is that from the longest promontory. Beginning at the west end of the chasm, there is first a romantic fall of about 60 feet in breadth, then an island of 600 feet diameter; after which comes the main fall, consisting of an unbroken volume of water nearly 600 feet wide. This is separated by a few yards of projecting rock from the fall which is second in point of size and volume, being upwards of 300 feet from side to side. East of this lies Garden Island, succeeded, the water being then at its lowest, by a series of bare rocks alternating with a score of narrow falls, any one of which would make an English county famous. When the river is full, these may probably be blended into one or two larger falls. Near the east end of the chasm are two falls of considerable size, though nothing like the two betwixt the islands. The spray from these last is thrown up to an immense height. We saw the mass of vapour from a Batoka village four-and-twenty miles beyond, at which distance it appeared to be 300 feet high. The early morning sun paints this vapoury mass with all the colours of the rainbow. It descends in a never-ending shower upon the large green trees opposite, from the leaves of which heavy drops are constantly falling. No bird sits and sings upon their twigs, or builds her nest amidst their branches. Hornbills and flocks of a pretty little black bird with brownish wings flitted across from the mainland to the islands, and thence to the promontory and back again; but they always shunned the evergreen trees, ever dripping with ever-falling showers. After a descent of some twenty feet the white waters suddenly became, as it were, animated. Comets, with heads resembling stars of the first magnitude, spring into existence, and leap out like living things, three, eight, or a dozen score at once, till the whole Fall seems like a mass of salient comets, each having a distinct and beautiful train of pure white vapour. Every few seconds some vigorous little fellow, as if anxious to escape the inevitable abyss, springs out far beyond the range of his companions, with a long train waving behind him. If Niagara has any such phenomenon, I failed to observe it, and never saw anything of the kind in any other waterfall. We tried to get to the bottom of the chasm at its east end. A too adventurous antelope had made the attempt before us, and got within fifty feet of the lowest ground. He could proceed no further, and there left its bones and horns; and, though we got back with ours, we would not advise any one else to try the experiment.

OBITUARY.

The Rev. John Stevens Henslow, Professor of Botany in the University of Cambridge, was born at Rochester on the 6th of February 1796, where his father was a solicitor. He was the eldest of eleven children, of whom four sisters only survive him. His grandfather was Sir John Henslow, surveyor of the navy. He was educated first at the Free Commercial School at Rochester, and afterwards at Camberwell in Surrey, under the late Rev. W. Jephson, D.D. At the latter institution he acquired a taste for collecting, arranging, and illustrating objects of natural history. This became a ruling passion through life, and placed him in a high position as a benefactor of mankind. He entered St John's College, Cambridge, in October 1814. He graduated B.A. (16th Wrangler) in 1818, and in the same year he was elected a Fellow of the Linnean Society. During his college career he devoted himself assiduously to science, which in those days did not occupy a prominent position in the University of Cambridge. He studied Chemistry under Prof. Cumming, and Mineralogy under Dr Clarke. He also prosecuted geology with vigour, and in 1819 became a Fellow of the Geological Society. In 1821 he passed on to M.A., and during that year he communicated to the Geological Society "Observations on Dr Roger's Account of the Isle of Man," and to the Cambridge Philosophical Transactions an account of the Geology of the Isle of Anglesea.

In 1822 he was elected Professor of Mineralogy, succeeding Dr Clarke, the celebrated Russian traveller. He held this office for three years. In July 1825 he succeeded Martyn as Professor of Botany in the University of Cambridge, and resigned the Mineralogical Chair. He now made botany the chief object of study and prelection, and in the elucidation of the subject he applied his chemical, physiological, and mathematical knowledge with the highest success. He diffused a taste for botanical science among the undergraduates, as well as among other members of the University, not merely by his lectures, but by his excursions into the country. His herborizations were well attended, and much practical information in field-work was conveyed. He contributed botanical papers to the Cambridge Philosophical Society, and wrote the volume on botany in Lardner's Cyclopædia. This little work is an excellent introduction to the structure and physiology of plants.

In 1823 Henslow married a daughter of the Rev. George Jenyns of Bottisham Hall, in Cambridgeshire. He was ordained in 1824, and became perpetual curate of Little St Mary's, Cambridge. In 1833 he was presented by Lord Brougham, then Chancellor, to the vicarage of Cholsey-cum-Moulsford, Berks, and in 1837 he received from the Crown the Rectory of Hitcham in Suffolk, which he held till his death. During sixteen years of his professorship he resided at Cambridge, and subsequently at the Rectory, going to Cambridge for five or six weeks in the Easter term to deliver his lectures on botany.

He was an able and successful lecturer, and was distinguished for the clear popular manner in which he illustrated science. He took an especial interest in bringing Botany and Horticulture under the notice of the young, and in this way he did much good to the children of his parish. His method of teaching botany to the village children has long been a model of scientific instruction, and the Horticultural fêtes at the Rectory of Hitcham have been celebrated for years.

The knowledge of botany displayed by the Hitcham children was truly wonderful, and those who had the pleasure of being present at the Rectory gatherings speak in the highest terms of the beneficial effects produced by the introduction of natural history among the juvenile population of the parish.

Henslow also originated great improvements in the farming of Suffolk. He introduced ploughing matches with much success, and elevated the character of the agricultural labourers. This was not accomplished, however, without a struggle. The Rector had to encounter deep-rooted prejudices which it required no small amount of prudence, perseverance, and conciliation to overcome. The allotment system, which he initiated, is now carried out fully, and the produce of the land has been highly improved and augmented. He published letters to the farmers of Suffolk, which did much to diffuse correct views as to farming operations; and he called attention to the phosphatic nodules, which have been of great use in adding to the fertility of the soil.

Henslow paid much attention to the health and recreations of the people, and organised excursions of various kinds for their benefit. He thus has aided in remedying many social evils. He lectured not only in Hitcham, but also in the neighbouring towns, and thus helped in diffusing knowledge among all classes of the community. He gave a short course of lectures at Buckingham Palace to the junior members of the Royal Family, on the invitation of H.R.H. the Prince Consort.

Henslow was one of the founders of the Cambridge Philosophical Society, and sent large donations to the Ipswich Museum which was planned and arranged by him. He founded a botanical museum at Cambridge, and assisted materially in the arrangement of the Kew Museum He also made valuable contributions to the Great Exhibition of 1851 and to the South Kensington Museum. The rooms at the Rectory of Hitcham were filled with specimens belonging to all departments of natural history and antiquities. He prepared a catalogue of British plants, and published a Flora of Suffolk. His illustrations of natural orders, published by the Department of Science and Arts, are of great value, and deserve a place in every school where botany is taught. At the time of his death he was employed revising the third edition of his "Principles of Botany," and in preparing a popular volume on botany. He strongly advocated the importance of botany in an educational point of view. In a letter written by him in February last, he says:—"In my opinion botany is the best adapted of all the classificatory sciences for strictly *educational* purposes. It offers greater facilities to both pupils and examiners for avoiding mere *cram.* My promised little volume on 'Practical Lessons in Botany for all Classes,' is at length in a forward state, and I hope and trust I shall be able to convince people of the value of this science in training the mental faculties when it is properly pursued and insisted on, and not made a mere plaything." In the same letter he writes:—"I am intending next week to deliver a lecture at Ipswich on the Pre-Celtic Celts, which are confounding all our geological notions, and turning the world upside down in regard to received chronologies. I strenuously advise *caution,* and repudiate some of the inferences which have been deduced from these remarkable discoveries. We shall hear of more of them. A new locality has just turned up at Herne Bay."

Henslow was one of the founders of the British Association, and was a regular attendant at its meetings. He was an Examiner in the University of London and a Member of its Council.

In political matters he took a deep interest at one time, and was a decided liberal. He was strongly opposed to bribery, and involved himself in much trouble by his unflinching exposure of corrupt proceedings in the town of Cambridge.

He was the chief promoter of science in Cambridge, and his efforts to establish the scientific tripos and degrees in science were crowned with success. He has also done much to adapt natural history in all its departments to the wants of the common people, and to induce the working classes to enter upon the study of common things. During the latter years of his life, Professor Henslow's health became impaired by incessant mental and manual labours, and he suffered from symptoms of disease of the heart, accompanied with dyspepsia. During the spring of the present year these were aggravated by an attack of bronchitis caught during a visit to the south of England, and after protracted suffering he expired at the Rectory at Hitcham on the 16th May last in the sixty-fifth year of his age. A biographer in the "Gardener's Chronicle" says of him:—"There are few men whose loss will be more generally deplored. To give even a sketch of the varied attainments and personal qualifications that were so blended in Professor Henslow, as to render him at once the most popular and useful man of science of his day, is quite impossible here, for they depended on a combination of rare qualities of head and heart, each natural, but all well trained and conscientiously cultivated by their possessor during a long period of his life. These were a sense of truth and fair play so instinctive, that deception or even reticence, when the cause of truth was at stake, were things almost unintelligible to him; a geniality of disposition that rendered him an attractive companion from his childhood upwards; a temper of which he was never known to lose command even by his most intimate friends; an organisation of brain that rendered all subjects of study equally easy of acquirement; a keen love of nature and of natural knowledge; an ardour in communicating it; a quick perception; excellent powers of generalisation; the largest charity; a total absence of vanity or pride; a winning countenance, and a robust frame. Few men, indeed, were more gifted by nature to take a commanding position in the many spheres of life, in one or other of which he was always busy." His name will descend to posterity associated with great and successful efforts to diffuse the knowledge of the natural sciences among all classes of the community, and to illustrate in the productions of nature the wisdom and goodness of God.

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Compte rendu Annuel, addressé à S. Exc. M. de Knajèvitch. Ministre des Finances, par le Directeur de l'Observatoire Physique Central, A. T. Kupffer, 1858. St Petersburg.—*From the Author.*

American Journal of Science and Art, November 1860 and January and March 1861.—*From the Editors.*

Discussion of Magnetic and Meteorological Observations made at Philadelphia. By Professor A. D. Bache, LL.D. Part I.—*From the Author.*

On certain Storms of Europe and America, December 1856. By Elias Loomis, LL.D.—*From the Author.*

Report of the Superintendent of the United States Coast Survey for 1858.—*From Professor A. D. Bache.*

Check-Lists of the Shells of North America.—*From the Smithsonian Institution.*

The Motions of Fluids and Solids relative to the Earth's Surface. By W. Ferrel, A.M.—*From the Author.*

Proceedings of the Literary and Philosophical Society of Manchester for April 1861.—*From the Society.*

Proceedings of the Californian Academy of Sciences, 1855 to 1859.—*From the Academy.*

A Treatise on Attraction, Laplace's Function, and the Figure of the Earth. By Archdeacon Pratt.—*From the Publishers* (Macmillan and Co.)

The Quadrature of the Circle; Correspondence between an Eminent Mathematician and James Smith, Esq., Member of the Mersey Docks and Harbour Board.—*From the Publishers* (Simpkin, Marshall and Co.)

Journal of the Asiatic Society of Bengal, No. IV., for 1860.—*From the Secretary.*

Mineral Veins, an Enquiry into their Origin, founded on a study of the Auriferous Quartz Veins of Australia. By Thomas Bett.—*From the Author.*

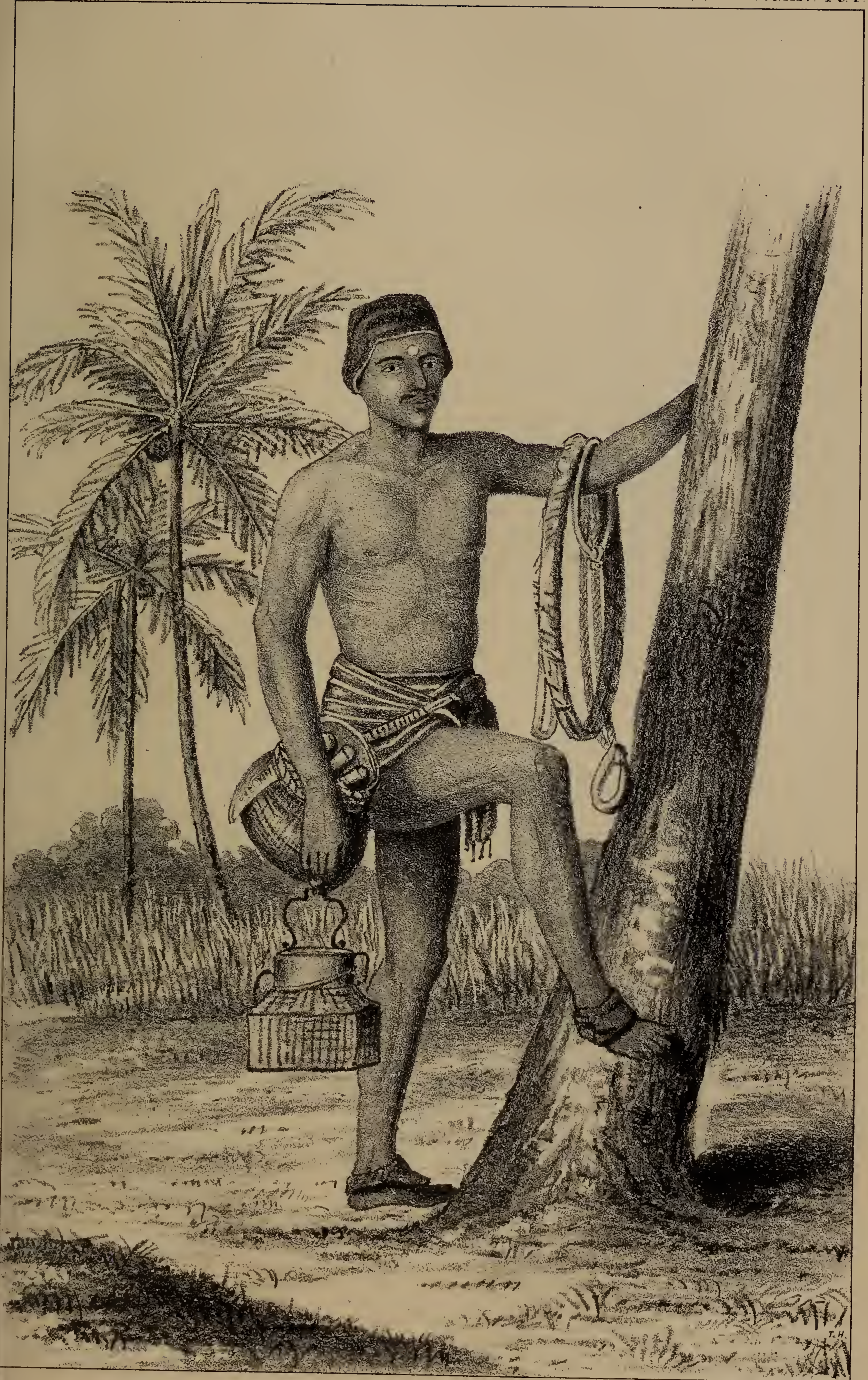
List of American Writers in Recent Conchology, with Titles of their Memoirs and dates of publication. By George W. Tryon.—*From the Author.*

The Past and Present Life of the Globe. By David Page.—*From the Publishers* (Messrs Blackwood).

Errata and Addenda in last Number of the Journal.

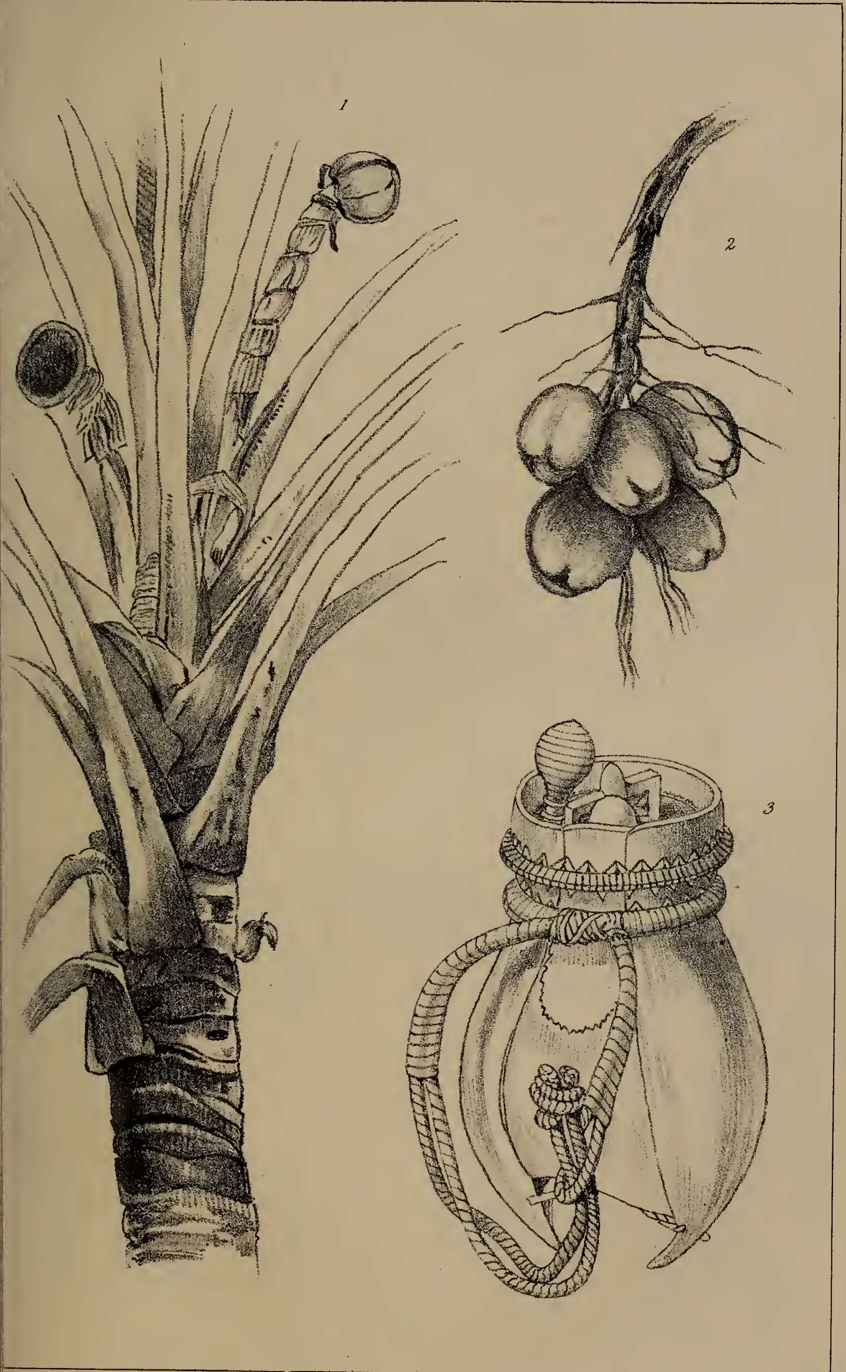
Page 237.—It should have been stated that the degrees given by M. Martins are Centigrade.

Page 269, line 8 from the bottom.—For *injured*, read *uninjured.*



W. H. Mᶜ. Farlane, Lithʳ. Edinʳ.

Sánar preparing to climb a Coco-Palm.



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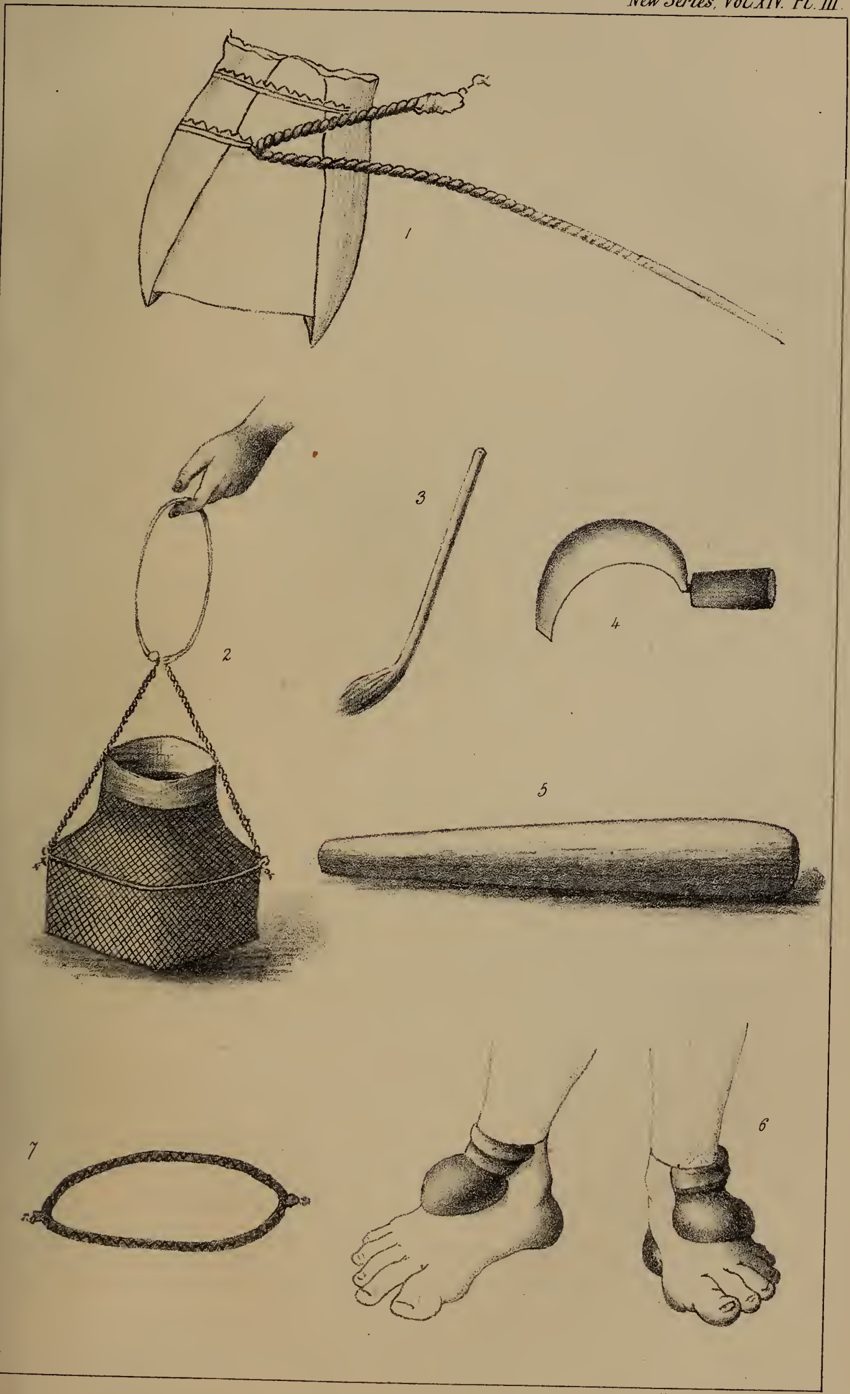
Process of extracting Toddy.



W. H. M^c Farlane, Lith^r. Edin^r.

Apparatus for collecting Toddy.

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*Notes upon the Coco-Nut Tree and its Uses.** By Hugh Cleghorn, M.D. (Plates I. to III.)

It seems needless to bring under notice the many useful purposes to which Palms are applied, the high position which the tribe holds in the vegetable kingdom, and the peculiar Oriental character they give to the landscape. The majestic character of the palm, its gigantic foliage, and its economical importance, are facts familiar to all; and of the coco-nut and palmyra trees especially, it may with truth be said, that there is scarcely a single part of them which is not applied to some particular purpose. In India, we are readily convinced of this; for we can scarcely look abroad without observing some use or other made by the ingenious native, of the foliage, the fruit, or the stem of these wonderful plants. We see the leaves rendered serviceable for thatch, screens, baskets, and mat-work, and as a material to write upon; we see the fibrous coating of the fruit twisted into the pliant and durable coir rope, and used for stuffing mattresses; we are indebted to the kernel for a rich clear oil, in most extensive use over India, and one of her chief exports; while the trunks of the trees are employed for rafters, for boats, and for building purposes.

Of all the palm tribe, by far the most important is the *genus* Cocos. This contains twelve species, of which the coco-nut tree, or *Cocos nucifera* of Linnæus is the most valuable. Many varieties of the *Cocos nucifera* have been observed. Mr Berthold Seemann, in his "Popular History of

* Read to the Botanical Society, May 9th, 1861.

the Palms," mentions five varieties as indigenous to Ceylon. The first, or King Coco-nut, "the Tembili of the Cingalese, must be well known to those who reside in Ceylon; its bright orange colour, and somewhat oval shape, cannot fail to attract notice, and it is usually presented to respectable Europeans by the Modeliars, or by the priests, as a compliment to those whose curiosity may have induced a visit to the shrine of Buddhoo. The second is of a similar colour to the preceding, but of a more spherical shape. The third is of a pale yellow, and rather heart-shaped; it is the *Nowasi* or edible husk, and has the peculiar quality, that, after the *epicarpium* has been removed the inner rind (*mesocarpium*) turns to a pale red, and is edible. The fourth is the common coco-nut which is in general use, and the one most known. The fifth is a species of Maldivia or dwarf coco-nut, about the size of a turkey's egg, which, being rare, is more esteemed as a curiosity than for any peculiar good quality it possesses."*

The principal difference in the several varieties appears to consist in the shape of the nut, which takes a different form, and varies in size in different countries. In Canara it is more oval, for instance, than on the Coromandel coast; and it is smaller and more spherical in the Maldives than elsewhere.

The different names for the coco-nut tree in Southern India are as follows:—Tamil, *Tenna-maram;* Telugu, *Tenkai-mānú;* Canarese, *Tenganī-maram;* Malayalam, *Tengana-maram*; Hindostani, *Narel-ka-jhâr*. A description of the tree is unnecessary. It is found all over the tropical parts of the world. It grows to 60, 70, or 80 feet high. Dr Hunter, who measured a coco-nut tree at Pairur, found it to be 85 feet high, and a palmyra tree 65 feet. The size and fruitfulness of the coco-nut tree varies considerably with the nature of the soil. It seems partial to the sea-coasts, where it flourishes in great luxuriance. All along the Malabar coast, in particular, forests of coco-nut trees line the water's edge, and yield abundant crops of fruit.

Notwithstanding its partiality for the sea, however, there seems to be no arid sandy drift too barren to admit of the

* Popular History of the Palms, p. 165.

processes of assimilation and nutrition on which its growth and reproduction depend, and this qualification alone increases its value a hundred-fold to the natives of a sandy coast or the dry and sultry plain. Possessed of a habitation darkened by a clump of coco-nuts, a jak, and a palmyra tree, a native is envied, and considered an independent proprietor.*

The stem of the coco-nut tree at the bottom varies from one to two feet in diameter, gradually lessening towards the top, where its girth is considerably reduced. The leaves sprout from the top in the form of a crown, and are about twelve in number; those at the top and in the centre stand erect, while the middle and the lower range bend gracefully over, and are often from 14 to 15 feet long by about 3 feet broad in the widest part.

In the middle of the leaf runs a strong mid-rib, thick and grooved at its base, but tapering to a point at the extremity. From the side of the rib hang *pinnœ*, or long thin strips called *olé* by the natives. They are usually from a foot to a foot and a half long, according to their position on the rib, and give to the leaf a light and feathery appearance. These *pinnœ*, when plaited, form what are called *Kithú*, and answer a number of purposes in the domestic arrangements of a native hut. They come into play to form temporary sheds in their numerous festivals. The poorer classes have no other roof over their heads than one made of *Kithú.* Everywhere they meet the eye in the form of mats, partition-walls, or screens, contributing to the privacy of their humble dwellings. The fruit grows in clusters at the top of the tree and around the base of the leaves (*vide* Plate II. fig. 2). Each nut is rather oval in form, and when full grown, with the outer husk on, is about the size of a man's head: with the outer husk off, about the size of an ostrich's egg, with three small depressions of a quarter of an inch in diameter at the end next the stem. These depressions are the eyes of the fruit, one of them forming the hole through which the germ sprouts when the nut is

* "The Indian nut alone
Is clothing, meat and trencher, drink and can,
Boat, cable, sail, mast, needle, all in one."
G. Herbert.

planted in the ground *eyes upwards.* From the position of the eyes giving the end of the shell something of the appearance of a monkey's face, some have derived the tree's name, *coco* or *cognesa* being Portuguese for monkey. In the Parliamentary papers we find there were imported of these nuts into the United Kingdom, in 1858, "2,508,869, which were almost wholly retained for consumption. They are used instead of wedges to fill up the interstices between casks and packages in the cargoes of ships, so that the freight costs little. In the same year our imports of coco-nut oil amounted to 197,788 cwts."*

Ceylon and the Laccadives have long been famous for their coco-nut trees, and the oil, arrack, and coir (or *kayar*) manufactured therefrom form the chief articles of export of those islands; about 2½ millions of pounds of coir are annually exported from Ceylon to Calcutta and other parts in the East Indies alone. By the "Report of External Commerce of Madras," the quantity and value of coco-nut and coco-nut kernel exported from the Madras territories in 1858–59 stood

	Quantity.	Value.
Coco-nuts, . .	2,73,42,940 No. .	3,60,740 Rs.
Coco-nut Kernel, .	1,09,053 cwt. .	4,34,000 ,,

Of this, Rs. 357,287 worth of the coco-nut, and Rs. 430,944 worth of the kernel, were exported to the Indian or home ports, such as Rangoon, Kutch, Moulmein, Scinde, Bombay, and Concan. Of the remainder some went to the Mauritius, some to the Persian Gulf, &c., and a little to the United Kingdom. Nearly the whole was exported from Malabar and Canara. Ganjam supplied a little to Moulmein. The quantity and value of coco-nut oil and coir exported from the Madras territories in 1858–59 were as follows:—

	Foreign or External Ports.		Indian or Home Ports.		
	Quantity.	Value, Rs.	Quantity.	Value, Rs.	Total Value, Rs.
Oil, gal. . .	19,55,382	4,10,642	2,33,732	63,378	4,74,020
Coir, cwt. .	46,675	96,945	1,05,661	2,14,642	3,11,587

* Annual Statement of Trade and Navigation for the Year 1858, pp. 68 and 82.

Topes of coco-nut trees pay a small tax to Government, varying in amount in different districts. Single trees in gardens or on cultivated land pay no tax, unless the latter is left waste, when a small assessment is imposed upon each tree. Ward, in his work on the Hindus (III. 107), written forty years ago, gives the following rate at which trees were rented at that time in Bengal:—"A mango tree, one rupee; a coco-nut tree, eight annas; a jak, one rupee; a tamarind, one rupee; a betel nut, four annas; a talu,* four annas; a date, two annas; a vilvu,† four annas; a lime tree, four annas."

The tree is propagated by the nuts, which, when planted thoroughly ripe, come up usually in a few months. The coco-nut tree is planted with the fibrous shell in May, one foot and a half deep, and in good ground comes up in November. The first leaf is single, and the young plant is transplanted before it divides. In seven years the tree begins to bear, and at about fifteen years it is in full bearing. In the notes descriptive of the Laccadives, in the "Madras Journal of Literature and Science," it is stated that the coco-nut tree "requires some attention for the first year, and after transplanting, until it takes root; it may then be left to itself, and comes into bearing in periods varying from ten to twenty years, according to the soil. It continues bearing from seventy to eighty years. From 60 to 70 nuts is a fair average annually, of which 5 rupees per 1000 is the value in the islands." This is something less than one pie for each. In Madras they sell from 3 to 5 rupees a hundred; in the adjoining districts, from 1 rupee to $2\frac{1}{2}$ a 100. Each tree is said to throw out one leaf and one flowering spathe every month. It is probable that the time which an individual tree takes to come into flower, and the number and size of the leaves and spathes it throws out, depend more upon exterior causes, as soil, climate, and the care bestowed upon its nurture, than upon any uniform law which would enable us to speak positively upon the subject. Porter, in the "Tropical Agriculturalist" (p. 255), writes, "Where the plant has been constantly watered, the first bud will appear in the fourth or fifth year; but if it has been left merely to obtain moisture from rain, the flowering will be delayed till the

* Palmyra Palm. † Wood apple.

seventh or eighth year. Plants of vigorous growth send forth nine, ten, and even twelve clusters of buds in the year; but those on which little care has been bestowed, and which are consequently feeble, produce only four or five of these spathes."

Having made these remarks upon the coco-nut tree, and upon the many uses to which it is applied, I shall now give some account of the extraction of toddy from the trees, and of the means and appliances used in the process. When a tree has thrown out a spathe (called in Tamil *pālai*) from which it is intended to extract toddy, about a month is usually allowed to elapse for the flower-buds inside the spathe to become sufficiently juicy to yield a fair return to the toddy-drawer. The spathe, at that time elliptical in form and pointed, will have attained a length of two feet, and a diameter of about two inches in the thickest part. The sheath of the spathe will be about an eighth of an inch thick, and very hard. At this stage the nut is a small, round-looking knob, of the same colour as the flowers—pale yellow, and of about the size of a marble. A few of the spathes are barren of nuts; some of them contain two or three, some five or six, and others as many as ten or twenty. When a month or five weeks have elapsed, and the spathe is considered in a fit state to commence operations upon, it is tightly bound round with strips of young leaves, to prevent the expansion of the sheath, and is cut transversely at the point, bruised, and otherwise carefully treated from day to day. To do this is the business of the Sānar or toddy-drawer. In Plate I. a representation is given of a Sānar, accoutred with the toddy-basket, back-rope, and regular *paraphernalia* peculiar to his employment.

First in importance among his appointments is the *Arival-pétty* (*lit.* knife-box) made from the sheath of the spathe, and bound round tight with two binders of ratan (Plate II. fig. 3). Inside is a thin wooden collar of palmyra bark, circling round and made fast with fibrous cording. A wooden partition divides the *pétty* longitudinally into two divisions, in one of which he carries his knife, in the other his mallet, sandbox, and fibre. An iron hook is fixed to the *arivalpétty*, in order to take a chatty up a tree or bring one down, a string being tied to the mouth of the chatty, and fastened to the hook.

The chatty is attached with about a foot of line, swings clear of his legs as he mounts, and away from the tree, and is drawn up *a tergo.* The hook also serves to hang up the *arivalpétty* in his house. Alongside of the hook are some small iron ornaments, which make a jingling noise as he climbs, and scare away snakes and other vermin that might prove unpleasant neighbours.

A strongly plaited rope is permanently fastened to one side of the *arivalpétty*, as in Plate III. fig. 1. The short arm *a* is about half as long as *b*, and with a much smaller loop. When fastened round the waist, the longer arm is passed inside the small loop of the short arm. Through the loop of the long arm the toddy-drawer passes the end of his waist-cloth, and ties it into a knot. Next in importance is the *Eropétty* (Plate III. fig. 2), into which the toddy-drawer empties the toddy collected in the chatty up the tree. It is made of palmyra fibre closely plaited, and when well moistened is water-tight. Two wooden collar shavings, about two inches broad, encircle the mouth of the *eropétty*, one inside and one outside; between them the plaited wicker-work is run up, and made fast. To keep the *eropétty* in its bulged bottle-like form, a piece of ratan about half way down is woven in, and encircles the vessel like the hoop of a barrel. The *eropétty* hangs suspended over the *arivalpétty* (*vide* Plate I.) by a roughly-twisted rope of palmyra fibre. The *eropétty* holds about 2½ Madras measures, which make its cubic contents about 250 inches. In Plate III. fig. 3, is shown the *Palai mattai*, called also *Vandal mattai.* It is a little more than a foot long, and is made of the rachis or spadix inside the spathe. The end is jagged into a brush, whence its name *palai* a spathe, and *mattai*, a brush. Its place is in the *eropétty* (Plate II. fig. 3). It is used to brush away insects, or foreign matter floating upon the top of the toddy. It also serves to moisten the end of the spathe before cutting it with a knife. In Plate III. fig. 4, is shown the *Arival* or knife, shaped like a sickle, with the inner edge sharpened. It is used for trimming the spathe, and is very sharp. When not in the hand it is kept in the *arivalpétty.* The handle is of common wood, and about three inches long. The circle of this blade carried round, would make a common sized dinner plate. The *Pathady* (Plate III. fig. 5), a wooden club or mallet, about a foot long, and an inch and a half in diameter in the thickest part, is used for hammering the end of the spathe, when cut, to crush the flowers, that the juice may flow freely. The *Moongul* is a small bamboo tube for holding finely-powdered white sand, to sharpen the knife with. This the Sānar accomplishes by sprinkling the sand upon a flat piece of wood he carries about with him, called *Arival tittu cuttá*, one end of which being pressed against his chest, and the other against the trunk of a tree, he rubs the blade up and down, and makes an edge like a razor. The *arival tittu cuttá* is made of the Kanal-Mooraga maram (*Erythrina indica*), and is generally about two feet long by two inches broad and deep.

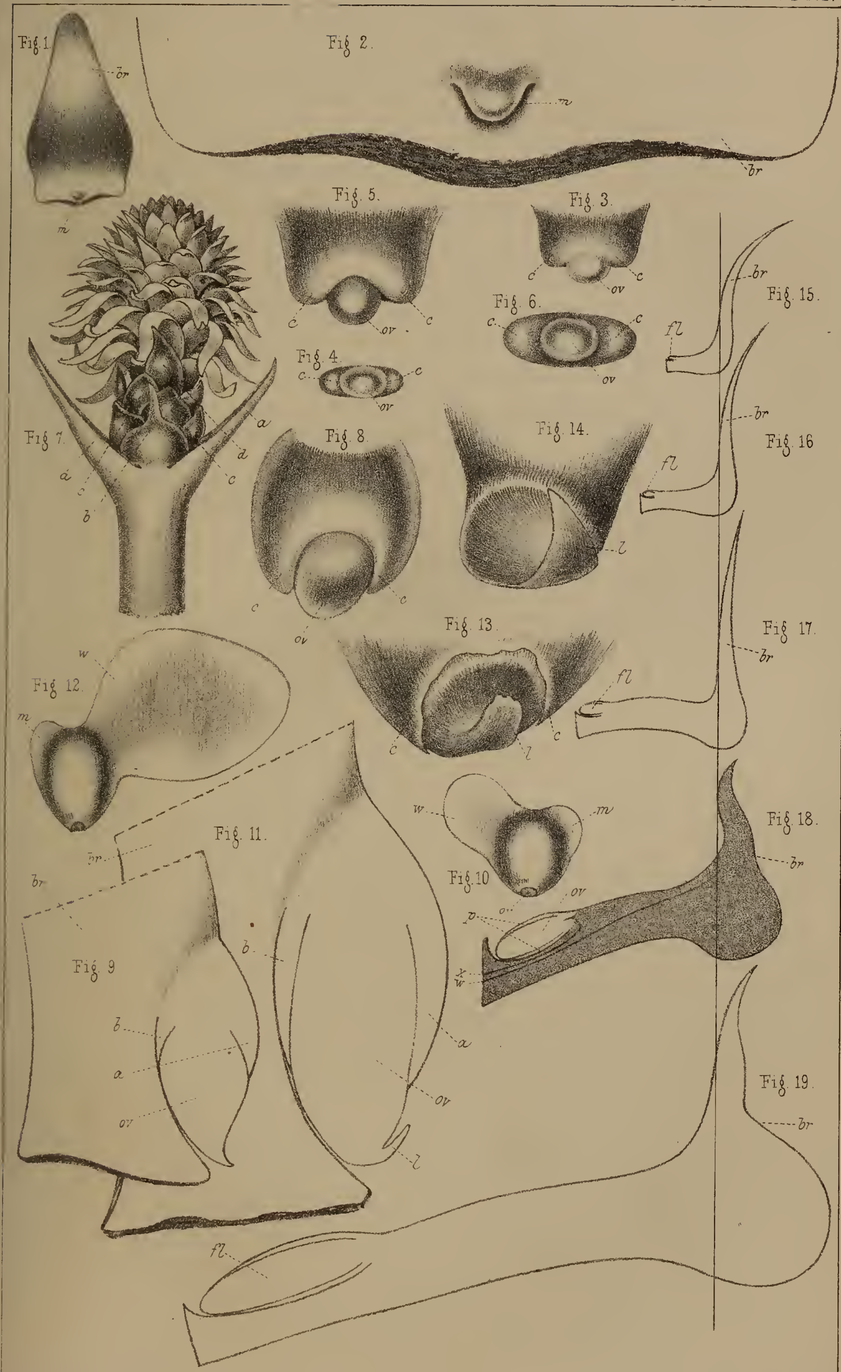
The *Kaltol* (Plate III. fig. 6), made of leather and lined with cloth, is put upon the instep, as represented, to prevent the chafing of the *kāltaly* (Plate III. fig. 7), a circular rope into which the Sānar's feet are placed to assist him in climbing. The *Vada-cour* is a strong rope, about 2½ yards in length, made of cow or buffalo hide. It encircles both the Sānar and the tree, as he climbs, and is, as the name denotes, the "back rope." The part which comes in contact with his back is usually lined with cloth to prevent chafing.

Furnished, then, with the necessaries as described above, and sometimes with a small bamboo ladder, the Sānar starts early of a morning in the direction of his trees, to collect the toddy drawn during the night. Arrived at the foot of a tree, he first fastens the *vada-cour* round himself and the trunk, and puts his feet into the *kāltaly*, fitting the rope over the *kaltols* and under the soles of his feet. Then, in order to plant his two feet (which are thus kept from separating by the *kāltaly*) upon the trunk of the tree, he presses the upper part of his back strongly against the *vada-cour*, and keeps his body poised upwards, as it were, by planting his left hand firmly against the tree—fingers pointing downwards, and pushing in that direction, In Plate I. is shown the attitude of the man as he is preparing to mount, before he has attached the rope which keeps his feet in apposition. His first motion, after the *kaltol* has been tied on, is to lift his feet off the ground, and place them upon the trunk, by pressing his back against the rope, and his left hand against the tree.

Immediately after this he moves up the *vada-cour* with his right hand, and fixes his left hand in a position higher up the tree. His left arm acts as a *fulcrum* as it were, on which, resting the weight of his body, he is enabled to set his legs free, and thus alternately to move up his arms and the upper part of his body, and to drag up his legs after them. When at the top of the tree, he lowers the *vada-cour* so far down from his shoulders, that he can sit upon it, and thereby obtains a rest, with his hands entirely disengaged to do anything that is required of them. It takes nearly a year's practice to make a man master of this curious mode of climbing, after which the loftiest trees are ascended in a minute with surprising ease, and with perfect security. After a hard morning's work, the left arm always aches more than the other limb, showing that there is more strain on it than anywhere else. When an accident befalls a toddy-drawer, it is usually occasioned by his left hand missing its hold on the tree and slipping aside, which brings him to the ground instantly, often with fracture or injury of that limb.

When the spathe is a month or a month and a half old, the toddy-drawer begins his labours by binding the sheath to prevent its expansion, as represented in Plate II., after which he cuts about an inch off the end, and gently hammers the flowers which are thereby exposed. Finally, he binds up the end with a broad strip of fibre (Plate II.), and descends. This process he continues morning and evening for fifteen days, a thin slice being cut away on each occasion. During this time, also, by shaving away a little of the under part of the sheath, he trains it to bend over. It is probable that the exact term of days during which the spathe undergoes this initiatory preparation varies in different places, and depends upon surrounding circumstances. Mr Berthold Seemann, in his "Popular History of Palms," mentions five or six days as sufficient. Near Madras, a toddy-drawer assured me that fifteen days was the usual time. It is a matter of little moment, however, for the time when a spathe is ready to yield toddy will be easily known by the chattering of birds, the crowding of insects, the dropping of the juice, and other unmistakable signs. When ready, the end of the spathe is fixed into a *kuduvé* (small chatty); and a small slip of leaf is pricked into the flowers to catch the oozing liquor, and to convey the drops, without wastage, clear into the vessel. When the spathe begins to yield toddy he ceases to hammer it. It will give toddy for about a month, during which time, every morning and evening, he mounts the tree, empties the toddy into his *eropetty*, binds the spathe an inch lower down, smears the end of it with his *pālai mattai*, and shaves a little away, then pricks in the slip of leaf, and ties the *kuduvé* on again.

The man who ascends the tree is generally a paid servant, receiving about Rs. 7 a month. He will attend to thirty or forty trees. Forty trees yield about twelve measures (Madras) of juice, seven in the morning and five in the evening. During the heat of the day the spathe does not bleed so freely as in the night. Twelve measures for forty trees is at the rate of a little more than one-fourth of a measure to each tree. A first-rate tree in a good soil, and carefully tended, will produce one measure during the night, and three-fourths or one-half of that uantity during the day. But taking one tree with another, a quarter or half a measure is a fair average. Some trees, under favourable circumstances, continue yielding at this rate throughout the year, others only for six months. It is not prudent, however, to draw all you can from them, as they will be exhausted, and become barren. Every morning and evening when the Sānar goes to draw the toddy, a servant or some one connected with the owner or contractor for the trees usually accompanies him with a chatty, into which is emptied the toddy from the *eropetty*. When all the trees have been visited, and the toddy measured into the chatty or *cullu-paní*, it is carried away to the bazaar rented by the contractor from Government at a fixed price. In Madras, there are 58 first-class toddy shops, to each of which 330 coco-nut trees are allotted; the contractor paying daily Rs. 2-12-10 to Government for each such shop. There are 63 second-class toddy shops, to each of which 247 coco-nut trees are allotted—each shop yielding daily Rs. 2-2-10 to government; also 205 third-class shops, to each of which 165 trees are allotted—each



A Dickson, delt. W. H. Mc Farlane, Lithr. Edinr.

shop yielding Rs. 1-5-2 to Government; and 81 fourth-class shops, to each of which 110 trees are allotted—each shop paying Rs. 1-2-5 to Government. The gross collections annually upon all the shops amount to about Rs. 2-32-567. It is not always men of the Sānar caste who rent these shops; rich sowcars and natives of other castes generally contract for them, and place men of the Sānar caste in charge. There is nothing very peculiar about the habit, custom, or dress of the Sānars to separate them from other Hindu castes, apart from their occupation, which, being exclusively that of the sale and manufacture of toddy, may be said to distinguish them. Around Madras the Sānars are divided into two classes, the higher and the lower; the latter are called Pully Sānar, and permit their widows to marry. For a brief account of the mode of extracting toddy, illustrated by coloured plates, see "Kew Miscellany," vol. ii. p. 23. Much information regarding the culture of the coco-nut will be found in Buchanan's "Journey through Mysore."*

Description of Plates.

Plate I.

Coco-nut palm; Sānar preparing to ascend with apparatus.

Plate II.

Fig. 1. Coco-nut; end of spathe tied up. 2. Coco-nuts on spadix. 3. Basket (*Arival pétty*), with apparatus.

Plate III.

Fig. 1. Rope for binding. 2. Toddy vessel (*Eropétty*). 3. Brush (*Palai mallai*). 4. Knife (*Arival*). 5. Mallet (*Pathady*). 6. Pads on feet (*Kaltol*). 7. Circular rope for feet (*Kaltaly*).

On some of the Stages of Development in the Female Flower of Dammara australis. By Alexander Dickson, M.D. Edin.† (Plate IV.)

In a short notice upon the morphology of the cones of *Araucaria, Dammara,* &c., which I read before this Society in January last, I called in question the ordinarily received interpretation of the structures in the female cones of these plants.

In the first place, I drew attention to the easily demonstrated

* For some of the local statistics given above I am indebted to Mr Breeks, C.S.

† Read before the Botanical Society of Edinburgh, July 11th, 1861.

and incontestable fact, that the so-called *squamæ fructiferæ* in *Araucaria* are serially continuous with the leaves of the shoot which the cone terminates, and that, therefore, these "squamæ" are in the position of the bracts, and not of the scales of a larch, or any of our ordinary Abietineæ. It is a fact which cannot be too strongly insisted upon, that *in Araucaria the leaves of a cone-bearing shoot pass by gradual transitions into the so-called "squamæ fructiferæ" of the cone; these leaves and "scales" forming a continuous series of homologous parts.*

Regarding *Dammara*, I could not at that time give any special particulars of importance, as the specimens (cones developed in the summer of 1859?) which I then obtained were about half-grown, and had lost the bud-scales surrounding the base of the cone. I could only argue from the close analogy between *Dammara* and *Araucaria*, that what holds good for the one genus may be presumed to do so for the other. Being compelled to recognize in the so-called scales of *Araucaria* structures corresponding to the bracts in *Abies*, *Pinus*, &c., I endeavoured to show that the scale-like "appendage to the seed" in *Araucaria* might be considered as representing the free portion of an otherwise adherent true *squama fructifera;* this view being supported by the somewhat similar structure in *Cunninghamia*, and by the greater or less amount of adhesion between bract and scale even in our ordinary coniferæ. As to *Dammara*, I held that the free portion of the true *squama fructifera*, which is much reduced in *Araucaria*, had here entirely disappeared.*

Since offering this explanation of the structures in question, I have fortunately had an opportunity of examining, to a cer-

* In my paper on the Morphology of *Araucaria*, &c., (Edin. New Philosophical Journal, April 1861, pp. 198–9), I erroneously referred to an absence of the *squamula* in the "scales" of *A. brasiliensis.* I have since then, through the kindness of Mr Bennett, obtained some of these scales, in which the *squamula* is very distinctly developed, even more fully than in *A. imbricata.* This error on my part arose from my having inadvertently misread a passage in Richard's *Mémoires*, in which he speaks not of the *squamula* but of the apex (*languette*) of the scale as being absent in *A. brasiliensis.* As, however, the state of the question under discussion is not materially affected, any evils resulting from my unfortunate mistake can be but trifling.

tain extent, the development of the female flowers of *Dammara australis*, a plant of which has this summer produced cones in one of the hot-houses in the Botanic Garden here.*

These cones were first observed in the early part of May, but would have attracted attention sooner had they not been confined to the uppermost branches of the tree. The cones which I then obtained (May 10th) are axillary shoots. They are roundly oval in form, and vary from a little under to a little above an inch in length, exclusive of the stalk and that portion bearing the bud-scales of the cone.

The scales of the cone are nearly triangular in outline, and more or less elongated; broadest a little above the base, at that part where the scale is bent upon itself. Just at its base the scale is rounded at its angles or slightly auricled. (See fig. 1.)

In the best developed of these cones (see fig. 7) the scales are more or less patent, the lower ones deflexed. The lower scales are more elongated and acute than the upper; and a good number of them, although persistent and becoming enlarged along with the other scales, are sterile. The bud-scales vary in extent of development in different cones. In the cone represented in fig. 7 the lowermost pair, which are identical in form to those found in leaf-buds, present a diminished, almost bar-like lamina, with dilated base (fig. 7, *a*). In the pair next above, the lamina is still further reduced, with the base more manifestly dilated. In the succeeding ones we lose the appearance of a lamina altogether; the scales being short and rounded, or slightly pointed. They soon pass off above into more elongated and pointed structures (fig 7 *d*), which lead at once to the so-called *squamæ fructiferæ*. Of these bud-scales the first two pairs are opposite and decussate, but they gradually pass off above into the more complex spiral of the cone. They soon wither, and ultimately fall off.

* This plant had produced cones previously (in 1859?), some of which I examined last winter. I accordingly asked one of the gardeners, William Bell, an enthusiastic and intelligent botanist, to look at the plant from time to time, so that the cones might be obtained early, in the event of its flowering this season. To his attention, and to the kind permission of Mr M'Nab and Professor Balfour, I am indebted for the materials of this investigation.

Thus, since the lower of these bud-scales do not differ from the first leaves of the leaf-bud, and since they certainly form a continuous series with the cone-scales, it follows, as might have been anticipated, that in *Dammara*, just as in *Araucaria*, the scales so called are in fact the *leaves* of the cone-shoot.

Not to pursue this subject further at present, I will now proceed to detail the principal points which I have been able to investigate in the development of the female flower.

The earliest condition which I have seen is that represented in Plate IV. figs. 1 and 2. It consists in a small, somewhat flattened mammilla, springing from a broadish base, on the inner or upper surface, and in the middle line of the scale close to its base. Even at this period it is inverted, its apex being directed towards the axis. The attachment of the mammilla is about $\frac{1}{70}$ of an inch from the base of the "scale;" the length of the "scale" itself being about $\frac{1}{4}$ of an inch, or a little more.

In a further advanced stage two shoulder-like projections are to be seen, one on either side of the apex of the mammilla (Plate IV. fig. 3); which, when looked at in the direction of the apex (Plate IV. fig. 4), are found to be two semilunar elevations embracing it. These manifestly correspond to what Baillon has described as carpels occurring in *Pinus*, *Taxus*, &c.

I cannot say that I have seen these elevations actually free from one other at their bases, although *very nearly so*. At first they appeared to me as being quite free from each other, and I had even made a drawing representing such to be the case; but on closer scrutiny and more careful adjustment of them to the light, there can always be detected an extremely faint elevation of the surface between their bases. I regret extremely that my materials have not enabled me to make certain of this point, as it is of great importance in confirming Baillon's view of the primitive duality of the structure enclosing the "nucleus" or ovule, and which I am strongly inclined to hold as correct.*

* I must here state that the flowers near the apices of the cones, and whence I obtained the specimens such as are represented in figs. 1 and 3, are often imperfectly developed, and that many of the apparently very young flowers are probably in reality older than they seem, and so be liable to induce misconcep-

In the next stage, the connation of the carpels by their bases is very manifest (Plate IV. figs. 5 and 6). The central mammilla is now very well marked, and, I daresay, may with propriety be termed "ovule." After this stage there exists a slight gap in my materials, as I was somewhat delayed in obtaining my second supply.

In the flower represented in fig. 8, the different parts, although very considerably grown, are easily recognised in their relation to the corresponding parts in the earlier stage. (To avoid confusion in description, I shall term that surface of the pistil which is applied to the "scale" the posterior, and that which is exposed, the anterior.)

The "nucleus" still projects to a comparatively large extent beyond the two carpels which surround it, and by whose connate bases it is covered to about its middle in front, and to a somewhat less extent behind. The pointed apices of the free portions of the carpels extend at the sides nearly as far as the extremity of the ovule, falling only a little short of it. There is thus a deep, rounded notch, both before and behind, between the apices of the carpels; the posterior notch being the deeper. The pistil is somewhat compressed from before backwards, but it is more convex before than behind. Its thin lateral margins (corresponding to the mesial dorsal lines of the carpels) do not yet exhibit any of that want of symmetry which afterwards occurs, from the formation of a wing on one side.

The extremity of the ovule ("nucleus") is now found to be compressed from before backwards, or, better to express it, thinned off to an edge which is curved slightly forwards (see Plate IV. figs. 8 and 9). In the subsequent stages this edge is often developed into a more or less leaf-like lamina, which is folded over the anterior surface of the exposed portion of the ovule. This lamina varies very much in the extent of its development; it is usually small and irregularly shaped, as in fig. 13; but in one specimen which I possess, it is produced into a beautifully tapered point (Plate IV. fig. 14). This pro-

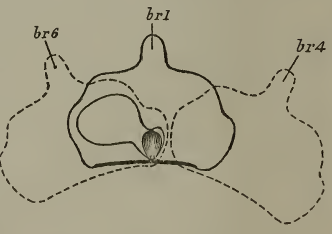
tion. Even the structure represented in figs. 1 and 2, although no doubt representing truly enough the essentials of the early stage, yet in minor particulars may not be perfectly trustworthy.

longation of the extremity of the ovule, although very curious, cannot I think be of much importance, either morphologically or physiologically, since it is comparatively late in its apparition, and, although of very frequent, is not of universal occurrence.

Regarding the subsequent stages in the development of the pistil, I need not say much. The ovule always remains exposed by the anterior and posterior notches between the apices of the carpels, but always to a relatively less extent as development advances. The apices of the carpels never project as style-like prolongations, but are closely applied to the sides of the ovule. (See figs. 12 and 13.)

In the flower represented in fig. 10, the unsymmetrical development of the wing-like margins of the pistil has commenced.

The *great* wing is developed sometimes on the right, sometimes on the left side of the pistil; but the side upon which it occurs is constant in any given cone. This, I find, is dependent upon, or at least correlated with, the direction of the generating spiral of the cone. *If the cone-spiral be from right to left (supposing the observer to be in the axis of the spiral), the wing is developed on the right side of the pistil; but if, on the contrary, the cone-spiral be from left to right, the wing is developed on the left side of the pistil.** The relation of the unequal development to the disposition of the scales may be briefly described as follows:—If we take a bract-scale—say No. 1 of the cone-spiral—we find that of the two bract-scales immediately applied to its upper or inner surface, No. 6 extends from one side to past its middle line, and entirely covers the flower of bract No. 1; while bract No. 4 extends from



the opposite side just to the margin of No. 6, without overlapping it. It would appear almost as if the development of the

* I have examined six cones with reference to this point—three with right-handed, and three with left-handed spiral—and all with the result stated above.

margins of the pistil was limited, on the one side by the margin of its own bract (No. 1), and on the other by that of bract No. 6; so that, according to the position to right or left of bract No. 6, so is the great wing developed on the right or left side of the pistil. Rarely, nearly equal wings are developed on both sides of the pistil.

The "scales" of the cone, as development advances, become much broader, with thin auricled margins at the base. A great increase in thickness occurs at the angle which the apex of the scale makes with the basal portion, so that the back of the scale at that part projects as a well-marked gibbosity. This thickening is precisely analogous to what is seen in the "scales" of *Araucaria*, where it is also well marked. In the furthest developed cone* which I have examined, this swelling is so great that the apices of the scales appear almost as if sunk among the gibbosities. Almost the only increase in the length of the scale, and that is considerable, occurs in its basal portion. To illustrate this last point, I have given a series of drawings representing longitudinal mesial sections of scales at different stages. During its growth the form of the cone becomes considerably altered. As before mentioned, it is oval at first; from this it passes to pyriform (in second season?); and, finally, it becomes oblately spheroidal, or orange-shaped.

In conclusion, I must express my regret that these observations are so imperfect. Indeed, I hesitated for some time whether I should publish any of these results before I could render them in some measure more complete. But when I reflected that possibly I might not have another opportunity of continuing the investigation, and that what facts I had observed were not without importance, I decided upon laying them before the Society.

Although I have not been able actually to demonstrate the perfect independence of the two carpels in their origin, yet I have shown sufficient to make it highly probable that they are so.

* One of those developed, as I suppose, in the summer of 1859, and picked in the middle of last month.

As regards determining the relations between the "scale" and pistil, it is unfortunate that I obtained no cones sufficiently young to allow of tracing the floral rudiment to its first origin. When, however, we review the phases in the development of the scale, and take note of the manifestly determinate or "basipetal" character of its evolution; when, in running the eye back upon the different stages, we find the basal portion becoming rapidly shorter, while the terminal portion remains comparatively stationary, until we find the attachment of the floral rudiment only $\frac{1}{70}$th of an inch from the base of the scale, I think we may confidently expect a still earlier condition in which the mammilla will be found to be actually at the base of the bract-scale, in the position of axillary bud. Add to this, the extreme improbability that a structure such as I have described in the female flower should be developed, *ab origine*, from a leaf, which the bract-scale certainly is, and the truth of the theory which I proposed as to a connation between the bract-scale and the peduncle of the flower, may be considered as virtually proved.

Description of Plate.

Fig. 1. Bract (*br*) from young cone of *Dammara australis;* with floral rudiment (*m*) close to its base.

2. Base of the same, more highly magnified, showing the floral mammilla (*m*).

3. Flower further advanced, showing the carpellary elevations (*cc*) on either side of the apex of the mammilla (*ov*), and which are almost free from one another at their bases.

4. A similar flower looked at towards the apex; *c c*, the two semilunar carpellary elevations, embracing the termination of the mammilla or ovule (*ov*).

5 and 6. A still further developed flower seen from the same points of view as the preceding. The carpel (*c*) are now very manifestly connected by their bases, and the ovule (*ov*) is more distinctly marked.

7. Young cone (natural size), whence the flowers represented in Figs. 5 and 6 were taken; (*a*), (*b*), (*c*), and (*d*), bud-scales, showing the transition between these and the "scales" of the cone.

8. Flower considerably further advanced than the preceding (its length being rather more than double of that represented in fig. 5). The ovule ("nucleus") (*ov*) is still exposed to a relatively great extent

from between the apices of the carpels (*c, c*). The extremity of the ovule is thinned off or compressed antero-posteriorly.

Fig. 9. Longitudinal mesial section of a flower, a little older than the preceding; (*br*) portion of base of bract, (*a*) anterior higher, an (*b*) posterior lower wall of the pistil. The extremity of the ovule compressed to an edge, which is slightly curved forwards, is well seen.

10. Flower considerably further advanced. The thin margin of the pistil on the left side is now becoming developed as a wing (*w*), while that opposite (*m*) remains small; (*ov*) ovule exposed between the apices of the carpels.

11. Longitudinal mesial section of a similar flower; (*br*), (*a*), (*b*), and (*ov*) as in fig. 9. The edge of the termination of the ovule (*ov*) has here become developed into a lamina (*l*), which is turned over upon the anterior surface of the exposed portion of the ovule.

12. Pistil much further developed (in second season ?); (*w*) the developed, and (*m*) the undeveloped, wing of the pistil, the great wing being here on the right side.

13. Portion of the extremity of the same, showing a small irregularly-shaped lamina (*l*) turned over upon the anterior surface of the exposed portion of the ovule, between the apices of the carpels (*c, c*).

14. Portion of the extremity of the nucleus from a flower of the same age, with its leaf-like process (*l*) elegantly pointed. The carpels have been removed.

15. Longitudinal section of bract, with its flower at a stage corresponding to fig. 5; (*br*) bract, (*fl*) flower.

16. Similar section, at a stage corresponding to that in fig. 9.

17. Similar section, corresponding to fig. 10.

18. Similar section, corresponding to fig. 12; (*p*) walls of pistil; (*ov*) ovule; (*x*) vascular bundle supplying the pistil; (*w*) mesial vascular bundle of the bract.

19. Similar section from cone in its third season (?).

Observations upon Sixteen Ancient Human Skulls found in Excavations made on the Kirkhill, St Andrews, 1860. By JOSEPH BARNARD DAVIS, F.S.A., &c. (With a Table of Measurements). Communicated to the Literary and Philosophical Society, St Andrews.

This series of fine skulls is of considerable interest from their unquestionable antiquity, the district in which they have been obtained, and from the peculiar aboriginal, or commonly named Celtic, air which pervades one section of them. This latter aspect it may be difficult to describe, but it will be at once apparent to the eye of an anatomist who has been accustomed to the examination of ancient British crania, and perhaps may be made obvious to others by reference to accurate figures of well-authenticated examples. The series divides itself into *two sections*—viz., those skulls derived from *cistic tombs*, and those found in *graves and other tombs*. Of the former, there are four specimens, Nos. 4, 8, 9, and 13; of the latter twelve, Nos. 1, 2, 3, 5, 6, 7, 10, 11, 12, 14, 15, and 16. Being requested by Mr Robert Walker of the University Museum, St Andrews, to make a few observations upon this series of skulls,—which it affords me much pleasure to do,—I will take a somewhat particular survey of them, making a note on any peculiarity I may observe, and add an enumeration of the sex, age, measurements, &c., of each in a table; and then proceed to any more general remarks that may suggest themselves; premising, *in limine*, that objects of this kind, discovered under circumstances which evince the period to which they have belonged to be uncertain, do not admit of that definiteness which imparts such special value and interest to some antiquities. The skulls may go some way towards determining the era and the race to which they have appertained; but the evidence they afford is to be taken cautiously, and not estimated at more than it is worth. Therefore more must not be expected from the proposed observations than approximate results. If approximate results can be attained with any degree of assurance, they will have a certain amount of interest, but they cannot fully satisfy a keen curiosity. To begin with the crania derived from *cists*.

No. 4 found on the north-west of the foundations of the church, in a cist the full length of the skeleton, and with the head to the west. One of the covering stones of this cist, that above the head, was thought to have some sculpture on its lower surface.

This is the globular skull of a man of advanced age, probably as much as seventy years, as the principal sutures are almost obliterated, and the bones are thin, notwithstanding the teeth have all been present, although considerably worn. It is a very decidedly *brachycephalic* skull, and exhibits considerable breadth both of face and calvarium. Its principal difference from the aboriginal series consists in its being more regular and equable, not so uneven and nodular; for instance, the frontal sinuses are not so prominent, and the nose does not descend so abruptly from a deep depression, as is usual in the aboriginal series.

No. 8 belongs to a skeleton which was found extended on the bottom of a rude cist, formed of undressed flags, on the southern side of the church. This skull is that of a man of about fifty-five years of age, and just enters into the *brachycephalic* series.* It is a thick heavy skull, with a particularly short and massive lower jaw, which is in some places eight-tenths of an inch in thickness; and it is remarkable for its small internal capacity—in truth, in this respect, it is the smallest of the sixteen skulls, although there is no doubt of its being the relic of a man. It presents that perpendicularity of the occipital region, common among the aboriginal skulls of these islands. It does not agree closely with any of the skulls figured in the "Crania Britannica," but somewhat resembles both that from the Caedegai Barrow in Denbyshire, plate 23, and that from Norton, in Yorkshire, plate 37.

No. 9, also derived from a skeleton lying in a rude stone cist near the last. This skull is that of a man about 75 years of age, and likewise just enters the *brachycephalic* series, although it presents much of the low swoln-out, discoid form which I have named *platycephalic*. The frontal sinus is prominent, and the nasal bones rise abruptly from a rather deep depression; the occipital region is also flat—all aboriginal forms. The cheek depressions are so unusually deep, that the cavities of the *antra* are encroached upon to a considerable degree. This no doubt is an indication of the great age of the individual. The skull closely resembles an ancient British specimen, derived from a barrow on Wetton Hill, Staffordshire, and figured in the "Crania Britannica," plate 12.

* It is desirable to state that I use this term to express the form, in a vertical aspect, of all crania in which the extreme transverse diameter is to the extreme longitudinal, as 4, or more, is to 5; or as 80, or more, is to 100.

No. 13, from a rude cist, is probably the skull of a woman of about forty-five years of age. It presents a good deal of resemblance to No. 8, but the face has apparently had pretensions to womanly beauty, and the nose has been aquiline.

In describing these skulls as having an aboriginal or Pictish air, it is not to be understood that they present *precisely* the same peculiarities of form as the skulls which are derived from the *short stone cists* of Scotland, belonging to the primeval period, one of which, from Kinaldy, in Banffshire, is figured in the "Crania Britannica," plate 25, and others in plates 15 and 16; but they appear, in the eyes of the writer, to have a tendency towards those peculiarities of form, whilst they are not precisely the same, and not so rude in their traits; indeed, they certainly do not differ from them materially. The average measurements of the three skulls of men, Nos. 4, 8, and 9, will be found to be slighly below the averages of twenty male skulls of the aboriginal series of the "Crania Britannica," which I have added to the table for comparison.

In approaching the *second section* of the skulls, or those derived from *graves or tombs*, of which Nos. 1, 3, 5, 6, 10, 11, 12, and 15, are all those of men, we are at once struck with their fine capacious appearance. This will be clearly apparent by an examination of their average measurements.

Nos. 5 and 12 are decidedly *brachycephalic*; No. 3 just comes within the *brachycephalic* category; and all the rest are *dolichocephalic;* No. 6, the largest skull of the whole series, deserving the name of *platycephalic.* It will thus be at once apparent, that, in this section of the skulls, the brachycephalic character is much less prevalent; so it is also with the other peculiarities which appertain to aboriginal crania. The boss over the frontal sinuses is not very prominent; the nasal bones do not descend very abruptly from a great depression; the forehead is of good size and elevation; the occipital region well developed and generally prominent; the entire calvarium is well and equally swollen out and smooth, a peculiarity mostly strange to the skulls of all aboriginal people; and the ovoid outline, when viewed vertically, greatly prevails among them. In the cases of the old men, Nos. 11 and 15, the cheek depressions are deep. The crania in this section approximate more to the form of the modern Scottish skull than those of the first section; indeed, we believe they resemble this form closely.

This section of the skulls does not lend any support to a doctrine maintained by phrenologists, and still more generally received, that the cranium undergoes a development or enlargement in the progress of society and the advancement of civilization—a doctrine which the examination of ancient skulls in general does not tend to confirm. I am persuaded that differences in size and form in human crania are more deeply rooted and more unchangeable, and that they depend on difference of race. The skulls of this section may be regarded as fine "domes of thought," and are equal in development to those of many modern Scotchmen. No. 6 is a cranium of even unusual capacity, which may be easily tested by applying to it the hats which fit the generality of heads; although denuded of soft parts, it will be found to fill them, or more than fill them. If an attempt were made to trace out the resemblances which may be detected among individual skulls of this section and those depicted in the plates of the "Crania Britannica," it would be found that these likenesses are apparent between them and the *Anglo-Saxon* series of the work, not the aboriginal series. Sometimes such resemblances are even striking, as between No. 10 and the Anglo-Saxon skull, derived from the cemetery at Firle, in Sussex, forming the subject of plate 29.

No. 5 presents a very unusual development of the lateral portions of the inferior semicircular ridge of the occiput, indicating the vigour of the *recti postici majores*, and other muscles which extend and turn the head upon the spinal column. The femur of this skeleton measured 19½ inches, so that the man must have been tall and powerful.

No. 12, a fine large brachycephalic skull of a young man, of probably about thirty-five, appears to have received a severe injury on the left side of the upper part of the frontal bone during life, producing a fracture five inches long, and a considerable loss of substance, with depression on one side.

No. 15 presents a certain degree of obliquity in the calvarium, most apparent on the right side of the occiput, which is flattened. I believe this is a *posthumous* distortion. It will be seen to have occasioned a slightly greater prominence on the right side of the frontal bone. It is this very kind of distortion which has been noticed so frequently in the skulls lately exhumed from the ruins of the Roman city of *Uriconium* (Wroxeter), and which has given rise to so much that is truly absurd, both in speaking and writing, respecting the monstrous barbarians, with one eye before the other, and with frightfully misshapen heads, supposed to have been engaged in the destruction of this city. As it is probable that the famous Picts and Scots effected the overthrow of the city of *Uriconium*, and as we are now engaged with ancient skulls, which show their relationship to the former people, and were excavated in their own land, there only needs a knowledge of the fact that a skull so deformed has been met with in a Pictish cemetery, to hatch in the brains of some antiquaries "confirmations strong as proofs of holy writ" in behalf of these fictions of the imagination, truly *monstrous* in absurdity.

So far, I have spoken of the skulls and the appearances they present on an anatomical examination only; and I have wished, in what I have said, expressly to avoid anything presumptive and dogmatical. A still more generally interesting subject remains, on which I shall only venture a few words. Many persons much more thoroughly acquainted with Scottish history than I can be, especially those versed in the history of the district and city from which these crania are derived, possess, I am persuaded, better information and ability than I do to arrive at any conclusion as to the antiquity of these interments, and the particular period to which they appertain.

All the interments apparently belong to Christian times, the bodies not having been placed in the pagan contracted position. There seems no ground for implicating any battle or any plague to account for their presence; on the contrary, they appear to be the usual burials of the people inhabiting St Andrews, who had come to their deaths by ordinary causes, and were brought by sympathizing friends to be laid in the grave, on a spot rendered sacred by the erection of a Christian church, and the supposed presence of the relics of St Andrew; as we know that it was the custom of this early age to inter bodies around, not within, places dedicated to religion. The fact that six of the persons interred are about or above seventy years of age, is decisively against either plague or battle, when we recollect that these occur in sixteen only. Many of the graves have contained the bodies of women, not warriors; and it appears, from what was observed in some cases, that a practice prevailed of interring the husband and wife in one tomb, which ever might die the first. We know that Christianity was propagated at an early age among the Picts; and also, that in this very district it was professed. It has been thought probable that near, if not upon, this hill, called the Kirkheugh, the first humble building dedicated to Christian service in Scotland was constructed.* Columba of Iona converted the Picts under their king, Bridei, before the middle of the latter half of the sixth century, a period at which this ancient aboriginal people may be considered to have received very small, if any, mixture of alien blood.† There does not appear to be any certain authority for determining the date of the foundation of a Culdee church at St Andrews; and it is believed that about, or at least, 250 years elapsed before such church was founded. Whether this were the earliest church or place of worship erected on the Kirkhill seems very doubtful. There is, however, no reason to suppose that even this building would be anything more than a structure of the simplest and rudest character,—perhaps scarcely better than those formed of wattles and mire in previous use,—for of such materials the best houses were built in the time of Columba, whose monks

* Martine, "Reliq. Div. Andr.," 1683, p. 24.

† "From this epoch, the Picts may be considered as Christians, a circumstance which seems not to have much changed their principles or much altered their customs."—*Chalmers's Caledonia*, i. 209.

were clothed in the skins of animals. The legend is, that Hungus, the king of the Picts, whose death is placed in the year 833, was the founder of the religious house of Kil-rule, or the Church of Regulus, who brought the relics of St Andrew to this spot.* How soon after this time the Christian people, who have so long occupied the rude cists in the Kirk-hill, were placed in them, as their last resting place, it is impossible to tell. From the inartificial character of these cists, which, I am informed on good authority, were constructed of undressed flags of the natural stone of the district, piled at the sides, with other stones of the same description covered over the top, but without any pavement at the bottom, and which seem to be only one stage in advance of the scarcely less rude, short, primeval cists of the unconverted Picts,—a step in advance taken in obedience to ecclesiastical rule for extending the body, with the face regarding the east,—I am inclined to conclude, that the interval of time to that at which these cists were constructed could not have been long, possibly not more than one hundred years. If we might rely with unhesitating confidence on the cranial relics of the cists, it is likely that the period of their formation was at least as early as that we have mentioned, when the Pictish blood was still pure, and that the relics of the cists belong to the ninth century, if not earlier. Those derived from the tombs and the graves are probably of a later age. In support of this view, we have both the superior construction of the tomb, with a further departure from the primeval cist, and the more modern aspect of the skulls. This latter seems to me to indicate an admixture of extraneous blood with that of the Picts. Judging from cranial evidence alone, and with the little knowledge I possess of the skulls of the Scandinavian nations, I am inclined to think that the mixture is not derived from a northern source—the Danes—but, more likely, from a *Saxon* source. Still this, like all the rest that I have said, I wish to be taken, not as by any means definite, but merely for as much as it may be worth. I fear that it may be

* Chalmers's Caledonia, i. 429.

thought that mine is but "a judgment maimed and most imperfect." I shall, however, be very happy if some one better informed will "amplify my judgment in other conclusions."

P.S.—On a revision of what I have previously written relative to the skulls from the Kirkhill of St Andrews, there are a few points which appear to stand out rather more strongly than I at first thought, and which afford a little more definiteness to the conclusions we may arrive at respecting both the period and people to which these crania have belonged.

In the first place, there seems to be good ground for considering this spot to have been used for funeral purposes from great antiquity, and during pre-Christian times. Three small places on the hill were found to be distinctly marked as the positions of fires, by ashes scattered about. One of them was surrounded with stones. These are probable indications of the rite of cremation. The want of orientation in some of the interments is a like indication of pre-Christian times. And the fact of one of the interments, *in a rude cist*, being situated within the foundations of the nave of the ancient church, brought to light by the recent excavations, proves that the site was used for sepulchral purposes before the erection of this church, the foundations of which alone now exist.

Upon the whole, it seems very probable that some of the cistic interments belong to *pre-Christian times*, and may date from the sixth century; others are clearly the sepulchral relics of *the early Culdees*, or the first Pictish converts to Christianity; whilst a third series of remains, or some of them, it is fair to infer may be those of *Anglo-Saxon or other Teutonic settlers*.*

* The Flemings, the great commercial people of that age, visited this eastern coast of Scotland much in the twelfth and thirteenth centuries, and settled in the towns. In the reign of William the Lion (1165–1214), St Andrews was inhabited by Scots, French, *English*, and *Flandrenses*.

Table of Measurements of Sixteen Human Skulls found in Excavations on the Kirkhill, St Andrews, 1860.

Number of Skull.	Grave or Cist.	Sex.	Age.	Internal capacity.*	Circumference.	Length.	Breadth.	Frontal Region. len.	Frontal Region. bre.	Frontal Region. hei.	Parietal Region. len.	Parietal Region. bre.	Parietal Region. hei.	Occipital Region. len.	Occipital Region. bre.	Occipital Region. hei.	Face. len.	Face. bre.	Inter-mastoid Arch.	Length of Femur.	
1	Gr.	♂	c 35	86·5	21·5	7·3	5·8	5·1	4·9	4·9	5·2	5·6	5·2	4·6	4·5	4·5	5·2	5·3	15·8	18·5	
2	Gr.	♀	c 45	67·0	20·2	7·0	5·5	4·8	4·7	4·7	5·1	5·2	4·6	4·6	4·6	3·7	4·3	5·1	14·9	16·5	
3	Gr.	♂	c 40	73·0	20·7	7·1	5·8	5·0	4·9	4·5	5·0	5·5	4·5	4·6	4·4	4·0	4·5	5·4	15·0	18·1	
4	Ci.	♂	c 70	78·0	20·4	6·8	6·0	4·9	4·8	4·5	4·8	5·5	4·7	4·7	4·4	4·0	4·5	5·3	15·0	18·2	
5	Gr.	♂	c 35	85·0	21·2	7·2	6·0	5·0	c	4·7	5·1	6·0	4·9	5·0	4·4	4·0	4·8	c	15·7	19·5	
6	Gr.	♂	c 70	92·5	22·6	7·9	6·2	5·6	5·2	4·9	5·7	6·1	4·9	4·8	4·8	4·3	4·8	5·2	15·2	18·8	
7	Gr.	♀	c 70	63·0	19·7	6·7	5·6	4·9	4·6	4·2	4·6	4·9	4·5	4·4	4·4	4·0	c	c	14·0	15·8	
8	Ci.	♂	c 55	62·5	20·3	7·0	5·7	4·8	4·4	4·6	5·0	5·3	4·6	4·6	4·4	3·9	4·1	5·0	14·7	18·0	
9	Ci.	♂	c 75	74·0	21·5	7·3	6·0	4·9	5·0	4·6	5·0	5·8	4·8	5·1	4·5	4·0	4·8	5·2	15·4	18·3	
10	Gr.	♂	c 55	86·0	21·8	7·6	5·7	5·4	5·2	5·0	5·0	5·6	5·1	5·0	4·5	4·3	4·8	5·3	15·6	19·2	
11	Gr.	♂	c 80	76·5	20·6	7·1	5·6	5·0	4·7	4·6	4·8	5·3	4·8	4·7	4·7	4·1	4·6	5·4	15·0	c	
12	Gr.	♂	c 35	77·5	21·0	7·1	6·0	5·0	4·8	4·8	5·0	5·7	5·0	4·8	4·7	4·2	5·1	5·6	15·6	19·8	
13	Ci.	♀	c 45	67·5	20·2	7·2	5·4	4·8	4·4	4·5	4·6	5·0	4·7	5·0	4·1	4·1	4·5	5·0	14·5	17·6	
14	Gr.	♀	c 55	80·0	21·5	7·6	5·7	5·1	4·5	4·7	5·5	5·1	4·8	4·6	4·6	4·3	5·0	c	14·5	c	
15	Gr.	♂	c 70	81·5	21·2	7·3	5·8	5·0	5·0	4·7	5·5	5·5	5·1	4·9	4·3	4·4	4·7	5·2	15·1	c	
16	Gr.	♀	c 30	72·0	20·1	7·0	5·4	4·8	4·6	4·5	4·8	5·0	4·6	4·6	4·1	3·7	4·6	5·0	14·4	17·5	
Averages of 4, 8, 9.	Ci.	♂		71·5	20·7	7·0	5·9	4·8	4·7	4·6	4·9	5·5	4·7	4·8	4·4	4·0	4·5	5·2	15·0	18·2	
Aver. of 1, 3, 5, 6, 10, 11, 12, 15.	Gr.	♂		82·3	21·3	7·3	5·9	5·1	5·0	4·8	5·2	5·7	4·9	4·8	4·4	4·5	4·8	5·3	15·4	19·0	
Aver. of both sections.		♂		76·9	21·0	7·1	5·9	4·9	4·8	4·7	5·0	5·6	4·8	4·8	4·4	4·2	4·7	5·2	15·2	18·8	
Aver. of 20 abor. skulls in Cr. Br.		♂		71·2	20·9	7·3	c	5·1	4·7	4·8	5·0	5·6	4·9	4·7	5·0	4·0	4·7	5·3	15·2	18·4	Averages of 20 male skulls of aborigines of British Islands depicted in the "Crania Britannica."

* Internal capacity is given in [illegible] All the other [illegible] are given in [illegible]

*Ancient British Caves. The Bee-hive Cave at Chapel Euny, and the Longitudinal Cave at Chyoyster, each built with overlapping stones.** By R. Edmonds, Esq.

The "bee-hive *hut*" constructed with overlapping stones, appears, from the paper of Sir J. Gardner Wilkinson in the last year's *Report* of this Institution, to be found in Cornwall only on Brown Willy. But no "bee-hive" *cave* seems to have been found any where except at Chapel Euny, on the west of Penzance. This cave, and the cave at Chyoyster,† on the north of Penzance, I have described in the *Report* of this Institution for 1857.‡ Having in that year, when in the neighbourhood of Chapel Euny, accidentally heard that an ancient cave had been opened by some miners, I went immediately to the spot, and observed that the innermost part of it was in the form of a bee-hive, and so built that each successive layer of stones projected considerably over the layer next below it. This led me to suspect a similar overlapping of the layers forming the walls of the longitudinal cave at Chyoyster, and having gone thither shortly afterwards with a neighbouring farmer, we found the stones overlapping one another in the manner I had anticipated. Prior to this no one appears to have noticed this very remarkable and most striking peculiarity. I will now add a few more particulars respecting these caves, both of which are built of uncemented stones unmarked by any tool. The longitudinal one at Chyoyster, or rather the exposed part of what remains of it, is internally about four feet wide at the roof, and the highest layer of stones which supports the massive slabs (five or six feet long) forming the roof, projects over the lowest layer, now in sight, about a foot on each side in a depth of three feet perpendicularly, so that when the soil now deeply covering the floor is

* Read at the Meeting of the Royal Institution of Cornwall on the 10th of May 1861.

† This village is called *Chysoyster* in the Ordnance Map, but I have omitted the fourth letter, as Martyn spells it without that letter in his very much older map of Cornwall.

‡ See also Edinburgh New Philosophical Journal for Jan. 1858, p. 146—the author's name being by mistake printed *Edwards*.

removed, it will probably be found that this cave is six feet deep, and that the top of each wall overhangs its base two feet. It extended originally, as appears from its remains and the rubbish left by its recent spoilers, fifty feet or more in a straight line up the sloping side of the hill. Nor was so long a cave, six feet high, four feet wide on the top, and eight feet wide at the bottom, a larger storehouse (if used as such) than so considerable a village as old Chyoyster required. It appears to have been built on the natural surface of the hill-side, and then covered over with stones and earth, and planted with the evergreens which still abound there. So much of the old village has been lately removed, that the cave, although originally within, now lies outside it, towards New Chyoyster. The pit in the centre of one of the old dwellings is a recent excavation.

The structure of this cave at Chyoyster is very different from that of the well-known cave at Boleit on the south-west of Penzance, six feet deep and thirty-six feet long. In the walls of the Chyoyster cave every successive layer overlaps considerably the layer next beneath it. The walls of the Boleit cave, on the contrary, are perpendicular, and none of the stones overlap, except where the capstone happens to be too short, in which case a stone or two on the top of the wall is projected a little to enable the short capstone to rest upon it.

Another longitudinal cave, constructed, like that of Chyoyster, with overlapping stones, as appears from the very small portion of it at present exposed to view, adjoins and opens into the "bee-hive" cave at Chapel Euny. In the "bee-hive" cave itself the now remaining highest circular layer of stones overhangs the lowest about three feet in a depth of about six feet.

Should a deputation from the Cambrian Archæological Association favour us with a visit next year, as is contemplated, I know of no antiquities in the west of Cornwall more worthy of their exploration, or more likely to reward them for their labour, than these caves near Penzance.

PENZANCE, 10th May 1861.

*Notes on Earthquakes and Extraordinary Agitations of the Sea.** By R. Edmonds, Esq.

I stated many years since that extraordinary agitations of the sea and of inland lakes are probably produced by vertical earthquake-shocks acting on the waters perpendicularly to the plane or surface of the ground on which they rest. The effect of such a shock in the bed of a canal would be not only to drive the water from its sides towards the centre where it would rise into a long ridge, but also to drive the water from its higher towards its lower end. In this latter case the water, when its momentum ceased, would flow back to the higher end, where, rising probably to a higher level than it had before, it would dam back any stream gently entering there. All this was exemplified in the Surrey Canal on the day of the great earthquake of Lisbon. That canal was 700 feet long and 58 broad. "The water at its higher end usually deepens from two to four feet, growing gradually deeper to the west end, where it deepens to about ten feet." At and near the higher (eastern) end the ridge of water raised in the centre was about ninety feet long, and between two and three feet above the usual level. This ridge heeled northward, and flowed over the walk on the north side of the canal; on the water's returning into the canal, another such ridge was raised in the middle which heeled southward, and flowed over the walk on the south side. During this second oscillation, the small stream at the higher end, which constantly flowed through the canal, was driven back thirty-six feet towards its source. This was considered† as *the effect of the second oscillation;* but *no oscillation from side to side* could have increased the depth at the higher end where the stream entered. It was probably the *second oscillation from end to end* that dammed back the stream, for *it* must then have reached the higher end of the canal, and deepened the water there. The *oscillations from end to end* no doubt escaped observation on account of the tenfold more striking oscillations *from side to side.*

* Read at the Meeting of the Royal Institution of Cornwall on the 10th of May 1861.

† Philosophical Transactions, vol. xlix. p. 354.

Every extraordinary agitation of the sea (unaccompanied with a known earthquake-shock) that I have read of, where the state of the weather is mentioned, has occurred during a thunder-storm, or at or near a minimum of the barometer; whereas earthquakes appear to take place equally in all states of the atmosphere. It is therefore important to ascertain why such earthquakes as are known only by the extraordinary agitation of the sea which they produce should occur exclusively during storms, or at or near minima of the barometer. Is it because submarine shocks are always vertical, while those on dry land are generally horizontal? In *vertical* shocks there may be electrical discharges between the earth and the atmosphere which might occasion the attendant minima, as in the case observed by Humboldt, where "the mercury was *precisely* at its *minimum* height at the moment of the third and last shock,*" whilst in *horizontal* shocks the discharges may be only between differently charged portions of the earth without much affecting the atmosphere.

Mr Mallet, in his first report on earthquakes, asks whether the reason why ducks in ponds often rush suddenly from the water immediately before an earthquake may not be, "that with their heads immersed they are able to hear the first distant mutterings while yet inaudible through the air?" But how can this be when sounds do not travel through the earth faster than shocks? It is true that earthquake sounds are often heard immediately before shocks are felt; but such sounds must have been produced, not by the vibrations which were afterwards felt, but by preceding vibrations which were not felt at all. The numberless rapid vibrations constituting a shock vary considerably in power, so that the weaker ones if they came first and reached no higher than the bottom of the pond, might have alarmed the birds before the stronger ones were felt on its banks. That shocks may reach ponds without being perceived by persons close by them was abundantly proved during the great earthquake of Lisbon.

Humboldt, at Cumana, felt an earthquake during a thunder-storm at the moment of the strongest electrical explosion; on the following day at the same hour was a violent gust of wind

* Personal Narrative, vol. iii., p. 319.

with thunder, but no shock; the wind and storm returned for five or six days at the same hour, almost at the same minute: and he states that such diurnal periodicities have been often observed at Cumana, and by M. Arago and himself at Paris.* I have observed periodicities equally striking, although the intervals, instead of being days, are lunations (29½ days each) or multiples of a lunation, and generally at the moon's first quarter. As these, as well as those observed by Humboldt, resulted probably from changes in the magnetic or electric state of the earth or atmosphere, which is periodically varying not only each day, but also according to the positions of the sun and moon in respect of the earth, it seems probable that at the end of each lunation, when the circuit is completed, and the sun, moon, and earth have returned to nearly the same relative positions as they had at the beginning, the magnetic or electric states of the earth and atmosphere, and the weather consequent thereon, would also be nearly the same at the end as at the beginning, subject only to such modifications as other intervening influences would occasion. These intervening influences are no doubt so considerable as to render it difficult to determine whether the examples referred to are merely accidental, or whether they depend in some measure on the relative positions of the sun, moon, and earth, and the locality of the observer. The very numerous examples, however, of lunar periodicities which I have given in the British Association Report for 1850 (Sections), p. 32, cannot, I think, be merely accidental. These are exclusively remarkable maxima of the thermometer. Other tables of remarkable lunar periodicities I have given in the British Association Report for 1845 and elsewhere, consisting sometimes of maxima and sometimes of minima, and sometimes of the barometer and sometimes of the thermometer, and it might therefore be objected that the proof of lunar influences would have been more satisfactory had the examples been all maxima or all minima of the same instrument. But it must be borne in mind that the weather being at all times dependent on the ever-changing electric or magnetic state of the atmosphere, must be very different in most respects immediately *after* a discharge (visible or invisible)

* Personal Narrative, vol. iii., p. 319.

of its electricity or magnetism from what it was immediately *before;* and a considerable maximum one day might be followed by a considerable minimum the next. Some have concluded that the moon has no sensible influence on the weather, because the means of the observations of the barometer or other instruments on the days of new and full moon, and of the quarters respectively, show no difference between any one of these four days and any other. But this proves nothing, as the change expected rarely occurs at the precise day owing to other influences retarding or accelerating it.

Others deny any such influence of the moon, because it is not apparent in the averages of the readings of each respective day of the new and full moon and quarter days conjoined with the two days before and the two days after it. But should any remarkable change occur, it could not be detected by such averages, as the maximum or minimum in the former part of these five days would be often neutralized by an opposite state of the instrument in the latter part.

The only way, therefore, of ascertaining whether the moon's first quarter is or is not most remarkable for excessive meteorological changes, is to refer each excessive or remarkable state of the atmosphere to such of the moon's four quarter-days as may be nearest, and then to compare the results.

On the Geographical Distribution of the Coniferæ in Canada.

By the Hon. William Sheppard, D.C.L., F.B.S.C., of Fairymead, Drummondville, Lower Canada.*

Pinus Banksiana (Gray Pine).†—This is essentially a northern pine, not having been observed south of the St Lawrence. It grows abundantly in Labrador, and up the north shore of the St Lawrence, among the rocks of the Laurentian formation. At St Paul's Bay it has taken possession of the

* Read to the Botanical Society of Canada, 14th June 1861, and communicated to this Journal by Professor Lawson, Secretary.

† Omitting the diagnoses, I give the botanical name from Dr A. Gray's "Manual of the Botany of the Northern States," a sufficient identification of the plants; the common names are for the most part local.

sand dunes near the shore. It appears again at Quebec, on the road to Caprouge, though now nearly all cut away. A few full-grown specimens are preserved in Mount Hermon Cemetery, as a memorial of an extensive grove formerly inhabiting that vicinity; the soil there being the shale of the Oneida sandstones. Proceeding upwards, we find it in some quantity on the sandhills at Three Rivers. This pine inhabits extensively that Laurentian tract of country between the headwaters of the Saguenay westward to Lake Huron, occupying the fissures of the rocks. It appears to thrive on the dryest and worst of soils. It attains a height of 40 to 50 feet, but is worthless for any economical purpose. The branches are open and distant, not making a picturesque object, except in connection with the wild scenery in which it delights to dwell.

Pinus rigida (Pitch Pine).—A scarce tree in Canada; found by Mr C. Billings near Brockville, and may be sought for with probable success in the Laurentian Hills, between that town and Kingston, and among the Thousand Islands. Possibly the *P. Banksiana* may also be discovered in the same locality. Its principal habitats are from Lake Champlain southwards.

Pinus resinosa (Red Pine; also, though improperly, called Norway Pine).—This pine is found in scattered localities on many of the tributaries of the St Lawrence and the Bay of Quinté, but in the greatest abundance at the headwaters of the Ottawa, growing in the poorest land. Very large quantities of this timber—principally from the last-mentioned tract of country—are yearly floated down to market at Quebec for exportation. It attains a height of from 60 to 70 feet; and the trunks are straight, and generally free from branches to the height of 30 to 40 feet. The timber of this species, if not quite equal, at least approaches in quality to that of the Norway Pine, which is obtained in commerce principally from the ports in the Baltic. Next, after white pine, it forms the greatest article of exportation from Canada. The young branches are well furnished with long leaves of a dark-green colour, giving the tree a massive appearance, yet it is wanting in picturesque effect.

Pinus Strobus (White Pine).—This pine is the most magnificent, and at the same time the most useful, of all our

Canadian trees. It grows scattered throughout the province, preferring richer soil than do the pines already mentioned; the quality of the soil causing it to be social or gregarious. The timber of the white pine furnishes by far the greatest article of exportation the produce of our forests affords. It is taken to market in the shape of square timber, of all sizes, from 12 inches to double that dimension, and in lengths from 20 to 60 feet, and more. Larger sizes are partially squared, to be afterwards wrought into masts and bowsprits, for which purpose it is admirably fitted, by reason of its lightness and strength. Large quantities are also floated to the many saw-mills scattered about the province, to be cut into planks and boards, principally for exportation, finding outlets from Quebec to Britain and Ireland, and by railroads and sailing craft to the neighbouring states. This pine is exclusively used in the province for carpentry and joiner's work for our buildings, being well adapted to all the purposes of house-building, easily worked, and generally free of knots. While this tree is the most useful and the largest product of our forests, it is the most picturesque of all those we possess, when growing in places where it has room to expand its massive branches from the ground upwards, densely clothed with foliage, and broken into great masses of light and shade, which the painter delights to contemplate. This tree is seen raising its head above all the other denizens of the forest, frequently attaining a height of 120 feet and upwards.

Pinus serotina (Pond Pine).—Dr Gray ignores this species, probably referring it to *P. rigida* as a variety merely, though he does not say so; other authors making it a distinct species. On the authority of Pursh, it is here adopted as a native of Canada. The latter botanist found it at Anticosti, on the occasion of his visiting that island in 1817. As this is a southern species, its having established itself on that northern island is a singular circumstance; yet Pursh was well acquainted with the pines of America, and could scarcely have been mistaken. On the same occasion he brought back, in the shape of dried specimens, a swell as in a living state, many plants which seem peculiar to the island.

Assuming the existence of this pine in Anticosti, we possess five species in Canada.

Abies balsamea (Balsam Spruce).—This tree grows sparingly throughout the province, on dry and rocky soils, in the company of the white and black spruce. It grows very symmetrically to the height of about 30 to 40 feet, spreading its branches around the stem, from the ground upwards, in regular tiers, forming a tapering pyramid. It is much grown as an ornamental tree, especially in the south, where it is a favourite object for lawns and plantations. The well-known Canada Balsam is the produce of this tree, showing itself in blisters between the wood and the bark. The timber is soft, and of little practical utility, except for fence rails and for the manufacture of butter firkins, for which latter purpose it is preferred to any other timber, in consequence of its communicating no unpleasant taint to butter.

Abies canadensis (Hemlock Spruce).—A large tree, growing abundantly throughout a great part of Canada, congregating densely on dry sandy soils little adapted for cultivation. The timber is coarse, and not much used for economical purposes, except for the walls of farm-houses and barns. A moderate quantity is yearly cut up into lathwood, and taken to Quebec for exportation, to meet the limited demand which exists for this article of commerce. The bark abounds in tannin, and is exclusively used in Lower Canada by the tanner, being a good substitute for oak bark.* This is a beautiful and picturesque tree, where it has free room to display its light spray and dark-green foliage, becoming varied in shape, and presenting large masses of light and shade. It is well worthy of a place in ornamental grounds.

Abies alba (White Spruce).—A straight pyramidal tree, attaining the height of about 50 feet: growing everywhere in dry grounds in the company of the black spruce, but in smaller numbers. The timber is light, on which account it is used in common with the next species for the small spars of shipping; it is also sawed into planks for exportation, being of a colour and texture resembling the white deal of Norway. The leaves are of a bright green, and are longer than those of the black spruce; the cones also are of a different shape. These marks serve to distinguish the two trees, which have a great general

* *Hemlock bark* is also exclusively used in the extensive tanneries in the neighbourhood of Kingston in Upper Canada.—G. L.

resemblance. It is a beautiful object on the lawn, with its graceful branches regularly feathered down to the ground.

Abies nigra (Black Spruce).—This is a somewhat taller and stouter tree than the last-described species, on which account it is more useful as a deal-producing timber, the quality being very similar. It is widely diffused throughout the country, grows on dry and rocky soils, and is generally found along with the white spruce, though in some localities inhabited by this species the other is absent. This is the tree from whose branches the well-known spruce beer is manufactured, a wholesome and pleasant beverage in warm weather.

Larix americana (American Larch, Tamarac).—The leaves of our larch are in bundles of many, and are deciduous, like its congener of the Old World. It delights in rich moist lands, where it attains the height of sixty feet and upwards, with a proportionately stout stem, straight and taper; it is found scattered throughout the province, growing in such abundance in favourable soils as almost to exclude other trees. It is also often seen in sandy soils, in which the moisture is retained by what are called "hardpans" underlying them, and preventing the escape of water; in such situations it grows thickly together, but attains no size, and dies off prematurely. This tree furnishes timber of superior quality, strong, heavy, and durable, answering well for railway ties, and admirably adapted for ship-building, for which purpose it is floated to market dressed on two opposite sides only. It also makes first-rate firewood for steamers, and is used extensively as such by those plying on our rivers.

This tree, when growing singly, forms a beautiful object, its slender, pendulous spray adding much to its gracefulness; it well deserves a place in ornamental grounds.

Thuja occidentalis (White Cedar; in Canada erroneously).—It grows in rich, moist soils everywhere, and on the banks of rivers, there taking a bowed shape, and crowding together, frequently to the exclusion of other trees. The foliage is of a dark olive colour, becoming foxey in winter. The wood furnishes the best rails and posts for fencing, being almost everlasting, except the portion sunk in the ground, where it is subject to slow decay.

Juniperus communis (Juniper).—A recumbent bush spreading on all sides from a common centre. Grows along the banks of the St Lawrence on both sides from Quebec downwards. On the plains of Abraham a single specimen is found. Upwards it is not met with till we reach the Falls of Chaudière in Hull, where a few specimens exist.* Foliage, light olive; berries blue, possessing the properties of the juniper berries of the North of Europe.

Juniperus virginiana (Red Cedar).—A small tree growing along the shores of the Upper Lakes. It appears to dread the severe climate of Lower Canada, for, with the exception of a few specimens at the Falls of the Chaudière in Hull, it is not found in this section of the province in the shape of a tree; but a variety with a dwarf prostrate habit grows on the rocks on both shores of the St Lawrence below Quebec, generally associated with the common juniper; the deep clothing of snow proving a protection to it in the severe winter weather of those localities, and in all probability causing its procumbent habit. This variety rises with a single stem, but, instead of assuming the shape of a tree, becomes quite prostrate, and is blown about in all directions by the wind. The timber of the tree, as growing in Upper Canada, resembles in texture, and has the fragrance of, *J. bermudiana*, with which lead-pencils are made; it is light, close-grained, strong, and indestructible: possessing these good qualities, it is much used for the ties of railroads.

Taxus canadensis (Ground Hemlock).—Our yew can scarcely be distinguished botanically from the European tree, its decumbent habit constituting the greatest difference between them. It grows in rich shady woods, steep banks of rivers, and dark ravines throughout the province, forming extensive patches in its favourite localities. It never rises to the shape of a tree like its namesake of England, therefore it is unsuited to the purpose for which our sturdy forefathers used this wood. It forms only a prostrate bush, the branches bending upwards. The berries are red, like those of the European species, yet I once found in a deep ravine a very marked variety, bearing white berries, partially translucent.

* It is also common about Kingston, and along the banks of the Gananogue River and connected lakes.

Physical Features of the Central Part of British North America, with Special Reference to its Botanical Physiognomy. By JAMES HECTOR, M.D., F.G.S., &c.*

The following paper is intended as a sketch of the botanical results of a Government expedition which was sent out in the spring of 1857 to explore the British territories lying in the neighbourhood of the northern boundary line of the United States, and stretching westward from Lake Superior across the Rocky Mountains. The expedition was placed under the command of Captain Palliser, who had previously travelled among the Indians in the district of the Upper Missouri and Yellowstone Rivers. His party consisted of Lieutenant, now Captain Blackiston, R.A., who had charge of the magnetical observations; Mr Sullivan, as secretary and assistant-astronomer to Capt. Palliser; M. Bourgeau, a botanical collector whose name must be familiar to the members of this Society who have had occasion to consult the Herbarium; and the writer of this paper, who filled the post of surgeon and naturalist. The expedition was in the field for three years, and in that time examined and mapped a region embracing 33° of longitude, and in some places 5° of latitude.

Physical Characters of the Area explored.—Commencing at Lake Superior, the route of the expedition for the first 600 miles to Lake Winipeg, crossed over a spur which diverges to the south-west from an axis of crystalline rocks that runs from Canada to the Arctic Ocean in a north-west direction, and known as the "Intermediate Primitive Belt" of Richardson, or the "Laurentian Axis" of Logan. This belt of rocky country nowhere acquires a mountainous character, but is throughout extremely rugged and traversed by innumerable watercourses, and by long narrow lakes. The greatest altitude passed over in this portion of the journey was 1000 feet above Lake Superior, or 1600 feet above the sea-level. The inequalities of surface, and the diversity in the nature and amount of soil, has given a greater degree of complexity to the flora of this district than we might expect from its other physical conditions. The winter experienced in this

* Read before the Botanical Society of Edinburgh, 13th June 1861.

region is severe, but steady. From the commencement of November till May the whole country is ice-bound, so that the vegetation is perfectly dormant. The spring is very lingering, owing to the great extent of surface occupied by water, and the neighbourhood of the large lakes on the one hand, and of Hudson Bay on the other, the slow melting of the ice which accumulates on these sheets of water keeping the temperature depressed till far on in the season. Thus, in crossing Lake Superior, on the 9th of June, the expedition encountered much cold weather, and got entangled in the ice floes that were, even so late in the season, drifting about the lake. The summer temperature is high, and for the same reason that renders the spring late, the autumn is prolonged beyond its normal extent, the influence of the large internal masses of water not having the effect of producing an equalised climate like that of a sea-coast, but merely prolonging the force exercised by the half-yearly extremes of heat and cold.

To the west of the Laurentian Axis commences the region of plains that extends to the eastern base of the Rocky Mountains, and north and south throughout the whole central district of the North American continent. In the neighbourhood of Lake Winipeg, the primitive rocks are overlaid by nearly horizontal strata of Silurian and Devonian age, consisting of limestones sometimes containing magnesia to such an extent that the soil derived from their decomposition must be of inferior quality. Excepting along the margins of the group of lakes that lie close to the axis, outcrops of these limestones are, however, rarely met with, the floor of the plateau being almost everywhere concealed by superficial deposits, consisting of sands, gravels, and marls, the bulk of which have been derived by denudation from the cretaceous strata that at one time must have overlaid the area now occupied by the chain of lakes that extends from Lake Winipeg to Great Bear Lake. A succession of steps, composed of these superficial deposits, and covered with a great profusion of erratic blocks, raises the level as we proceed westward, until, at an altitude of 1600 to 2000 feet, the finely assorted and well-mixed soils of the drift deposits cease, and the surface of the plain is occupied by strata of the age of the chalk, but formed of plastic and sandy clays much impregnated with sulphates, and yielding little or no soil that can support vegetation. In some localities sandstones prevail, which disintegrate with facility, and give rise to immense wastes of blown sand, that are continually, though slowly, travelling before the prevailing winds.

The whole prairie-slope of the continent is divided into two regions by a low watershed, which traverses it from east to west, nearly following the political boundary, which is the 49th parallel of latitude, and throwing off the drainage, south to the Gulf of Mexico, and north to the Arctic Ocean and Hudson Bay. This watershed is very indistinctly marked, and has been formed entirely by denudation of the soft strata, being quite unconnected with any disturbance of the rocky framework of the basin. The prairies are traversed by several large rivers, but, excepting the sudden carrying off of the surface water when the snows melt in spring, these rivers can hardly be said to drain the country through which they flow, as their waters are derived throughout the greater part of the year from the Rocky Mountains; and the excess of evaporation over the rain-fall is shown by the drying up in summer of those streams that do not rise in the mountains or from the swampy region along their eastern base.

There is one physical feature, which has an important bearing on the question of botanical distribution, the effect of which will be alluded to in an after part of this paper. This is the manner in which the plains are traversed by deep and narrow valleys, with abrupt slopes, and cut into the otherwise level, or only slightly undulating surface of the country. Those troughlike valleys, by favouring variety in the exposure, soil, and drainage, have afforded continuous lines for the migration and diffusion of plants through tracts of country, where the prevailing conditions are quite unsuited for their support.

The plains rise gently as the Rocky Mountains are approached, and at their western limit have an altitude of 4000 feet above the sea level. With only a very narrow intervening belt of hilly country, the mountains rise almost abruptly from the plains, and present lofty precipices that frown like battlements over the level country to the eastward.

When travelling in any of the transverse valleys, by which the chain is cut through almost to the prairie level, the mountains are seen to be composed of successive ranges formed by the escarpments of highly disturbed limestones and quartzites of palæozoic age.*

The average altitude of the highest part of the Rocky Mountains is 12,000 feet, but they never rise into marked peaks, and their cliff-like structure still further detracts from the grandeur of their appearance. The forest extends in altitude to 7000 feet; and as some of the passes are much under this elevation, the chain cannot be considered as a direct bar to the passage of the more striking kinds of vegetation.

Meteorological observations were obtained for the winter and spring seasons of both 1857–58 and 1858–59, at Fort Edmonton, which is situated in the plain country, and about 100 miles east of the Rocky Mountains, in Lat. 53° 32′ N., Long. 113° 20′ W., and at an altitude above the sea of 2000 feet.

In order to show more exactly the nature of the climate at these seasons of the year, the following abstract of the thermometric observations is given :—

I. *From Daily Observations, excluding Maxima and Minima.*

	Highest.	Lowest.	Range.	Mean.	No. of Observations.
1858. January, . .	45°·	−19°·5	64°·5	11°·2	62
... February, .	55·5	−41·5	97·	9·3	61
... March, . .	56·	5·	51·	34·9	93
... April, . . .	76·	24·	52·	45·1	90
... October, . .	53·	16·	37·	38·5	49
... November, .	47·5	−19·	66·5	27·1	85
... December,. .	29·8	−27·5	68·	− 2·9	93
1859. January, . .	42·	−26·	68·	12·	93
... February, . .	42·	−37·	79·	5·1	84
... March, . . .	44·5	− 2·5	47·	24·9	91
... April, . . .	65·	11·	54·	32·5	90
... May, . . .	64·	37·	27·	50·8	22
Mean for January, February, March, and April 1858, .					25·12
Do. do. do. 1859, .					18·62

* A sketch of the geology of this country will be found in the "Geological Journal." November 1861.

II. *From Daily Maxima and Minima Observations.*

	Maxima.		Minima.		Mean Temperature.
	Highest.	Mean.	Lowest.	Mean.	
	°	°	°	°	°
1858. January, . .	...	...	−22·5	−3·3	...
... February, .	...	...	−41·	−3·2	...
... March, . .	...	...	1·5	22·	...
... April, . . .	...	...	11·5	27·9	...
... October, . .	...	...	18·5	26·2	...
... November, .	52·	34·	− 2·	18·9	26·45
... December, . .	37·5	6·4	−25·	−14·	−7·6
1859. January, . .	45·	20·1	−35·7	− 1·	9·55
... February, .	43·5	13·6	−38·	−11·1	1·25
... March, . .	44·5	34·7	− 6·	11·4	23·05
... April, . . .	67·	41·8	0·0	20·4	31·1
... May, . . .	67·	58·6	31·	37·2	47·9
Mean of Minima for Jan., Feb., March, and April 1858, .					21·°7
Do. do. do. 1859, .					9·8

The climate of the prairies, and of the eastern slope of the Rocky Mountains, a district having a mean latitude of 53° N., differs in many respects from that of the Eastern Lake District, the mean latitude of which is about 48° N., although they possess nearly the same average temperature for the year. Thus, while the Canadian and Eastern climate is expressed by a low but steady winter curve of temperature, which is counteracted in its effect upon the vegetation by a correspondingly high summer curve, the manner in which the more northern and equally continental climate of the Western Saskatchewan acquires the same average, is by rapidly succeeding irregularities and variations of temperature, according to the direction of the dominant wind for the time. The influence exerted by those winds during the winter months was very clearly observed at Edmonton during the first part of the year 1858. They may be divided into three groups at this place:—1. The clear winds, that in winter bring the intense extremes of cold, and which blow from the north-west. In summer, this direction is exactly reversed, when it becomes a clear, hot, and dry wind. This may be considered as the proper continental current, and is the wind of fine steady weather. It often only affects the lower stratum of the atmosphere, the clouds being seen to pass right across it in upper air. This wind must not be too rigidly defined by its mere direction, as it often blows from anomalous quarters, while its character remains the same, being quite subordinate in form to either of the next two groups, which are both stormy winds.

2. This group includes all the winds that generally blow from between north and east, and which in winter bring snow, and in summer cold fogs.

3. The south and south-west winds, that, blowing from the Pacific Ocean through and over the Rocky Mountains, always bring clouds, warmth, and sometimes even rain during the winter.

The struggle among these three climatic agencies gives rise to the following succession of phenomena. A few days of fine, steady, though perhaps intensely cold weather, with the wind from the north-west, is followed by a slight rise in the temperature, caused by the north-east wind having piled a canopy of cloud over the lower stratum, and so preventing radiation. This is effected gradually, every morning the sky being more and more overcast, and clearing later in each successive day, until at length it remains cloudy till evening, when a cutting north-east wind commences, that soon increases to a storm, followed by snow. This lasts for two or three days, till the snow begins to fall more gently, and with the temperature rising, at length the clouds break, when the upper stratum of air is seen moving rapidly from the south-west, carrying light fleecy clouds against a clear sky. Generally, in the course of the following night, the south-west wind affects the lowest stratum of air, and increases in violence, sometimes ranging rapidly through many points of the compass, showing that it takes the form of a cyclone, and at the same time bringing a high temperature and dense clouds discharging rain. One of these storms, for instance, passed over the Saskatchewan Plains on the 3d of January 1858; and at Edmonton the *minimum* temperature for that day and night was 36°, while the *maximum* for the next twenty-four hours was only 10°. Again, on the 24th of the same month, at the close of another of these storms, the temperature fell from 37° at 4

P.M., to 13°.5 before midnight, or a difference of 50°.5 in eight hours.

After the storm from the south-west has passed, the light north-wester generally sets in irregularly, and the temperature falls in the course of a few days to an extreme, during which there is calm, followed by the haze and the overhanging cloud from the north-east as before.

Along the eastern base of the Rocky Mountains these changes are even more distinctly marked than in the longitude of Edmonton, and the effect they have in reducing the amount of snow is very remarkable, so that there is a narrow tract close to the mountains where there is never more than a few inches of snow on the ground, and the rivers, when rapid, remain open during the winter. In consequence of this, a few ducks are found to linger throughout the whole season in the mountains, while from the Plain country, in latitudes much further south, they are necessarily absent from October till May. Forty miles east of the mountains the snow-fall is much increased, but during the depth of winter rarely exceeds two feet in depth. From the prairies the snow evaporates rapidly, and excepting in hollows where it drifts, it never accumulates; but in the woods, where protected, it often reaches the depth of three to four feet towards spring.

During the steady cold of the winter the ground freezes to a considerable depth, especially in seasons when there is a small fall of snow. Thus at Edmonton the limit of the frozen soil was found on the 5th of March 1858 to be at the depth of nearly seven feet; and in the same spot in the year following, on the 16th of March, it was marked at six feet. Regular observations were taken during both winters, and also when travelling in the plains, for the purpose of ascertaining the temperature of the soil at the depth of two or three feet, according to the method suggested by Dr Hooker. The following table gives the means of these observations:—

1857–8, *Fort Carlton.*

Month.	Mean Temp. of Air.	Mean at Two Feet.	Mean at Three Feet.
November, . . .	17°·3	35°·8	36°·6
December, . . .	8·9	30·4	32·8
January, . . .	0·0	23·4	29·3
February,* . . .	7·4	18·3	24·3
March, ...	26·3	24·6	25·3
April, ...	35·8	30·3	30·2
May, ...	45·0	33·8	31·6
June,†	54·9	38·6	33·8
	1858–9, *Fort Edmonton.*		
November,‡ . . .	26·45	35·7	Not observed.
December, . . .	7·6	23·4	
January, . . .	9·55	20·8	
February, . . .	1·25	17·6	
March, ...	23·0	25·2	
April, ...	31·1	30·3	
May,§	47·9	32·1	

(The thermometers were sunk in brass tubes attached to a light wooden rod, and had the bulbs protected with flannel, to preserve them from the influence of the atmosphere while they were removed for examination.)

At Fort Carlton observations were also made by M. Bourgeau almost daily, in order to determine the temperature within the trunks of large trees. For this purpose thermometers were placed obliquely into the heart of a *Populus balsamifera* two feet in diameter, and of an *Abies alba* of the same size. These observations only served to show that, as might be expected, the temperature of the trees accords much more closely with the mean temperature of the atmosphere than does that of the soil, even at the depth of only two feet; and further, that there is no marked difference at very low temperatures between the resisting power of evergreen and deciduous trees. The means of these observations were as follows:‖—

* First seventeen days only.

† First eight days only.

‡ From 9th to 30th.

§ First eight days only.

‖ Some of these observations have been printed in the Proceedings of the Linnean Society, 1859.

Month.	Air.	Poplar.	Spruce.
1857. December, .	8°9	9°67	13°63
1858. January, . .	0·0	0·	0·8
... February, .	7·4	7·11	3·96
... March, . .	26·3	29·27	20·93
... April, . .	35 8	35·54	...

So long as the vegetation remains dormant during the winter season, the sudden changes which have been described, however great, can have little influence upon plant life; but when the mean temperature for the twenty-four hours rises above the freezing-point, and the powerful sun of each day, with the abundant moisture derived from the melting of the snows, stimulate the ascent of the sap and the germination of seeds, these sudden alternations must have a very baneful effect, and exclude from the flora of the country many plants that it would otherwise be quite fitted to sustain. From the middle of March until the third week of April is the usual duration of this critical period; but as late as the middle of May serious damage is frequently done to the vegetation by sudden variations of the temperature. This is without taking into consideration the night frosts, which are of common occurrence almost throughout the entire summer, and which, of course, must completely prevent the growth of many kinds of plants.

During the summer months, even in the true prairie country, rain, with cloudy weather, is much more frequent than might be expected from the position which the district occupies in the centre of a continent, and barred from the influence of the moist south-west winds by a continuous chain of mountains. On the prairies immediately to the west of the Red River settlement, as far as Turtle Mount, thunder-storms, with heavy rains, are of almost daily occurrence during the months of July and August. The temperature in that district was often very high, the thermometer several times reaching 95° in the shade.

On the higher plains to the west, between Carlton and the Rocky Mountains, which range in altitude from 2000 to

3000 feet, thunder storms are more rare, yet a good deal of rain falls. During the latter half of June 1858, there were nine days of rain and cloudy weather to six of fine clear sky. The mean temperature for the same period was 58°·8, from observations taken at sunrise, 2 P.M., and sunset, the highest recorded being 72°, and the lowest 46°. This excludes the minimum night temperature, however, which often fell within a few degrees of the freezing point. The mean degree of moisture in the atmosphere was 0·64, saturation being 100. During the month of July in the same year there were twelve days of cloudy sky and rain. The mean temperature was 59°·5, the extremes recorded being 70° and 40°, with the degree of humidity 0·59, or rather less than in June.

In August, in the district along the base of the mountains, having an altitude of nearly 4000 feet, the mean temperature was 54°, and the extremes recorded as occurring between sunrise and sunset were 79° and 40°·5. Almost every night, however, we found that ice formed in the kettles, and that the ground was covered with hoar-frost.

The radiation, as might be expected, is very great during the summer nights in the northern prairies, so that when the sky is clear the quantity of dew that forms is great in proportion to the degree of moisture in the atmosphere. It is owing to this, combined with the sharp frosts in August and September, which arrest the sap before the grasses have fully flowered and faded, that the rich pasture along the North Saskatchewan plains is preserved green and juicy until the snow falls, after which the hard steady winter keeps it fresh and nutritious as artificial hay until the return of spring. Along the South Saskatchewan the country is arid, and without such pasture; but in travelling in that region, no marked difference was observed in the frequency of rain-clouds during the summer than when further to the north; and that a considerable amount of moisture passes over these plains is proved by the marked increase in the vigour of the vegetation on the high and isolated patches of table-land which are scattered over the arid country. It is probable that the prevalence of a hard clay soil, formed from the cretaceous strata, which bakes under the heat of the sun from the want of moisture in early spring, is the immediate cause of this barrenness. The little snow which falls on the open plain is at once swept off by the wind and evaporated during the winter, so that in spring the clear powerful sun at once bakes the soil and prevents the germination of seeds.

The weather experienced in the Rocky Mountains was very irregular, with a great daily range of temperature. Thus, in the end of August the thermometer during the night was as low as 14° at an altitude of 6000 feet, and almost every night it fell considerably below the freezing point, although during the day it often reached 70° to 80°. In the valleys of the eastern slope the amount of rain-fall is very small compared to that on the first part of the descent to the west, when fine weather is the rare exception even in September. This only applies, however, to the mountains north of the fifty-first parallel of latitude, south of which, for some reason, the rainfall on the western slope in the valley of the Kootani River must be much less, judging both from the experience of two seasons and from the nature of the vegetation, which is of the arid type.

On the eastern slope, throughout the entire summer, there are occasional falls of snow at altitudes above 5000 feet; but snow never lies deeply at any season. It is only on the various "heights of land" which have an altitude of from 6000 to 7000 feet, and for the first few miles of the western descent, that snow appears to accumulate in the valleys in large quantities—sometimes to the depth of 16 to 20 feet. The higher valleys of the central mass of the mountains are occupied by glaciers, some of which are of very considerable size, even when resting on the eastern slope. They are, however, fed principally by the snows that accumulate on the western slope, so that when ranges equally high are cut off from the influence of the western moisture, no glaciers have been formed. This exactly conforms to what has been observed by Dr Hooker and others regarding the diminished altitude of the snow-line as the nearest seaboard to a range of mountains is approached.

In the Latitude of 49° the country to the west of the Rocky Mountains is very rugged and mountainous for the whole distance to the Pacific coast. South of that parallel, however, there are great expanses of desert plain, owing to the influence of the Cascade Range of mountains, which forms almost an unbroken wall 4000 feet in height, running parallel to the coast, and cutting off the moisture from the interior. In descending to the westward, therefore, from the Rocky Mountains, into the depression that intervenes between them and the Cascade Range, a belt of moist climate is met with where the winds that have passed over the coast-range first strike on the higher and interior range. Then follows a belt of dry climate, increasing in aridity as we proceed westward, and get more completely sheltered by the coast range, but on crossing which we at once get into the humid climate of the Pacific coast, with its wonderful development of forest growth.

Having thus briefly sketched the leading physical peculiarities which influence the character of the vegetation in the region treated of, I shall next give a short outline of the manner in which authors have divided British North America into botanical areas, and endeavour to show the position which the country explored by the Expedition occupies among them, as indicated by the collections of M. Bourgeau and by the physiognomy of its vegetation.

The collections made by M. Bourgeau were forwarded to England from time to time, and were duly received by Sir William Hooker at the Royal Botanic Garden at Kew. They consisted—1*st*, Of plant specimens prepared for preservation in the herbarium; 2*d*, Seeds and roots of plants for culture, many of which have been successfully raised at Kew; 3d, Specimens of the vegetable products used in the country by the Indians, and which are preserved in the Kew Museum of Economic Botany. M. Bourgeau also made collections of insects and shelled mollusca, all of which were forwarded to the British Museum.

Of the dried plants, there were in general twelve specimens of each species sent home, and the duplicate sets have been distributed to the various public herbaria in Europe and America, including that of our own university, each specimen having been named before its issue from Kew by Mr Black, curator of the Herbarium there, who prepared the list under the superintendence of Dr Hooker.

The collection of flowering plants and ferns consists of 819 species, belonging to 349 genera and 92 orders, which is more than two-fifths of the total flora of British North America. In the list, there are 62 species returned as undetermined, some of which will most likely prove to be new. In the relative order of their importance, from a number of species, the principal families stand thus :—

Compositæ form $\frac{1}{7}$th of the whole.
Cyperaceæ ... $\frac{1}{12}$th ...
Gramineæ ... $\frac{1}{16}$th ...
Leguminosæ ... $\frac{1}{16}$th ...
Rosaceæ ... $\frac{1}{16}$th ...
Ranunculaceæ $\frac{1}{26}$th ...
Cruciferæ ... $\frac{1}{26}$th ...
Salicaceæ ... $\frac{1}{28}$th ...
Scrophulariaceæ $\frac{1}{28}$th ...

The following analysis of the collection will give a further idea of the general nature of the flora of the country from which it was made.

Orders.	No. of Genera.	No. of Species.	Of which undetermined.	In British North America.	
				Genera.*	Species.*
Ranunculaceæ, . .	11	32	...	18	72
Menispermaceæ, .	1	1	...	1	1
Berberideæ, . .	1	1	...	3	5
Sarraceniaceæ, . .	1	1	...	1	1
Nymphæaceæ, . .	1	1	...	3	4
Papaveraceæ, . .	1	1	...	3	3
Fumariaceæ, . .	1	2	...	4	9
Cruciferæ, . . .	14	31	7	25	104
Capparideæ, . .	2	2	...	2	2
Cistineæ, . . .	1	1	...	3	5
Violaceæ, . . .	1	8	...	1	18
Polygalaceæ, . .	1	3	...	1	7
Droseraceæ, . .	1	1	...	2	9
Lineæ, . . .	1	2	...	1	3
Caryophylleæ, . .	6	17	3	12	66
Paronychieæ, . .	1	1	...	2	2

* These columns are given for comparison from Sir John Richardson's "Arctic Searching Expedition, 1851," vol. ii. p. 322. It is hardly necessary to remark that in this and the other works of this veteran explorer and philosopher, will be found generalizations respecting the climate and vegetation of British North America which the results of this expedition have only served to establish and apply for a very small area of the region which he treated of.

Orders.	No. of Genera.	No. of Species.	Of which undetermined.	In British North America.	
				Genera.	Species.
Malvaceæ, . .	1	1	...	3	5
Tiliaceæ, . . .	1	1	...	2	2
Hypericineæ, . .	1	1	...	1	8
Acerineæ, . .	2	3	...	2	8
Oxalideæ, . .	1	1	...	1	5
Geraniaceæ, . .	1	4	...	2	6
Balsamineæ, . .	1	2	...	1	2
Rhamneæ, . .	2	2	...	2	6
Anacardiaceæ, . .	1	2	...	1	6
Leguminosæ, . .	13	50	7	26	98
Rosaceæ, . . .	16	48	7	24	124
Halorageæ, . .	3	4	...	4	10
Onagrariæ, . .	3	13	2	6	28
Cucurbitaceæ, . .	1	1	...	2	2
Cactaceæ, . . .	1	4	4	1	2
Loasaceæ, . .	1	1	...	1	3
Grossulariaceæ, . .	1	7	...	1	16
Saxifragaceæ, . .	4	15	...	8	56
Crassulaceæ, . .	1	2	...	2	3
Umbelliferæ, . .	10	14	1	28	39
Araliaceæ, . .	1	3	...	3	7
Loranthaceæ, . .	1	1	...	1	1
Corneæ, . . .	1	4	...	1	7
Caprifoliaceæ, . .	6	13	...	7	24
Rubiaceæ, . .	2	5	...	5	15
Compositæ, . .	40	112	8	70	321
Valerianaceæ, . .	1	1	...	2	6
Campanulaceæ, . .	1	2	...	1	8
Lobeliaceæ, . .	1	1	...	1	6
Vaccineæ, . . .	2	5	...	1	16
Ericaceæ, . . .	7	9	...	10	40
Pyrolaceæ, . .	2	4	...	5	16
Primulaceæ, . .	7	10	...	8	23
Oleaceæ, . . .	1	1	...	1	3
Gentianaceæ, . .	2	6	...	8	34
Apocyneæ, . .	1	2	...	1	4
Asclepiadeæ, . .	2	5	...	1	11
Polemoniaceæ, . .	3	5	...	3	13
Hydrophylleæ, . .	1	1	...	2	5
Convolvulaceæ, . .	1	1	...	3	6
Solaneæ, . . .	2	5	2	5	8
Boraginaceæ, . .	8	17	2	5	27
Labiatæ, . . .	9	9	...	24	40
Verbenaceæ, . .	1	1	...	2	7
Scrophularineæ, . .	7	24	2	20	74
Lentibularieæ, . .	2	2	...	2	8

Orders.	No. of Genera.	No. of Species.	Of which undetermined.	In British North America.	
				Genera.	Species.
Plantagineæ, . .	1	2	...	1	5
Nyctagineæ, . .	2	2	...	2	3
Polygonaceæ, . .	4	14	...	5	34
Amaranthaceæ, . .	1	1	...	1	6
Chenopodeæ, . .	8	17	1	8	20
Santalaceæ, . .	1	2	...	1	2
Elæagneæ, . .	2	3	...	2	3
Aristolochiaceæ, .	1	1	...	1	1
Euphorbiaceæ, . .	1	1	...	2	8
Cupuliferæ, . .	3	4	1	5	15
Salicaceæ, . .	2	31	...	2	48
Cannabinaceæ, . .	1	1	...	2	2
Urticaceæ, . .	3	3	...	4	8
Betulaceæ, . .	2	4	...	2	11
Coniferæ, . . .	5	13	4	7	20
Typhaceæ, . .	2	3	...	2	4
Aroideæ, . . .	3	3	...	6	9
Naiadaceæ, . .	2	4	...	4	14
Alismaceæ, . .	3	5	...	2	3
Hydrocharideæ, .	1	1	...	2	2
Orchideæ, . . .	8	13	...	16	54
Irideæ, . . .	2	2	...	2	8
Liliaceæ, . . .	11	20	...	16	45
Melanthaceæ, . .	4	4	1	5	5
Juncaceæ, . . .	2	13	3	2	23
Commelynaceæ, . .	1	1	...	0	0
Cyperaceæ, . .	5	68	4	8	218
Gramineæ, . .	33	62	...	49	153
Filices, . . .	13	17	...	17	47
Lycopodiaceæ, . .	1	4	...	2	12

Summary of above.

1. In M. Bourgeau's collection,

819 species.
349 genera.
92 orders.

2. Of the same orders there have been enumerated by Richardson, as occurring in British and Russian North America—

471 genera;
2155 species—

the total flora which he enumerates; comprising

118 orders;
509 genera;
2270 species;

viz., 1725 dicotyledons and 554 monocotyledons.

In treating of the distribution of plants in British North America, Sir John Richardson* has divided the region into three zones, in the following manner:—

1. The Polar Zone, which embraces the land lying detached from the continent, and north of Lat. 73°. The flora of this zone consists of plants belonging to 21 natural orders, among which the *Cruciferæ*, *Gramineæ*, and *Saxifragaceæ*, are the principal.

2. The Arctic Zone, which extends from the above-mentioned limit south to the Arctic Circle, excepting towards the eastern side of the continent, when, owing to the configuration of the land and the abnormal depression of the temperature, the characteristic Arctic flora passes for 10° south of that limit. An outlier from this flora also passes the south along the ridge of the Rocky Mountains. The number of natural families is in the Arctic Zone increased to 67, and the most marked feature is the predominance of *Cyperaceæ*.

3. The Woodland Zone, which stretches across the continent obliquely, conforming to the divergence of the Arctic Zone from its proper latitudes, and thus lying between 45° and 55° of latitude on the Atlantic coast, but between 50° and 60° of latitude on the Pacific coast.

This zone he divides into three districts—

1. The Eastern Woodland district of Canadian Forest, which extends westward as far as Lake Winipeg.
2. The Western Woodland district, from the Pacific coast to the Rocky Mountains.
3. The Central or Plain district, lying east of the Rocky Mountains.

The number of natural orders represented in this zone is about 117, being an increase of 50 over the number in the Arctic Zone.

As M. Bourgeau returned to England at the commencement of the third season's explorations without crossing the Rocky Mountains, his collection only consisted of the plants gathered from between Lake Superior and the eastern slope of that range. It thus represents a portion of Richardson's Eastern district, nearly the whole of the Prairie district that

* Arctic Searching Expedition 1851, vol. ii. App. No. 3.

lies within the British territory, and the alpine and subalpine district of the Rocky Mountains.

Until a thorough and critical analysis of the whole flora is accomplished, we cannot however expect much light to be thrown by the method of tabulation on the natural affinities which the floras of the different areas bear to one another; and till then it is therefore safer, in adapting provisional geographical groups, to rely more on the nature of the forest growth and such evident characters that catch the eye of the traveller. Such an analysis has however been recently effected for the flora of the northern part of the continent in a highly philosophical memoir by Dr Hooker ("Outlines of the Distribution of Arctic Plants," read before the Lin. Soc. of London, June 21, 1861). His work has yielded most important results, modifying the generally received opinion of the uniformity of the Arctic flora throughout every longitude; and by tracing its distribution, he has found strong grounds for supporting the theory first promulgated by the late Edward Forbes, of a southern migration of northern types having taken place during the cold of the glacial epoch, and also of Darwin's view of the high antiquity of the Scandinavian Flora.

With regard to the northern flora of the American continent, Hooker has modified the areas described by Richardson, in so far as not distinguishing between an *Arctic* and a *Polar* flora, but merely dividing the whole region into an "Arctic West American Flora," which extends from Behring's Straits to M'Kenzie's River, and an "Arctic East American Flora," which extends from that river to Baffin's Bay, but excludes Greenland, the flora of which he shows to belong to a European and not to an American type.*

Bearing in view the leading physical features of the country which have already been alluded to, and to the general botanical divisions that have been quoted, I shall now follow the course of the expedition, and briefly sketch the features of the vegetation observed along the route.

The canoe route from Lake Superior to Lake Winipeg, by which the spur of the eastern axis was crossed, passes

* I am indebted to the kindness of Dr Hooker in letting me have an opportunity of studying this valuable memoir while passing through the press.

through a country that is on the whole heavily timbered, but the quality of the forest varies a good deal with the soil and elevation. Thus, round Thunder Bay, on Lake Superior, the ash, elm, maple, and cedar, with a rich undergrowth of rosaceous shrubs, are met with in addition to the white spruce, larch, pines of several species, birch and poplars; but on the high lands round Dog Lake, elevated 1500 feet above the sea, the forest consists almost entirely of the latter trees. In descending to Rainy Lake, the more valuable timber reappears, wherever the soil is favourable to its growth, and such trees as *Pinus resinosa*, *P. Strobus*, and *Cupressus thyoides*, sometimes reach a large size. From Rainy Lake to the Red River Settlement, the forest becomes more varied and richer in its character, comprising elms, oaks, ash, basswood, (*Tilia americana*), beech, and ironwood (*Ostrya virginica*), but still with a large admixture of Coniferæ. In this district the undergrowth is very luxuriant, many of the shrubs of the Northern States occurring plentifully. On the borders of the lakes and rivers, the Indian rice (*Zizania aquatica*) is abundant, the grain of which, along with fish, forms the principal food of the Salteau Indians.

In proceeding due west from the Red River Settlement, the Prairie country is at once entered upon, being bounded to the north by the wooded country, the limit of which nearly follows the isothermal mean of 41° in a northwest direction, until it reaches the 109th meridian in Lat. 53° N.,* when it sweeps again to the south-west to intersect the Rocky Mountain chain in Lat. 51°. The country to the north of the 49th parallel, and up to the 55th, which was the region examined, is thus boldly marked into two districts by the presence or absence of timber. A third district must however be also considered, forming a belt dividing the forests from the true plains, and which at one time was itself forest-land, but having been cleared by the successive devastations of prairie fires, it now combines the advantages of both, having extensive ranges of open land like the prairies, which possess the rich vegetable mould, and

* It is probable that this isothermal, as generally represented, does not sweep enough to the south after crossing the Rocky Mountains from the west when passing through Long. 114° to 96°.

are covered with the nutritious grasses and leguminous plants of the forest country.

The woodland country which bounds the plains clearly possesses the physiognomy of the sub-arctic province. The most prevalent tree is the *Abies alba*, which only reaches any great size in river valleys. On the dry rising grounds grows the *Cyprès* of the Canadian voyageurs; but under that name they include two different species of pines—*P. Banksiana*, and a pine allied to the *P. inops* of the United States, or to the *P. contorta* of the Pacific coast. A few of this latter species were seen near Fort Carlton, after which they were not again met with on a due west line until near the Rocky Mountains, south-west from Edmonton. The most important though not the most plentiful tree of the wooded country is the birch (*Betula papyracea*), as it is the only hard wood which the natives possess, and is used for making dog-sleighs, snow-shoes, and other necessary articles. These trees, with a few larches, balsam firs (*A. balsamea*), red pines, poplars (*P. balsamifera*, and *P. tremuloides*), comprise the bulk of the forest that covers the country to the north of the Saskatchewan; but by the sides of the rivers, which have generally deeply depressed valleys, there is of course a much greater variety in the vegetation, owing to the sheltered situation and the rich soil.

The belt of partially cleared country which lies to the south of the forest-land, and stretches continuously from the Red River Settlement to the Rocky Mountains, averages 80 to 100 miles in width, but it expands very much towards the west, owing to the bend which the southern border makes to the south-west. In this district the woods are very scanty, and consist almost exclusively of the aspen poplar, which forms small groves and artificial-looking clumps that dot rich pasture lands. Sometimes a small clump of spruce fir has been left by the fires, but this is only in a few rare localities, at least when at any distance from the limit of the true forest. Between Carlton and Edmonton, along the Hudson Bay Company's trail, for a distance of nearly 400 miles, there are not more than five or six spots where any of the Coniferæ have been left. The clearing of this country is due to a very simple cause. The prairie tribes of Indians, 15,000 to 16,000 in number, live wholly by the chase of the buffalo, and prefer, in consequence, to pitch their tents along the edge of the woods, for the sake of shelter, and at the same time to be near their game. Either by accident, or for the purpose of making signals, the prairies round their camps are generally burnt every few years, and, as a rule, where coniferous trees are destroyed, they are never replaced by the same stock; but the rich alkaline soil is at once seized upon by the wafted seeds of the aspen poplar, to the exclusion of other trees.

It is true that similar fires take place in the thick wood country and in the forests of the Rocky Mountains; but although they do much damage, the chance of their recurring on the same spot within a short enough time completely to remove the timber is small. Where the poplar seeds cannot reach such burnt spots, they are usually crowded with the gaudy plants of *Epilobium angustifolium*, among which the young pine seedlings can gain a footing, so that the forest often reverts in such a case to the coniferous type; but the thickets which spring up, strangely enough, very seldom contain plants of *Abies alba*, but almost invariably consist of the Pine which I have alluded to as allied to *P. inops*.

The Saskatchewan and other rivers of the prairies flow through valleys rarely a mile in width, and excavated to the depth of 200 to 300 feet below the general level. The river winds from side to side of this valley, successively rounding rich alluvial flats, which sustain a rich and very different kind of vegetation from that of the plains above. In such low situations, stragglers from the eastern flora are found to extend far beyond the western limit of where they continue to grow on the general surface of the country. Thus the false sugar maple (*Negundo fraxinifolium*) may be found as far west as Long. 108° in the valley of the North Saskatchewan; and on an island in the same river, a short distance above Fort Carlton, the red elm (*Ulmus fulva*) was observed. The oak follows up the valley of the Assineboine River as far west as Long. 100°. The true sugar-maple does not pass beyond the Red River, in which longitude is also found the western limit of the wild plum (*Prunus americana*), beech, ironwood, ash, cedar, arbor-vitæ, Weymouth pine, and other more valuable trees of the eastern forest. Some of these were however seen by Richardson in the wooded country as far north as Lat. 54°. A few trees of *Populus grandidentata* were seen in the valley of the South Saskatchewan at its elbow, although that tree does not extend into the lower part of the valley of Red River from the Mississippi, where it grows in abundance.

Within the "fertile belt" of cleared land we have the vegetation on the alluvial flats of the river valleys, consisting of *Populus balsamifera*, which is the largest tree in that part of the country, sometimes reaching three feet in diameter, with a dense thicket of *Salix longifolia*, *S. rostrata*, *Viburnum edule*, *Cratægus coccinea*, *Amelanchier canadensis*, the wood of which is used for making bows, and the luscious fruit for mixing with pemican; *Cornus stolonifera*, or "red willow," the bark of which the Indians smoke along with tobacco. *Shepherdia argentea* sometimes forms the greater mass of the thicket, and its red juicy berries are the favourite food of grisly bears.

On the prairies of this district, besides the groves of the *Populus tremuloides*, or aspen, there are dense willow thickets surrounding the swampy ground. In such spots there is an immense variety of *carices;* and when, as is often the case, the water is saline, saliferous plants abound, and, as usual, generally of species having a wide range. On the sides of rising grounds the *Elæagnus argentea* forms a low silvery copse, affording food to large coveys of prairie grouse. If the ground is high, or has a light sandy soil, it is then covered with a close matting of the Kin-i-kin-ic, or smoking weed, which is the *Arctostaphylos Uva-ursi* of the Scotch hills; or by the long flabelliform branches of *Juniperus virginiana* var. *prostrata*. Towards the mountains, large expanses of plain are covered with a low birch or alder (*Betula glandulosa ?*), six to eight inches high, which in winter give the appearance of a heather-covered moorland to these prairies.

In June and July, in some localities, the prairies are covered with brightly-coloured flowers of the genera *Astragalus*, *Hedysarum*, *Geranium*, *Lilium*, and others, or are completely clothed with a dense low copse of rose bushes. As the country towards the south merges into open prairie, the clumps of copse and young poplars are found only nestling on northern exposures. The last outliers of the woods to the south form "islands," as they are called in the country, which make a great show from a distance, but when approached, are found by the disappointed traveller to consist merely of a small species of willow, that will yield neither firewood nor shelter.

The true arid district, which occupies most of the country along the South Saskatchewan, and reaches as far north as Lat. 52°, acquires even very early in the season a dry parched look. In the northern district, the accumulation of *humus* and the distribution of the pleistocene deposits have given rise to a great variety in the nature of the soil; but to the south, the cretaceous and tertiary strata almost everywhere form the surface, so that the stiff clay soil, which is often highly impregnated with sulphates of soda and lime, bakes under the heat of the sun into a hard and cracked surface. This must be the principal reason for the arid plains ranging to such a high latitude, as there is quite a sufficient quantity of moisture in the atmosphere during the summer months to support a more vigorous vegetation. This is seen to be the case even as far south as Lat. 49° 30′ N., where, at the Cyprés Hills, and also on the south sides of the deep valleys and other exposures sheltered from the sun's rays in early spring, pines, spruce-firs, poplars, and many varieties of the northern type of vegetation, appear under congenial but strictly local conditions. In the arid country the characteristic plants are the prickly prairie apples (*Opuntia*), and the shrub-sage or absinthe (*Artemisia*); and in the trough-like valleys that lie east and west far out in the bare plains, these plants may sometimes be seen in full possession of the sunny slopes on the north side, while the opposite side of the valley is clothed with green and arborescent vegetation; while at the same time, showing that it is not local springs that cause the difference, the stream itself is often dried up into a chain of muddy pools. The arid district, although there are many fertile spots throughout its extent, can never be of much advantage to us as a possession. Even in June and July, the Expedition experienced great inconvenience in traversing it, from the want of wood, water, and pasture.

Along the eastern base of the Rocky Mountains there is much fine land with very rich pasture; but the sharp night frosts which occur throughout the summer would render the raising of cereals very precarious. When close to the mountains, several trees appear which are found in greatest number on the west slope of the continent. Of these the principal is the "Prushe" of the voyageurs, which is so named by them from its general resemblance to the hemlock spruce (*Abies canadensis*). It is however a very distinct tree. Two pines were also observed that were not remarked further to the eastward, one of which is only slightly different from the *Pinus monticola* of Douglas. The collections obtained at the base of the mountains are not satisfactory, as, at the time of M. Bourgeau's visit, the season was too late for any plants but alpines.

The valleys of the Rocky Mountains are occupied by forests, excepting in a few localities, where there occur level gravelly plains clothed with tufts of "bunch grass" (*Festuca*). The forest consists principally of the Prushe, Douglas, white and black spruce. This mixed forest, with a very varied undergrowth, extends to 5000 feet in altitude, when it is succeeded by a forest of *Abies balsamea*. The tree that is found highest, however, is the *Abies alba;* and at an altitude of 7000 feet in exposed situations it is quite dwarfed in size, with recumbent branches that spread like thatch over the mountain sides. The altitude of the alpine region in the Rocky Mountains is very variable, and ranges from 7000 to 9000 feet. It is characterised by the occurrence of many plants of identical species with those found in similar situations in Europe.

The following is a list of some of the plants collected by the writer in the eastern part of the chain, in Lat. 52° north, at an altitude of from 7000 to 9000 feet. They are all from one locality, near the height of land of a pass from the South to the North branches of the Saskatchewan River, and were gathered in the end of August 1859:—

Silene acaulis, *L.*
Cerastium alpinum, *L.*
—— arvense, *L.*
Stellaria longipes, *Gold.*
Fragaria virginiana, *Ehr.*
Potentilla fruticosa, *L.*
—— diversifolia, *Lehm.*
Epilobium alpinum, *L.*
Saxifraga bronchialis, *L.*
—— controversa, *Sternb.*
—— Dahurica, *Pall.*
Parnassia fimbriata, *Hook.*
Sedum stenopetalum, *Pursh.*
Youngia pygmæa, *Ced.*
Senecio triangularis, *Hook.*
Erigeron compositum, *Pursh.*
Valeriana capitata, (?) *Willd.*
Menziesia grandiflora, *Hook.*
Cassiope tetragona, *G. Don.*
Gentiana propinqua, *Rich.*
Castelleja minuta, *Doug.*
Polygonum viviparum, *L.*
Oxyria reniformis, *Hook.*
Salix reticulata, *L. var.* nana, *Andr.*
—— arctica, *R. Br.*
Allium Schœnoprasum, *C.*
Ligadenus chloranthus, *Rich.*
Juncus ensifolius, *Wick.*
—— arcticus, *Wick.*
—— castaneus, *Sm.*
Luzula parviflora, *Duv.*
—— spicata, *L.*
Poa alpina, *L.*
—— pratensis, *L.*
Phleum pratense, *L.*
Bromus ciliatus, *L.*
Trisetum subspicatum, *P. de B.*
Festuca ovina, *L.*
Calamagrostis (Desyeuxia) coarctata, *Torr.*

On commencing the descent of the slope to the west, the change in the nature of the vegetation is very marked, showing a great increase in the amount of moisture which is deposited. Thus, high up on the sides of the valleys, there are dense thickets of *Alnus viridis*, which grows to the height of six and eight feet, with sturdy stems and branches. In the valleys, the forest is quite choked by an undergrowth of *Thuja occidentalis, Mahonia Aquifolium, Panax horridum, Pyrus americana, Viburnum Opulus*, along with species of *Vaccinium, Ribes, Rubus, Symphoricarpos*, and many other plants not observed on the eastern slope of the mountains. Wherever the valleys are rocky, the rocks are covered by a close growth of mosses and ferns, both of which groups are almost wholly wanting on the east side, excepting those mosses that grow in swamps. The forest is often impenetrable, from the interlocking of the trunks of fallen trees, many of which are three and four feet in diameter. When travelling with horses, it is difficult, where there is no trail, to get on faster than a mile or two a-day; and to make matters worse, amidst all this luxuriance of vegetation there is nothing that the poor animals can eat excepting a scanty growth of *Equisetum*, of which they are very fond, and which grows on the shingle flats of the mountain torrents along with a matting of *Dryas* and *Epilobium*, and other alpine plants, the seeds of which are washed down every spring.

On descending the mountains as far as the Kootani River, which flows south-east for eighty miles through a wide valley lying parallel with the direction of the chain, a marked change is again observed in the nature of the vegetation. The forest is free from undergrowth, and consists principally of the *Pinus ponderosa*, which in its habit much resembles the Scotch fir, and frequently reaches the size of four feet in diameter. Along with it is the *Larix occidentalis*, which is equal in girth, but exceeds the pine in height and symmetry. Amongst the noble forest which these trees form, a rider can gallop with ease in every direction, the only underbrush consisting of a few scattered bushes of the red root (*Ceanothus*) or of the *Shepherdia argentea*. On the alluvial flats by the river, the *Juniperus virginiana* was found as far north as 51° 30′ to occur as a large tree 25 feet in height and 1 foot in diameter.

The surface of the ground, where dry and gravelly, is covered with wiry tufts of "bunch grass," and the slopes are clothed with a shrubbery of cherry and service-berry bushes (*Amelanchier*), the fruit of which is the principal food of the Kootani Indians. Westward from the Kootani River to Fort Colville, upon the Columbia, the country is very rugged, and when not confined in narrow valleys the forest generally forms open pine glades. By the sides of the streams and the low borders of lakes the yew and arbutus are found to occur, and in favourable spots the *Thuja gigantea* acquires an enormous size—often ten or twelve feet in diameter. Nevertheless, the prevailing physiognomy of the vegetation in this district is of the arid type; and further to the south, in the Columbian desert, this character is found to reach an extreme phase, there being a total absence of timber; and the country, even where the surface is irregular and rocky, supports nothing but a growth of dry tufty grass, or the worthless sage bush. (*Artemisia tridentifolia*). This sterility increases as we approach the Cascade Range; but on passing these mountains by the narrow chasm through which the Columbian River escapes to the Pacific, the change in the character of the vegetation is very abrupt. When sailing down that river from the Dalles to Fort Vancouver, in a distance of forty miles, the traveller passes from a desert flora to a country clothed by an evergreen forest of unrivalled variety and vigour. The scenery is magnificent, precipices of basaltic rocks rising from the water's edge tier above tier, to the height of several thousand feet, while in the distance occasional peeps are obtained of snow-capped peaks 10,000 to 12,000 feet above the sea-level.

On the western declivity of this mountain range, and on the narrow strip of country that lies between it and the coast, are found the beautiful and stately species of *Abies*, *Picea*, and *Pinus*, which have been introduced into this country from Oregon and Washington territories since the time of Douglas. The collections of that traveller, and those of Jeffrey, have made us familiar with the flora of the forest land along the Pacific coast; and our knowledge will be rendered still more complete by the ample collections of Dr Lyall, who is at present labouring in that country, attached to the N. W. Boundary-line Commission.

I am indebted to the kindness of Sir William Hooker for a memorandum which was left in his hands by M. Bourgeau, stating his opinion regarding the fitness of the Saskatchewan country for agricultural settlement, and a free translation of which I beg to append.

Memorandum by M. Bourgeau.

"I submit the following remarks on the advantages for agricultural settlement in Rupert's Land and the Saskatchewan prairies of British North America, having been appointed by Sir William Hooker to accompany Captain Palliser's Expedition as botanist.

"I had especially to collect the plants which grew naturally in the country traversed by the Expedition, and also their seeds. Besides my botanical collection, Dr Hooker advised me to make thermometrical observations at the various stations, and, above all things, to take the temperature of the earth at certain depths, as well as that of the interior of forest trees; also to notice the richness and poverty of the vegetation of the country, and the maladies to which plants are exposed. In the second letter and notes addressed to Sir William Hooker, which have already been published,* I have treated these questions with all the care that was permitted to me by observations taken in the midst of the harrassment and fatigue of a long journey, but it remains for me to call attention to the advantages there would be in establishing agricultural settlements in the vast plains of Rupert's Land, and particularly on the Saskatchewan in the neighbourhood of Fort Carlton. This district is much more adapted to the culture of staple crops of temperate climates—such as wheat, rye, barley, oats, &c.—than one would have been inclined to believe from its high latitude. In effect, the few attempts at the culture of cereals already made in the vicinity of the Hudson's Bay Company's trading ports, demonstrate by their success how easy it would be to obtain products sufficiently abundant largely to remunerate the efforts of the agriculturists. *There*, in order to put the land under cultivation, it would be necessary only to till the better portions of the soil. The prairies offer natural pasturage as favourable for the maintenance of numerous herds as if they had been artificially created. The construction of houses for habitations by the pioneers in the development of the country would be easy, because in many parts of the country, independent of wood, one would find fitting stones for building purposes; and in others it would be easy to find clay for bricks, more particularly near Battle River. The other parts most favourable for culture would be in the neighbourhood of Fort Edmonton, and also along the south side of the North Saskatchewan. In the latter district extend rich and vast prairies, interspersed with woods and forests, and where thick wood plants furnish excellent pasturage for domestic animals. The vetches found here, of which the principal are *Vicia*, *Hedysarum*, *Lathyrus*, and *Astragalus*, are as fitting for the nourishment of cattle as the clover of European pasturage. The abundance of buffalo, and the facility with which the herds of horses and oxen increase, demonstrate that it would be enough to shelter animals in winter, and to feed them in the shelters with hay collected in advance, in order to avoid the mortality that would result from cold and

* Lin. Soc. Proceedings. 1859.

from the attacks of wild beasts, and further to permit the acclimatisation of other domestic farmyard animals, such as the sheep and pig. The harvest could in general be commenced by the end of August, or the first week in September, which is a season when the temperature continues sufficiently high and rain is rare. In the gardens of the Hudson's Bay Company's Posts, and still more in those of the different Missions, vegetables of the leguminous family, such as beans, peas, and French beans, have been successfully cultivated; also potatoes, cabbages, turnips, carrots, rhubarb, and currants. No fruit tree has as yet been introduced; but one might perhaps, under favourable circumstances, try nut-trees, also apple-trees belonging to varieties that ripen early. Different species of gooseberries, with edible fruits, grow wild here; also different kinds of Vacciniaceæ are equally indigenous, and have pleasant fruits that will serve for the preparation of preserves and confectionary. The *Aronia ovalis* (*Amelanchier canadensis* must be meant) is very common in this country; and its fruit, commonly known as the *Poire*, or service-berry, is dried and eaten by the Indians, who collect it with great care; and it also serves for the purpose of making excellent pudding, recalling the taste of dried currants. The only difficulty that would oppose agricultural settlements, is the immense distance to traverse over countries devoid of roads, and almost uninhabited. The assistance of Government or of a well-organised company, would be indispensable to the colonization of this country. It would be important that settlements should be established in groups of at least fifty householders, for protection against the incursions of the Indians, who are, however, far from being hostile to Europeans. It stands to reason, that the colonists ought to be taken from the north of Europe or from mountain districts, being those accustomed to the climatological conditions and culture of the soil most resembling this interesting country, to the resources of which I call attention. The produce of agricultural settlements thus established would yield subsistence to the Indians, whose resources for food, supplied only by hunting, tend to diminish every day. The presence of European settlers would form a useful model for this primitive people, who, notwithstanding their native apathy, still appreciate the benefits of civilization."

(Signed) "E. BOURGEAU."

I may state, in conclusion, that the views here expressed by M. Bourgeau accord on the whole with the opinion I myself have formed of the fertile portion of the Saskatchewan country, and which I believe is also that of the other members of the Expedition.

On the Mountains forming the Eastern Side of the Basin of the Nile, and the origin of the designation "Mountains of the Moon," as applied to them. By CHARLES T. BEKE, Ph. D., F.S.A., F.R.G.S., &c.*

At the meeting of the British Association for the Advancement of Science at Southampton in September 1846, I read before the section of Geology and Physical Geography a paper "On the Physical Character of the Table-land of Abessinia;"† the object of which was to show the physical configuration of that portion of the African continent which forms the eastern side of the basin of the Nile.

On the 28th December and 11th January following, I read before the Royal Geographical Society of London a paper "On the Nile and its Tributaries,"‡ in which I traced the course of the Nile upwards as far as our existing knowledge permitted, and considered all the tributaries of that river on its right bank as they were then known; and in it I incorporated, with certain modifications, my previous communication to the British Association.

In both papers I particularly directed attention to Professor Ritter's ingenious but erroneous generalisation, which led him to regard the Abessinian plateau as consisting of a succession of terraces rising one above the other, the lowest being towards

* Read before the Section of Geography and Ethnology of the British Association for the Advancement of Science, at the meeting at Manchester, 7th September 1861.

† See "Report of the British Association for 1846;" Transactions of the Sections, pp. 70–72.

‡ See "Journal of the Royal Geographical Society," vol. xvii. pp. 1–84.

the Red Sea and the highest in Enárea, where the line of separation between the waters flowing to the Nile and those of the rivers having their course to the Indian Ocean, was supposed by him to exist; and I expressed the opinion, in accordance with that of Dr Rüppell, that so far from the high country rising in terraces as it recedes from the coast, its summit line is towards the coast itself, and from thence the land falls gradually towards the interior.

In the latter paper, when treating of the rivers which have their course over the table-land, I remarked that "the fall of the tributaries of the Nile diminishes gradually as they flow north-westwards to join the main stream; which latter, skirting as it does the western flank of the high land, is the *sink* into which the Tákkazie, the Bahr-el-Azrek, the Gódjeb, Telfi or Sobát, the Shoabérri,* and whatever other rivers there may be are received, its current being sluggish, and (as would appear) almost stagnant in the upper part of its course, except during the floods. In the dry season, its bed would indeed almost seem to consist of a succession of lakes and swamps, rather than to be the channel of a running stream. At Khartúm, at the confluence of the Bahr-el-Azrek, the height of the bed of the Nile above the ocean is only 1525 feet;† and it is far from improbable that even as high up as the fifth parallel of north latitude its absolute elevation does not much exceed 2000 feet."‡

In the same paper I first enunciated my hypothesis as to the derivation of the name of the Mountains of the Moon, in which the geographer Ptolemy places the sources of the Nile. This hypothesis may be thus briefly stated. The direct stream of the Nile was approximatively traced by me into that part of Eastern Africa where the country of Monomoezi (as I was then content to call it) had been placed by geographers and is now found to be situate; and as in the languages extending over the greater portion of Southern

* It is now found that there is no separate river of this name. The *Shol of Berri* is the upper course, or a principal tributary, of the Sobat. See "The Sources of the Nile," pp. 14 and 125; and see "Athenæum" of 31st August 1861, No. 1766, p. 283.

† Now estimated at only 1188 feet. See "The Sources of the Nile," p. 35.

‡ Journal Royal Geographical Society, vol. xvii. p. 80.

Africa the word "Moezi," in various forms, means "the moon,"* the name of the Mountains of the Moon appeared to me to be merely a translation of the native African expression, "the Mountains of Moezi."

Guided by this clew, I further developed my views at the meeting of the British Association at Swansea in 1848, when I claimed for the mountain range of Eastern Africa the generic designation of the Mountains of the Moon.†

Finally, at the meeting of the British Association at Ipswich in 1851, I read "A Summary of Recent Nilotic Discovery,"‡ in which I traced the progress of our knowledge in this direction as far as it then extended.

On my return to England, after an absence of several years, I have much gratification in renewing my communications to the British Association, especially as it is in my power to show that the great additions which have been made to our geographical knowledge since the opinions here referred to were expressed, have all tended to establish the substantial truth of those opinions.

The elevation of the bed of the direct stream of the White River at Gondókoro, in 4° 44′ north latitude, resulting from relative measurements made there and at Khartúm, appears to be even less than my estimate in 1846, being only 1911 feet;§ while the explorations of Mr Petherick further to the west, would seem to show the fall of the river to be even less in that direction than it is towards the south-east.

On the other hand, the mountain range of Eastern Africa, forming the anticlinal axis between the ocean and the basin of the Nile, which in 1846 I was only able to trace as far south as 9° 30′ north latitude, where I crossed it on my way to Shoa,‖ may now be regarded as extending beyond the sixth

* In "The Sources of the Nile," p. 82, is a list of upwards of twenty languages in which it has that signification.

† See "Report of the British Association for 1848;" Transactions of the Sections, pp. 63, 64. This paper is printed *in extenso* in the "Edinburgh New Philosophical Journal," vol. xlv. pp .221–251.

‡ See "Report of the British Association for 1851;" Transactions of the Sections, p. 84. This paper is printed *in extenso* in the "Philosophical Magazine," 4th Series, vol. ii. pp. 260–268.

§ See "The Sources of the Nile," p. 36.

‖ See "Journal Royal Geographical Society," vol. xiv., and the map there.

parallel of *south* latitude, on a line running generally from N.N.E. to S.S.W. between the 40th and 35th meridians. In about 2° north latitude and 39° east longitude, is what appears to be a lofty meridional chain, of which the white summits were seen in 1849 by Captain Short, the commander of one of the Imam of Muskat's vessels:* between the equator and 4° south latitude the missionaries Krapf and Rebmann have discovered the snow-capped mountains Kenia, Kilimandjaro, and Doengo Engai; and lastly, Captains Burton and Speke have crossed in 6° 40′ south latitude a meridional mountain range, at a distance of about 120 miles from the coast, which I cannot but regard as the continuation of that crossed by myself in the 16th and 9th parallels of north latitude; the mountains seen by Captain Short and the missionaries forming intervening portions of the same chain.

In thus connecting Kilimandjaro with the mountain range of Eastern Africa, I may seem opposed to Mr Rebmann, who states that Kilimandjaro forms no portion of a connected mountain system, but is "one whole and completely isolated mass of mountains"† rising from the midst of level ground, or rather that "the land sinks to where Kilimandjaro, in majestic simplicity, rears his white head to heaven; while to the west of it (says Mr Rebmann) I saw, to my astonishment, again this same plain not more elevated than on the eastern side, stretching away like the smooth surface of the sea."‡

But in the first place, without questioning the evidence of a credible eye-witness, I would nevertheless suggest that there is not so great a discrepancy between my opinion and Mr Rebmann's statement as may at first sight appear. When in the year 1839 Mr Rebmann's colleagues, Isenberg and Krapf, traversed the deserts between Tadjurrah and Shoa, on their way to the latter country, they saw before them to the north-west what they called "the Baadu and Aialu Mountains," the latter of considerable height; and to the south, "the Gebel Achmar, or the Galla Mountains;" and they described the land between themselves and those mountains as "an

* See "Athenæum" of 27th August 1853 (No. 1348), p. 1015.

† Church Missionary Intelligencer, vol. vii. p. 44.

‡ *Ibid.* p. 45.

undulating plain, said to extend from the banks of the Hawash as far as Berbera."* From my section of the country, published in the fourteenth volume of the Journal of the Royal Geographical Society, it will be seen, however, that the level of the Hawash at Melka Kuya, where those missionaries as well as myself crossed that river, is as much as 2200 feet above the level of the Indian Ocean, on the shore of which Berbera is situated. There is consequently nothing unreasonable in supposing the "level ground," out of which Kilimandjaro rises, to have an absolute elevation at least equal to that of the "undulating plain," extending to the foot of the Aialu Mountains.†

The notion that a plain must necessarily be of low elevation is so prevalent, that it generally requires an effort of reason to imagine it otherwise; and yet, as Humboldt remarks, "the level portions of our continents, to which we give the name of plains, are the broad summits of mountains, of which the feet are at the bottom of the ocean: considered in respect to submarine depths, these plains are elevated plateaus, of which the original inequalities have been partially filled up by horizontal layers of later sedimentary deposits, and covered over with alluvium."‡

Kilimandjaro was, on its discovery, described by Mr Rebmann as consisting of "two summits rising to the limit of snow out of the common mountain mass. The eastern is the lower, and terminates in several peaks, which in the rainy season are covered far down with snow; but in the dry season it sometimes melts entirely away, while at other times a few spots will remain. The western summit is the proper perpetual-snow mountain, which, rising considerably above its neighbour, affords also much more room for snow, it being formed like an immense dome. It is ten or twelve miles distant from the eastern summit, the intervening space pre-

* Journals of the Rev. Messrs Isenberg and Krapf, p. 45.

† "It is needless to remark how fallacious an instrument for levelling the eye is. The 'Shimba Range,' behind Mombasah, is estimated by Dr Krapf to attain a height of 4000 feet to 6000 feet. By B. P. thermometer, it appears to rise from 750 feet to 1200 feet above sea-level."—Burton in "Journ. Roy. Geogr. Soc.," vol. xxix. p. 23, note.

‡ Cosmos (Sabine's translation), vol. i. p. 278.

senting a saddle, which (so far as he could ascertain) was never covered with snow."*

This description of Kilimandjaro is entirely applicable to the "Aialu Mountains" of Messrs Isenberg and Krapf, by which expression are meant the twin mountains Aiyalu and Abida of my map in the fourteenth volume of the "Journal of the Royal Geographical Society."† Abida, the nearer and lower of the two, is evidently a gigantic volcano now extinct, of which the crater is two miles or more in diameter, while the numerous smaller volcanic cones by which it is surrounded are evidence of former tremendous activity. Aiyalu, by the Abessinians named Azalu, and famous among them as forming the eastern limit of their ancient empire, is distant about ten miles to the west of Abida, which it greatly exceeds in height, and, like Kilimandjaro, appears to be a massive cone or dome.

When Mr Rebmann's description of Kilimandjaro was first made public, I was led to observe and comment on the close resemblance in several particulars between that mountain and Chimborazo, as described and depicted by Humboldt in his "Vues des Cordillères," page 102 and plate xvi.‡ In one respect, however, Kilimandjaro, as also Aiyalu, seem to differ from Chimborazo. The latter forms an integral portion of the chain of the Andes; whereas the two mountains of eastern Africa appear to be mountain-masses comparatively isolated, which may in common parlance be said to be unconnected with any other mountains, though in fact they are but spurs or offsets from an extensive mountain system; and these related facts involve, in the second place, the harmony of my opinion with Mr Rebmann's. The distance of Aiyalu from the eastern edge of the Abessinian table-land is nearly a hundred miles, an interval more than sufficient to disconnect the two in the eyes of a cursory observer; and the case is probably the same with respect to Kilimandjaro and the elevated pla-

* Church Missionary Intelligencer, vol. i. p. 151.

† The author here exhibited to the meeting a representation of Aiyalu and Abida, from a sketch made by him at Baddikoma on the 28th January 1841, on his way to Shoa.

‡ See "Athenæum" of 1st December, 1849 (No. 1153), p. 1209.

teau beyond it,* of which the other snowy mountain Kenia, with its accompanying volcano, as also Doengo-Engai, in like manner covered with snow, form integral portions, as Chimborazo does of the Andes.

The following description of Kilimandjaro and the neighbouring range of mountains, given by a Portuguese writer in the sixteenth century, is entirely in conformity with my view of the subject:—"West of this port [Mombas] stands the Mount Olympus of Ethiopia, which is exceedingly high; and beyond it are the Mountains of the Moon, in which are the sources of the Nile." †

Before proceeding to show further how my hypothesis has been confirmed by subsequent discoveries, it will be proper to cite the passage in Ptolemy's Geography which forms the basis of the entire argument.

After describing the east coast of Africa as stretching towards the east from Cape Rhaptum, on the Barbarian Gulf, as far as Cape Prasum, and stating that near the latter Cape is an island named Menuthias, the Greek geographer proceeds in these terms:—"Round the Gulf dwell the Cannibal negroes, on the west of whose country are the Mountains of the Moon, from which the lakes of the Nile receive the snows." ‡

When I first attempted the interpretation of this important text, neither the two lakes Nyanza and Tanganyika nor the snowy mountains Kilimandjaro and Kenia were known; so that I could only assume the general correctness of Ptolemy's statement. But with our existing knowledge it is now possible to prove that geographer's information to have been as ample, and nearly as accurate, as our own. The Barbarian

* Djebel Dubbeh, a volcano about a day's journey inland from Edd on the Abessinian coast, from which a violent eruption took place on the 8th May 1861, lasting several days, is situate about 230 miles almost due north from Aiyalu, and would seem from its position to stand in the same relation to the mountain range of Eastern Africa as Aiyalu and Kilimandjaro. An account of this eruption is contained in *The Times* of 20th and 21st June 1861.

† Fernandez de Enciso, "Suma de Geographia" (1530), fol. 54; quoted by Mr Cooley in his "Inner Africa Laid Open," p. 127.

‡ *Τοῦτου μὲν οὖν τὸν κόλπου περιοικοῦσιν Αἰθίοπες ἀνθρωποφάγοι, ὧν ἀπὸ δυσμῶν διήκει τὸ τῆς Σελήνης ὄρος, ἀφ' οὗ ὑποδέχονται τὰς χιόνας αἱ τοῦ Νείλου λίμναι.*—*Geogr.* lib. iv. cap. ix. § 5 (Edit. Bertii, p. 135.)

Gulf is the bight in which Zanzibar, the ancient Menuthias, is situate: the Cannibal negroes are the Wadoe, who inhabit the coast between Zanzibar and the snowy mountains, in the very spot attributed to them by Ptolemy, and whose "name is terrible even in African ears:"* Kenia, Kilimandjaro, and Doengo Engai, are some of the snowy Mountains of the Moon: the lakes are Nyanza and Tanganyika; and the country whose name gives the key to the whole is *U-Nyamwezi*, the present representative of the earlier "Monomoezi," which name Dr Krapf translates "Possession of the Moon," and Captain Burton "Land of the Moon;" both versions being probably erroneous, as I shall endeavour to prove in the sequel, though the principal portion of that name, "Mwezi," does literally signify "the Moon," as has already been explained.

It might be objected that the positions and relative bearings of these several points are not correctly given by Ptolemy. Such an objection would be more specious than real. That geographer does not profess to do more than record the results of information collected from various independent sources, not always agreeing with one another, and none of them pretending to perfect accuracy. He does nothing more, in fact, than is done by modern geographers and chartographers, who describe countries and construct maps of them "from the latest and best authorities."

It might further be argued that Kilimandjaro and Kenia are not *proved* to be snow-capped mountains. We have, however, the reiterated assertions of Dr Krapf and Mr Rebmann, two educated natives of Germany, that they saw snow on those mountains with their own eyes; and if the persons from whom Ptolemy derived his information were only half as competent to give evidence on the subject as those two missionaries, that geographer could not be blamed for having believed in the existence of snow on the Mountains of the Moon, and having accordingly recorded it as a fact for the information of his own and future ages, even should it eventually turn out, as Dr Livingstone suggests, that "the whiteness of those mountains" is "nothing more than white quartz rocks and crystalline dolomitic limestones glittering under a tropical

* See "Journ. Royal Geogr. Soc.," vol. xxix. p. 99.

sun."* Yet this would be incompatible with the statements made by the natives to Mr Rebmann, that "the silver-like stuff, when brought down in bottles, proved to be nothing but water;" and that "many who ascended the mountain [Kilimandjaro] perished from extreme cold, or returned with frozen extremities."†

Or it might be contended that the two lakes, whether or not they receive the melted snows of the mountains, do not communicate with the Nile. This, however, like the other, is only a question of evidence. If Ptolemy was positively informed (as Captains Burton and Speke were in the first instance with respect to Tanganyika‡) that the two lakes are connected with the Nile, he was justified in believing and stating them to be so, even should the fact turn out otherwise.

The most material and interesting point on which an objection might be raised, is with respect to my derivation of the name of the Mountains of the Moon. It cannot, however, be denied, that there is a country named U-Nyamwezi,—or, if it be preferred, Monomoezi, as it was generally called till within the last few years.§ If this be conceded, and the fact also be, as Captain Burton informs us,‖ that "the Arabs and people of Zanzibar, for facility and rapidity of pronunciation, dispense with the initial dissyllable, and call the country and its race 'Mwezi;'" there is nothing unreasonable in the idea that the mountains on the way to that country should have been called by strangers travelling thither from the coast the mountains of *Mwezi*, just as the northern portion of the same range of mountains has of late years been styled the "Abessinian Alps" and the "Highlands of Ethiopia." And lastly, as "Mwezi" means "Moon," and the Greeks were in the habit of translating into their own language significant proper names, these "mountains of Mwezi" would naturally have been called by them Σελήνης ὄρος, the Mountains of the Moon.

* See "Journ. Roy. Geogr. Soc.," vol. xxvii. p. clxx.

† See "Krapf's Travels," &c., pp. 543, 544.

‡ See "Blackwood's Magazine" for September 1859, vol. lxxxvi. p. 352.

§ "Two centuries and a half have elapsed since Europe first learned the existence of the empire of Monomoezi."—Cooley "On the Geography of Nyassi," in Journ. Roy. Geogr. Soc., vol. xv. p. 212.

‖ Journ. Roy. Geogr. Soc., vol. xxix. p. 168.

In saying this, I do not intend to affirm that names so translated were necessarily significant in the language of the country to which they belonged, in the sense in which they were translated, but simply that they were significant in some (most probably other) language, through which they reached the Greek. In my work already cited* I have instanced the island of Java, whose Indian names, *Java-dvipa*, Ptolemy not only translated, but at the same time fortunately furnished direct evidence of his translation. His words are, Ἰαβαδίου ὃ σημαίνει κριθῆς νῆσος,† "*Jabadiou*, which signifies *Barley Island*;" the fact being, that in the Kavi language *java* really does mean *barley*, as *dvipa* means *island.* Yet it is not to be imagined that "Barley Island" was the signification of the primitive native name; and this for the simple but conclusive reason, that the climate of Java not being suited to the growth of barley, the indigenous name of that island could never have been derived from an exotic plant, though, from its resemblance to the word *java*, or "barley," in the language of the Indian invaders, the latter may have so understood and translated it.

On my journey home through Italy last autumn, I visited the site of the ancient Etruscan city of Luna, on the shores of the Gulf of Spezia,—the celebrated *Portus Lunæ* of antiquity,—*Lunai portum est operæ cognoscere. cives* ‡— which appeared to me likely to offer a parallel to the African "Mwezi." § Previously to my visit I had not the means of referring to the principal authorities on the subject. But since arriving in England I have had the gratification of finding, as in the case of Java, the recorded translation into Greek of the name of this Etruscan city, not directly from the original native language, but through the medium of a third tongue, which in this case is the Latin.

The same geographer, Ptolemy, when describing the country of the Tuscans or Tyrrhenians, mentions Λοῦνα, that is to say, *Luna*, and immediately following it, Σελήνης ἄκρον, || the pro-

* The Sources of the Nile, p. 83.

† Lib. vii. cap. ii. § 29.

‡ *Ennius.*

§ See "Athenæum" of 6th October 1860 (No. 1719), p. 451.

|| Lib. iii. cap. i., sec. 4 (Edit. Bertii, p. 68).

montory of *Selene*. As the identity of the two terms *Luna* and *Selene* was better known in Ptolemy's time that it is even in our own, we may conclude that he deemed it needless to offer an explanation of what was self-evident. The deficiency, if considered material, is however made good by Strabo, who states explicitly that "the city and harbour of Luna are named by the Greeks the harbour and city of Selene."*

Nevertheless, there is no sufficient reason for believing the Etruscan name of Luna to have involved a supposed connection with the earth's satellite any more than that of the African U-Nyamwezi. It is true that the Romans regarded the former name as signifying the moon, and as having, indeed, been derived from that planet: *nominis est auctor Sole corusca soror* are the express words of the poet Rutilius.† But the better opinion is, that "Luna was an Etruscan word, misinterpreted by the Romans. For the three chief ports on this coast, as we learn from coins, had this termination to their names, Luna, Pupluna (Populonia), and Vetluna (Vetulonia); and as no inland town of Etruria had the same ending, it is not improbable that Luna had a maritime signification, and meant 'a port;'—this, which has no prefix to its name, being, from its superior size, pre-eminently 'the port' of Etruria."‡

In a precisely similar manner the Greek expression, "the Mountains of the Moon," was derived from the name U-Nyamwezi, through the Sawahili term *Mwezi*, which signifies moon. Still it does not at all follow that the word U-Nyamwezi, or any portion of it, is significant, in the same sense, in the native language of that country itself, any more than that Luna in the Etruscan language means moon, or that Java means barley in the aboriginal tongue of that island.

In proceeding to explain my views of the subject at the present stage of the inquiry, I would premise, in the words of Captain Burton, that, "in the Kisawahili [*i.e.*, the language of the Sawáhilis], and its cognates, the vowel *u* prefixed to a a root, which, however, is never used without some prefix, de-

* *Λοῦνα πόλις ἐστὶ καὶ λιμήν, καλοῦσι οἱ Ἕλληνες Σελήνης λιμένα καὶ πόλιν.*—Lib. v. cap. ii. § 6.

† Itiner., lib. ii. v. 64.

‡ Dennis, "The Cities and Cemeteries of Etruria," vol. i. p. 83, *note*.

notes . . . a country or region, as Uzaramo, the region of Zaramo . . . The liquid *m*, or, before a vowel and an aspirated h, *mu*, . . . denotes the individual, Mzaramo, a man or woman of Zaramo. . . . The plural form of *m* and *mu* is *wá* . . . It is used to signify the population, as Wazaramo, the people or tribe of Zaramo . . . Finally, the syllable *ki*—prefixed to the theoretical root—denotes anything appertaining to a country, as the terminating *ish* in the word English. It especially refers in popular usage to languages, as Kizaramo, the language of Uzaramo."*

Proceeding to Captain Burton's derivation of the name U-Nyamwezi, we find that, seemingly forgetful of his own definitions, he thus analyses the word: "The initial U, the causal and locative prefix, denotes the land; nya, of; and mwezi (articulated m'ezí with semi-elision of the *w*) means the moon."† Had he been guided by his own rule, he would have adopted "Nyamwezi," and not "Mwezi," as the theoretical root; and then applying to it the several prefixes, as in the case of "the people or tribe of Zaramo," he would have said not merely that "the correct designation of the in-

* Jour. Roy. Geog. Soc., vol. xxix. p. 48, *note*. The same traveller states further, that "it has been deemed advisable to retain these terse and concise distinctions, which, if abandoned, would necessitate a weary redundance of words." An entirely different course is adopted by Mr Edwin Norris, who, in his edition of Dr Prichard's "Natural History of Man," when speaking of Dr Krapf's "Vocabulary of East African Languages," says (p. 400, *note*), "The editor has taken the liberty to remove the Kafir prefix, which he thinks not only awkward but positively incorrect. Dr Krapf calls these languages Kisuaheli, Kipokomo, Kigalla, &c. The fact is, that all the Kafir tongues have certain particles distinguishing singulars from plurals (and sometimes duals), adjectives from substantives, and one kind of substantive from another. Dr Krapf, in the narrative of his journeys into Sambara in 1852, speaks of the Kisambara language, spoken by the Wasambara, who live in Usambara; and now and then mentions a Masambara, one of a Kisambara family. Different dialects have different particles: in the language which the editor would wish to call Chuana, a native of the country is a Mochuana, two are Buchuana, the people generally are the Bichuana, and the language is Sichuana; and the latter words have become current in England, to the puzzlement of readers of African intelligence. Wherever the Kafir prefix has not become part and parcel of the English appellation, the editor omits it."

There are few persons, I think, who will not regard Mr Norris's rule as the preferable one.

† Journ. Roy. Geogr. Soc., vol. xxix. p. 167.

habitants of U-nyamwezi is M'-nyamwezi in the singular, and Wa-nyamwezi in the plural,"* and "Ki-nyamwezi is the adjectival form;"† but he would have continued, "and U-nyamwezi is the region of the people or tribe of Nyamwezi."

Several years ago I arrived at the root Nyamwezi by a different process. In the month of April 1856, Mohammed bin Khamis, a man well known to Captain Burton, had occasion to visit Mauritius, where I made his acquaintance. He is the son of Mr Cooley's informant, Khamis bin Othmán,‡ and is himself appealed to by that gentleman in his "Inner Africa Laid Open," being there described§ as "a very intelligent Sawahili, educated in England, formerly commanding one of Sultan Seid S'aíd's ships, but now [1852] secretary and interpreter to his highness." Mohammed became known to Captain Burton, fifteen months after his visit to Mauritius, as the sailing-master of the corvette Artémise, in which the traveller and his "companion" crossed from Zanzibar to the mainland.‖ On the occasion of Mohammed's visit to Mauritius, I laid before him Mr Cooley's recent works, the several articles in the "Athenæum" on the *vexata quæstio* of one lake or two lakes (the *third* and northernmost lake, Nyanza, being at that time unknown), and discussed with him the merits of the question generally; when he, asserted the existence of *two* lakes; the one, "Nyassa," being much smaller, more southerly, and nearer to the coast; the other, "the Monomwezi Lake," considerably larger, more towards the north, and much further in the interior. In the Sawáhili language they are respectively called, *Ziwa la Wa-nyássa*, or the Lake of the Tribe of Nyassa, and *Ziwa la Wa-nyamwézi*, or the Lake of the Tribe of Nyamwézi.¶

Captain Guillain, of the French navy, in his "Documents sur l'Histoire, la Géographie et le Commerce de l'Afrique Orien-

* Journ. Roy. Geogr. Soc., vol. xxix. p. 168. † *Ibid.*

‡ *Ibid.* vol. xv. p. 198. § P. 78.

‖ See "The Lake Regions of Central Africa," vol. i. p. 8. According to Captain Burton, he also helped Captain Speke in taking observations:—"A novice lunarian, he was assisted by Mohammed bin Khamis, who had read his 'Norie' in England."—*Ibid.* p. 12.

¶ See "Athenæum" of 12th July 1856, (No. 1498), p. 67.

tale,"* likewise makes use of the "theoretical root," when he says that "Mounyamouezy, or by contraction M'nyamouezy, signifies a man of the country of Nyamouezy."†

The determination of this theoretical root "Nyamwezi" throws much light on the various forms which the name of the country and that of its inhabitants have assumed in works on African history and geography.‡ It is evidently the "Nimeamaye" of Dapper, further corrupted to "Nimeaye" in our atlases; whilst the addition of the singular prefix *m* makes M'nyamwezi, which is evidently the original of "Monomoezi," respecting the orthography and the derivation of which word so much has been written. What this theoretical root may mean in the Nyamwezi language—or, as Captain Burton would say, in Ki-Nyamwezi—has yet to be ascertained. Meanwhile the proposed translations of "U-Nyamwezi" into "Possession of the Moon" and "Land of the Moon" may well be questioned.

Should it eventually be proved that the name of this country of Nyamwezi—U-Nyamwezi—has really no connection with the separate Kafir or Zingiar word *mwezi* in its literal signification of "the moon," the designation of "Mountains of the Moon," as applied to the great mountain range of Eastern Africa in which are the sources of the Nile, will have originated in a mistranslation. Still this well-known name has been in use during so many ages, that it would hardly be practicable, and certainly would not be judicious, to supersede it now. The Mountains of the Moon, then, with their snowy summits and their sources of the Nile, will assuredly retain the designation which Claudius Ptolemy, rightly or wrongly, gave to them seventeen centuries ago.

Now that Eastern Africa is in so many respects becoming the object of public attention, it is probable that the Mountains of

* P. 390, *note*.

† This is asserted by Captain Burton (*Journ. Roy. Geogr. Soc.*, vol. xxix. p. 167), to "show little knowledge of the Zangian dialects." But the truth is, that Captain Guillain, like Mr Norris and myself, adopts the "theoretical root" as best suited to the genius of European languages, without at all intending to dispute the fact asserted by Captain Burton, that this root is never employed by the natives themselves without some prefix.

‡ See examples cited by Captain Burton in the "Journ. Roy. Geogr. Soc.," vol. xxix. p. 166.

the Moon will ere long acquire a more prominent place in the world's history than they have hitherto occupied. The entire eastern side of the basin of the Nile appears to be auriferous, the gold collected in various parts of it since the earliest ages being brought down by the tributaries of that river; so that there is reason to consider the Mountains of the Moon as a meridional metalliferous cordillera, similar in its general characters to the Ural and the corresponding great mountain ranges of America and Australia. It is from this portion of Africa, as I have explained in my work "The Sources of the Nile,"* that the "gold of Ophir" of the Hebrew Scriptures was obtained. Whenever the discovery shall be made in Eastern Africa of some of the chief deposits of that precious metal, the influx from all parts of the civilised world to the "diggings" in the Mountains of the Moon will be such as to occasion a more rapid and complete revolution in the social condition of those hitherto neglected regions than could be caused by commerce, by missionary labours, by colonisation, or by conquest; as we have witnessed in other quarters of the globe, where the *auri sacra fames* has collected together masses of the most daring and energetic of human beings. We shall then, too, doubtless see in Eastern Africa, as in California and in Australia, the formation of another new race of mankind.

On Lightning Figures. By Charles Tomlinson, Lecturer on Science, King's College School, London.†

In the newspaper reports of accidents from lightning, we occasionally meet with statements that have given rise to much speculation, such as that certain tree-like or ramified figures have sometimes been found on the bodies of men and animals struck by the electric fluid. In the *Athenæum*, No. 1535 (28th March 1857), is given an abstract of a paper by M. Andres Poey, Director of the Physico-meteorological Observatory of Havannah, entitled "The Photographic Effects of

* Page 62; and see "Origines Biblicæ," p. 115.

† Read before the Physical Section of the British Association at Manchester, 5th Sept. 1861.

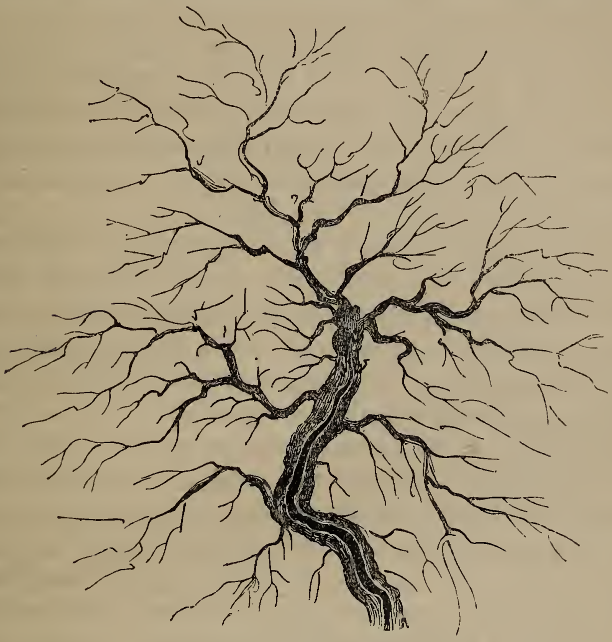
Lightning." Among these effects are the impressions above referred to, of objects left on the bodies of persons struck by lightning, or standing near to objects that have been struck. Thus, it is stated that Franklin was often heard to speak of the case of a man who, standing opposite a tree that was so struck, had on his breast "an exact representation of that tree." I have not been able to find any reference to this case in Franklin's works, which I think somewhat singular; but I do not wish to push that negative fact beyond the limits of a remark. Other cases quoted by M. Poey are as follows:—

In August 1853, a little girl was standing at a window, before which was a young maple tree, "a complete image of which" was found impressed on her body after a flash of lightning.

A boy climbed a tree to steal a bird's nest; the tree was struck by lightning, and the boy thrown to the ground: "on his breast the image of the tree, with the bird and nest on one of its branches, appeared very plainly." Here, again, it may be remarked, that when boys ascend trees to steal birds' nests, the poor little fluttering parent does not, in this country at least, stop to have its photographic portrait taken.

Another case is that of an Italian lady of Lugano, who, sitting at the window during a thunder-storm, had the portrait of a flower permanently impressed upon her leg.

In preparing a new edition of my little book, "The Thunder Storm," I included these and similar cases in a note in the appendix "On Electric Images." Among these are the *Breath-figures* (the *Electrische Hauch-figuren* of the Germans, and the *Figures roriques* of the French), or those figures resembling Moser's, but produced by Riess, Karsten, and others by means of electricity. For example, a coin is placed on glass, and a stream of sparks from an ordinary electrical machine is poured upon it. About 80 or 100 turns of a two-foot plate machine may be required. On throwing off the coin, and breathing on the glass, the image and superscription of the coin are, under favourable circumstances, perfectly reproduced, by the mode in which the breath condenses on the glass. I say under favourable circumstances, because it is necessary that a film of matter such as covers most objects exposed to the air or to contact with the hands be on the glass, and the action of the electricity seems to be to burn off greater or less portions of this film, coinciding with the greater or less projections of the coin, so that when the breath is projected on the glass, the moisture becomes condensed in a regulated manner according to the regulated action of the electricity on the film; that is, where the electricity has touched the glass and burnt off the organic film, the breath becomes condensed in continuous streams of water, but where the film still remains, the moisture is condensed in minute globules. Now, if we discharge a Leyden jar upon a pane of glass, by interposing it between the knob of the jar and that of the discharging rod, we get a breath figure which may be taken as the portrait of the discharge of a miniature flash of lightning, representing, doubtless on a small scale, the mode of discharge on the large, where the earth and the clouds take the place of the two coatings, and the air that of the insulating glass. In this experiment, a small Leyden jar and a pane of window glass three or four inches square suffice. The glass should be held by one corner; and one knob of the discharging rod being placed on the coating of the jar, the glass in contact with the other knob should be brought quickly up to the knob of the jar, when the discharge will take place not through the glass but along its surface, turning over its edge, and passing up the glass to the knob of the discharging rod on the other side. Thus we get two figures, the principal one on the side next the jar, and a second subsidiary figure on the discharging-rod side. These figures come out beautifully by breathing on the glass and holding it up to the light. Wherever the electricity has burnt off the film, the moisture is deposited in unbroken lines; but in the other parts where the film is intact, it is in very minute globules. The following engraving represents roughly a specimen of the principal figure, which is that of a leafless tree, or something so provokingly like a tree, that any one who has seen it, and has read the wonderful stories from M. Poey's Memoir, exclaims at once—"Here is the origin of the photo-electric figures of lightning." I showed this experiment to one of the Professors of King's College, and he exclaimed—"There is the branch and there is the bird's nest as plainly as possible!" We have, in fact. in all these figures a broad and somewhat rippled line, representing the line of least resistance or path of the principal discharge. Branching off from this line are numerous ramifications, exactly like the branches of



Electrical Breath-figure.

a tree; and from each branch proceed large twigs, and from these smaller ones of extreme beauty and delicacy of texture. The secondary figure is much less complicated, consisting only of the main trunk and one or two branches, but the principal figure is highly instructive and suggestive. Five of these figures are given in my "Thunder Storm;" they were drawn on wood from nature by my friend Mr Garbett. At the time they were drawn, we were not quite agreed as to some of the details of the trunk; and as the figure only lasts while the breath is visible on the glass, it is somewhat difficult to sketch all the details. Besides this, the hygrometric state of the air greatly influences the condensation and duration of the moisture. In warm wet weather, it is scarcely possible to produce these figures satisfactorily. In the article "Breath Figures," contributed by me to the "English Cyclopædia," are two figures drawn on wood by my friend Mr Thorne, from the originals which I produced in his presence, which I have no hesitation in pronouncing to be accurate. Since the date of these publications, M. Poey has brought out a new edition of his Memoir in a separate form, and has had the politeness to send me a copy, together with other meteorological papers of great interest and value. The Memoir now makes a small volume of 110 pages, and its title is as follows:—"Relation historique et Théorie des Images Photo-électriques de la Foudre; observées depuis l'an 360 de notre ère jusqu' en 1860. Par M. Andres Poey," &c., Paris, 1861.

Let us now return to these tree-like impressions produced by the discharge of a Leyden jar on the surface of glass. However rapid and instantaneous the discharge, time is occupied in making it. In the first place, the jar sends out ramifying feelers in all directions, to prepare the line of least resistance; and this being accurately chalked out, the principal discharge takes place. In some cases the discharge bifurcates, and we then have two trunks, each with its own system of branches. I have also had instances of trifurcation, forming admirable illustrations of the modes in which lightning often attacks several points at once. That these feelers precede the main discharge, is evident from the fact, that should the glass be too thick, or present too large an area, these ramifications only are formed; we get, in fact, those lines which produce the sensation of cobwebs being drawn over the face, which seamen describe as the forerunners of the ship being struck. Another most important fact is, that the main trunk is hollow. The breath-figure shows this very decidedly; it consists of two outer boundary lines, and two inner lines bounding a hollow core. I have made the discharge on a pane of smoked glass, and have thus obtained a permanent figure of the trunk, consisting of a couple of channels on each side of a black dotted line. Now, if we examine the stereotyped effects of a lightning stroke, as seen in the siliceous tubes or fulgurites, specimens of which are to be found in most museums, they too will be found to be hollow. The tubes found in a sandhill at Drig, in Cumberland, are described in the "Transactions of the Geological Society" for 1812 as being hollow, with a rough and uneven outer surface, containing deep furrows like the bark of a tree, in striking contrast with the limpid vitrified inner surface. Mr Darwin, in describing similar tubes, fragments of which he found in South America, speaks of the measure or *bore of the lightning* being about an inch and a quarter. A magnificent fulgurite from Dresden may be examined in the British Museum.

Now, as the identity between frictional electricity and lightning is admitted, it must also, I think, be admitted that the discharge of a Leyden jar resembles that of a thunder-cloud; and if the former produces these tree-like figures, the latter does so also. Indeed, the ramifications of fulgurites prove such to be the case. We are apt to be misled in our ideas as to the form of a flash of lightning, by the stereotyped zigzags by which artists agree to represent that terrible element. Jupiter's thunderbolts may have as conventional a form as the French carpenter's scarf joint, which he names *traits de Jupiter;* but Nature does her work with a far more fatal precision than these zigzags would imply. It is not often during a thunder-storm that we have an opportunity of seeing a terrestrial object struck by the thunder-bolt, but this I did see on one occasion in Saxony. During a terrible storm I was watching the distant mountains of Bohemia, when a very black cloud was seen to descend, and to discharge itself upon a hill in a nearly straight line of rippled dazzling light. This is what the sailors call *ribbon* or *chain* lightning, and is altogether different from *sheet* lightning, where reflected light makes up a large part of the phenomena. The ramifications which accompany or rather precede this discharge are not always visible, although they may sometimes be seen; but, as already noticed, they can be felt by a person in the vicinity of the stroke. And if felt, may they not impress themselves on the person? May not a small twig of a small branch of one of these ramifications of a stroke of lightning print itself on the skin, as the discharge of a Leyden jar does with so much facility on glass?

M. Poey relates a case which is said to have occurred in 1812 at the village of Combe Hay, four miles from Bath, of six sheep reposing in a meadow surrounded by woods being killed by lightning, and that, "when the skins were taken from the animals, a *fac-simile* of a portion of the surrounding scenery was visible on the inner surface of each skin." This looks so very much like a joke that I hesitate to quote it; but the authority for the statement given by M. Poey is Mr James H. Shaw, whose communication was made, it should be remarked, forty-five years after the event, and is included in the "Report of the Council of the British Meteorological Society, read at the Seventh Annual General Meeting, May 27, 1857," p. 17. Mr Shaw makes an addition to the above statement, which is hardly required *if* a fac-simile of the surrounding scenery were printed on the skins. However, he says that "the small field and its surrounding wood were so familiar to me and my schoolfellows, that when the skins were shown to us, we at once identified the local scenery so wonderfully represented." The authority for this may well indeed be Shaw, although I should prefer a slight variation in the spelling. But curiously enough, while I am writing, a friend has procured for me a number of the "Bath Express" for Saturday, June 8, 1861, in which is a paragraph headed, "Curious Effects of Lightning," correcting a statement which had appeared in the "Bath Express" a fortnight before, respecting the occurrence of 1812. The accident is now said, on the authority of Mr Wiltshire, "on whose farm the occurrence took place," to have happened at Twinney, not at Combe Hay, and it is thus related :—"About turnip-sowing time, in 1812, Mr Wiltshire and his men were engaged in the fields, when a violent storm of thunder and lightning came on, and three out of four valuable rams, which had taken shelter under a tree, were killed. When the skins reached the fellmonger, on the inside of each was found depicted a very accurate representation of the tree under which the animals had sought refuge." Now, in this short extract, we have some very important variations from Mr Shaw's statement, as adopted by M. Poey. In the first place, the accident occurred not at Combe Hay, but at Twinney. Secondly, three rams now take the place of six sheep. Thirdly, the rams had taken refuge under a tree—Mr Shaw's sheep were in a small field surrounded by trees. Fourthly, M. Poey states, that the skins were exposed to public view in Bath—Mr Wiltshire says, "when the skins reached the fellmonger's,"—that is, the man who skinned the sheep saw nothing particular in the skins, it was the fellmonger who discovered—what? Not a landscape, not a *fac-simile* of the surrounding scenery, but "simply a very accurate representation of the tree," &c. This brings us back to our ramified impressions of the Leyden jar, and redeems this wonderful story from the dreamy regions of the marvellous, into which science should never venture, except to rescue some poor misguided fact.

These tree-like impressions on men and animals did not escape the notice of some of the earlier electricians. In 1786, MM. Bossut and Leroy made a report to the Académie on the subject of some singular marks found on the body of a man who had been killed by a stroke of lightning. These marks were accounted for on the supposition that the electricity, in its passage through the body, had forced the blood into the vessels of the skin, and thus made all the ramifications of these vessels visible on the surface. The commissioners, in fact, adopted the theory of M. Besile, who reported the case, viz., that the effect was due "à l'eruption du sang dans les vaisseaux de la peau, et qui, dans cet instant forme un effet tout semblable à celui d'une injection." M. Arago adopts a similar explanation in a case which occurred in France in July 1841, where two persons standing near a poplar were struck by lightning, and on the breast of each were found marks "parfaitement semblable à des feuilles de peuplier." This case is noted in the *Comptes Rendus*, tome xvi., in the following terms. "Note relative à l'apparence singulière des ecchymoses formées par la foudre sur la peau de deux individus frappés du même coup." Cases of this kind are seldom or never seen by scientific observers, but are left to the observation of bystanders, who mix up with actual facts a good deal of imagination. That a person struck by lightning, while standing under a tree, should have tree-like impressions on his person, would naturally lead an ordinary observer to see "an exact portrait of the tree" in those marks; the blotches are taken for leaves, for a bird and bird's nest, &c., as the case may be. But should the victim be conveyed to a medical man, he would be likely to interpret those ramifications into a case of ecchymosis, and to report accordingly. My belief is, that the lightning itself, or one of its ramifications, prints its own fiery mark on the skin of the victim, and thus produces these tree-like impressions which have excited so much astonishment, and led to so much false description and theory during the last eighty or ninety years.

M. Poey relates twenty-four cases of lightning impressions on the bodies of men and animals. Of these, eight are said to be impressions of trees or parts of trees; two of animals, viz., a bird and a cow; four of crosses; three of circles or impressions of coins carried about the person; two of a horse-shoe; one of a nail; one of a metal comb; one of a number; one of the words of a sentence; and one of the back of an arm-chair.

M. Poey would refer the production of these figures to photography, in which lightning is the efficient agent instead of the sun.

M. Baudin (*Traité de Geographie Médicale*) proposes a new term for the branch of science which is to include these figures, viz., Keraunography (from κεραυνος, thunder). I do not think it necessary to seek for new laws to explain these effects, but I should not place the impressions of metal and other objects in the same class with the tree-like figures. The experiments of M. Fusinieri on the transference of metallic particles from one conductor to another are calculated to explain many of these cases; but details of this kind have already been included in the ordinary treatises on electricity.

P.S.—Since this paper was read before the British Association, a case has come to my knowledge which confirms my theory—namely, that the tree-like impressions sometimes found on the bodies of men and animals struck by lightning are produced by the figures which the lightning itself assumes in striking the earth. Conversing on this subject with Mr Charles Pooley of Weston-super-Mare, he informed me that some time ago, on examining a tree which had been stripped of its bark by a stroke of lightning, he found the inner surface of the bark to contain ramified impressions of the lightning, corresponding with those described in the above paper. Specimens of this bark were forwarded to Professor Faraday, and are now in the Museum of the Royal Institution of London. I hope to be able to describe the particulars of this case in the next number of this Journal.

On the Capabilities for Settlement of the Central Part of British North America. By JAMES HECTOR, M.D., F.G.S., &c.*

The following remarks refer to a portion of the British territories to which much public attention was directed a few years ago—namely, the region which extends from Lake Superior to the Pacific Ocean, lying immediately north of the boundary line of the United States, and drained principally by the River Saskatchewan.

As it was, and indeed—excepting that portion which falls within British Columbia—is still, under the direct control of the Hudson's Bay Company, for the purposes of a fur-trading monopoly, a considerable amount of agitation was employed in Canada, and also at home, in order to have the country I treat of thrown open for settlement, and many statements have gone forth giving an exaggerated view of its worthlessness on the one hand, or of its wonderful qualities on the other.

It is now, however, placed beyond doubt, principally through the labours of several Government expeditions, to one of which I had the honour to be attached, that there do exist within the British territories that I have mentioned extensive areas, with good and varied soil, adapted for agricultural colonisation, but which, from their geographical position, are necessarily subject to all the advantages and defects of a temperate continental climate. Thus the winter is long and severe, the spring short and uncertain, and the summer tends to scorch the vegetation.

But yet in this region the winter is not more severe than that experienced in Canada; and in the western districts, which are removed from the influence of the great lakes, the spring commences almost a month earlier than on the shores of Lake Superior, which is five degrees of latitude further to the south.

On the other hand, the higher latitude, combined with its increased altitude above the sea-level, reduces the effect of the sun's heat in summer so much, that many crops which are readily raised in Canada will not meet with equal success in the Saskatchewan. All common cereals and green crops have been grown successfully, however, even though night frosts are experienced throughout the entire summer.

* Read before the British Association, Manchester, September 10, 1861.

The depth of the snow is never excessive, while in the richest tracts the natural pasture is so abundant, that horses and cattle may be left to obtain their own food during the greater part of the winter; and with proper care and management there is no doubt that, as far as climate is concerned, sheep also might be reared, were it not for the immense packs of wolves which infest the country.

It is only during the month of March, when the snow acquires a tough glassy crust from the heat of the mid-day sun being each night followed by hard frost, that stock would require to be housed and fed.

These remarks apply, however, more especially to what has been termed the "Fertile Belt," and the nature of which I will endeavour to explain.

The wonderfully fertile savannahs and valuable woodlands of the eastern United States are succeeded to the west by a more or less arid desert, which occupies a region on both sides of the Rocky Mountains, and presents a barrier to the continuous growth of settlements between the valley of the Mississippi and the rich states of the Pacific coast, and at present only occupied by one spot of civilisation, the Mormon city at the Great Salt Lake.

Under such disadvantageous physical conditions, it is not likely that any line of route for rapid or heavy transport across this desert will be remunerative, while its construction, in the present disturbed state of American politics, may be indefinitely delayed. Nevertheless, during the last seven years, our sharp-witted and prompt-acting cousins have been spending much money in having every possible route thoroughly explored and surveyed; and were their domestic troubles over, there is no doubt that they would revert to their attempts to bind together their eastern and western provinces.

It is therefore highly satisfactory for us, as British subjects, to know that the arid region extends but a short way to the north of the 49th parallel of latitude, which is the position of the boundary line, and that even the small area of desert within our territories derives its character more from the nature of the soil than from the general climatic conditions.

The British portion of the arid country is a triangular region, its apex reaching to the 52d parallel, while its base, applied along the 49th, extends between Long. 100° and 114° W. It contains, however, many varieties of land, and some limited areas that are really even good; but, on the whole, it must be described as deficient in wood, water, and grass.

Round the northern border of this arid district sweeps the "Fertile Belt" of country which I before mentioned. It is nothing more than the ill-defined boundary of the bald plains from the gloomy woodlands of the circum-arctic forests. As it forms the favourite camping grounds of the Indian tribes, the habit which these savages have of burning the vegetation has gradually improved this country for the purposes of settlement, by clearing off the heavy timber, to remove which is always the first and most arduous labour of the colonist. The "Fertile Belt," which thus possesses all the good qualities of rich soil and an abundant growth of the nutritious leguminous plants of a woodland country, but associated with open expanses ready for the plough, or for depasturage, stretches from the wooded country at the south end of Lake Winipeg in a north-west direction continuously to the Rocky Mountains, so that the westward progress of settlement will not meet with the same obstacle that checks it within the United States.

We thus perceive that in some respects the Saskatchewan country compares favourably with Canada; but we must not forget that the valuable timber trees, which are such a great source of wealth to that province, totally disappear as we proceed to the west, only very few of them ever reaching the longitude of Lake Winipeg. Beyond that, in the northern thick woods, the coarse and worthless white spruce, with a few small birches, poplars, and willows, compose the forest growth, while in the "Fertile Belt" almost the only tree is the aspen poplar, which forms very artificial-looking groves and clumps, that add greatly to the beauty of the scenery, but are useless beyond giving shelter and yielding a very inferior quality of firewood.

With all its disadvantages, the Saskatchewan country offers a most desirable field to the settler who is deficient in capital, and who has no desires beyond the easy life and moderate gains of simple agricultural occupations; and it is only the difficulty of access to it that, for the present at all events, prevents its immediate occupation.

Three routes are at present in use by which the country is entered. One is from Hudson Bay, by a broken land and water carriage, rough and cumbrous in its nature, but which has hitherto been the one principally used by the Fur Company. Even they, however, have almost abandoned it now in favour of the third route I shall mention.

The second route is from Lake Superior to Lake Winipeg, and also involves many changes from water carriage to land transport, and never could be used for the introduction of live stock or the conveyance of heavy goods. The only advantage which either of these routes could possess for us is from their both being within British territory.

The third route, which is undoubtedly the natural line of ingress to the country, but, unfortunately for us, passes through American territory, is up the valley of the Mississippi River to the Red River settlement by way of St Paul's, Crow Wing, and across the low-water shed which there divides the waters of the Mississippi from those flowing to Hudson Bay.

A large portion of the rich fertile plains of Red River lie to the south of the boundary line, and are already being rapidly occupied by American settlers. An American steamer now plies on that river for a few trips each season, and a railway is projected, and the line partly surveyed, to connect St Paul's with Paulina, where there is a new town situated on the frontier. This route, even at present, is extremely convenient and easy for the emigrant, as it passes through prairie country, so that he incurs no expense for the food of his animals when travelling. There can be little doubt, that if a railway is once constructed by this route, it will become a permanent, and doubtless the favourite, line of communication, and against it no other will be able to compete successfully.

If there were a prospect of the western prairies being soon occupied by a producing population, it might in that case be remunerative to have a line of railway constructed entirely within the British territory that would have for its object the connection of Canada with our new colonies on the Pacific coast; but this would justly rank as a great national enterprise, in value much beyond the more western extension of our Canadian provinces.

From the large and flourishing agricultural settlement of whites and half-breeds at Red River, the population of which is now about 8000 souls, such a line of railway might pass westward through the "Fertile Belt" without encountering any serious engineering difficulties. It has been frequently stated that in the Prairie country nothing would be required but the mere laying of the rails; but this is a total misconception of the physical features of the region. The prairies are very rarely level, except over small areas. They have undulations that often swell to the height of several hundred feet, or for miles the traveller winds among abrupt conical eminences; and it is only the general absence of timber, and the sameness of the scenery, that deceive the eye, and give the appearance of flatness. Moreover, throughout the greater part of the Prairie country, not only all the large rivers, but even small and insignificant streams, flow in valleys, with steep sides, deeply depressed below the general level; and these valleys would require the construction of bridges, and often in districts far distant from a supply of any proper building materials. Nevertheless, I believe I can safely state, that in proportion to the extent of mileage, small engineering expenses would be incurred until the Rocky Mountains are reached.

We now know that this chain does not present any bar to the construction of a railway, as there are several passes which will admit of easy gradients through valleys so wide as to afford great variety in the choice of ground for locating the line.

The mountains proper are not more than 50 to 60 miles broad in the latitude that would be most probably chosen for the line of route, namely between 50° and 52°, when, on crossing them to the west, the gold-bearing valleys of British Columbia are reached. Indeed, within the last few weeks I have received letters from the Saskatchewan stating that gold has been discovered in the bed of that river at the Rocky Mountain House, which is 40 miles to the east of the mountains, and quite in the plain country. Two hundred miles further down that river I have seen a few specimens of gold washed out, but I doubt much if it will ever be worked with profit on the east side of the Rocky Mountains within the British territories, as there is no trace on that side of the axis of the ancient rocks from which it must have been derived.

In the rugged country that lies between the Rocky Mountains and the Pacific coast, I have no doubt that all the valleys are filled with rich auriferous deposits, and every few months accounts arrive of "diggings" discovered in fresh localities. The most recent of them was in a letter from Lieut. Wilson, who is attached to the Commission at present engaged in surveying the boundary line from the Pacific coast to the mountains, and who mentions that a rush has taken place to a point on the Kootani River.

In carrying a line of railway through this region of British Columbia, the difficulties to be overcome by the engineer are very great. The surface of the country is broken by low mountain chains that run parallel with the coast, and the narrow valleys by which the rivers break through these are rugged in the extreme, but to develope the mineral wealth of this country will in any case require the construction of roads, and would afford more inducement to the laying out of money on this than on any other part of the route.

The rush of diggers into the new country will ensure for it an active though temporary settlement; but those mineral products which it possesses, and which can only be reached by steady energy and the employment of capital, will retain a considerable permanent population, and give that solidity of wealth which alone would warrant the construction of a line of railway through a difficult and otherwise unproductive country. Throughout the Saskatchewan country there are deposits of coal, which, although not to be compared in quality with that we are familiar with in this country, yet are of considerable value. Coal of a similar geological formation, but of somewhat better quality, also occurs on Vancouver's Island and the opposite mainland, near the mouth of Fraser River; and at the former locality it is worked, and finds a market as ordinary fuel, for the manufacture of gas, and, above all in importance to us, for the supply of our steam navy. It answers well for the generation of steam; and the occurrence of this coal on Vancouver's Island, which possesses magnificent harbourage, renders that colony a valuable link in a chain of communication with China and the East Indies, by way of a route across the North American continent.

On Some Modifying Elements affecting the Ethnic Significance of Peculiar Forms of the Human Skull. By DANIEL WILSON, LL.D., Professor of History and English Literature, University College, Toronto.

The antiquity and wide geographical diffusion of the practice of cranial deformation on the American continent have tended in some degree to divert the attention of craniologists from causes, some at least of the operations of which have been long recognised in other departments of natural history. The palæontologist is familiar with the occurrence of skulls distorted or completely flattened, and even with solid bones and shells greatly changed in form by compression. It was due to such compression transforming the skull of a fossil batrachian into some rude resemblance of the human cranium, that the famous *Cryptobranchus Scheuchzeri,* found in a quarry at Œningen in 1725, was announced to the world in M. Scheuchzer's "Homo Diluvii Testis et Theoscopos," as the remains of one of the sinful antediluvians who perished in the Noahic deluge! In some of such examples, the palæontologist looks in reality only on the cast of the ancient bone or shell, compressed, along with its matrix, probably at a date long subsequent to its original deposition. But in the following examples of similar changes affecting the human skull, it will be seen that the distortion by which the crania now referred to have acquired their abnormal shapes must have taken place at no long period subsequent to inhumation, while the animal matter still remained in such abundance as to preserve the flexibility of the bones; and even in some cases, when the soft tissues still existed, to resist the fracture consequent on the pressure of the superimposed weight of earth or stone.

In the Museum of the University of Toronto, a female skull is now preserved, recovered in 1859 from an ancient Indian cemetery on the Georgian Bay. It is marked by considerable prolongation of the occiput, and is essentially a dolichocephalic cranium; but the natural excess in the longitudinal diameter has been exaggerated by great lateral compression, under which the left parietal and temporal bones, after being depressed and flattened, have at length partially yielded at the squamous suture. The head appears to have lain on the left side, and to have been subjected to slow continuous pressure, which modified the contour of the lower side before the bones gave way at the suture. The measurements of this skull are :—

Longitudinal diameter, . . .	7.40
Parietal diameter, ...	4.95
Frontal diameter, ...	4.10
Vertical diameter, ...	5.35
Intermastoid arch, ...	13.30
Occipito-frontal arch, ...	14.00
Horizontal circumference, . . .	20.00

In an interesting paper on "Aboriginal Antiquities recently discovered in the Island of Montreal," published by Dr Dawson in the "Canadian Naturalist," he has given a description of one female and two male skulls, found along with many human bones, at the base of the Montreal Mountain, on a site which he identifies, with much probability, as that of the ancient Hochelaga, an Indian village visited by Cartier in 1535, and which he assigns on less satisfactory evidence to an Algonquin tribe. Since the publication of that paper, my attention has been directed by Dr Dawson to two other skulls, a male and female, discovered on the same spot, both of which are now in the Museum of M'Gill College, Montreal. One of these furnishes a still more striking example of a cranium, greatly altered from its original shape subsequent to interment. It is the skull of a man about forty years of age, approximating to the common proportions of the Iroquois and Algonquin cranium, but with very marked lateral distortion, accompanied with flattening on the left and bulging out on the right side. There is also an abnormal configuration of the occiput, suggestive at first sight of the effects produced by the familiar native process of artificial malformation. This tends to add, in no slight degree, to the interest which attaches to the investigation of such illustrations of abnormal craniology, as the occurrence of well-established examples of posthumous deformation among crania, purposely modified by artificial means, exhibits in a striking manner the peculiar difficulties which complicate the investigations of the naturalist when dealing with man. The evidence which places beyond doubt the posthumous origin of the distortion in this Hochelaga skull is of the same nature as that which has already been accepted in relation to an example recovered from an Anglo-Saxon cemetery at Stone, in Buckinghamshire. The forehead is flattened and greatly depressed on the right side, and this recedes so far, owing to the distortion of the whole cranium, that the right external angular process of the frontal bone is nearly an inch behind that of the left side. The skull recedes proportionally on the same side throughout, with considerable lateral development at the parietal protuberance, and irregular posterior projection on the right side of the occiput. The right superior maxillary and malar bones are detached from the calvarium, but the nasal bones and the left maxillary remain *in situ*, exhibiting in the former evidence of the well-developed and prominent nose characteristic of Indian physiognomy. The bones of the calvarium, with one slight exception, have retained their coherence, notwithstanding the great distortion to which it has been subjected, though in this example ossification has not begun at any of the sutures. The exception referred to is in the left temporal bone, which is so far partially displaced as to have detached the upper edge of the squamous suture. Part also of the base of the skull is wanting.

The posthumous origin of the distortion of this skull is proved beyond dispute on replacing the condyles of the lower jaw in apposition with the glenoid cavities, when it is found that, instead of the front teeth meeting the corresponding ones of the upper maxillary, the lower right and left incisors both impinge on the first right canine tooth, and the remaining teeth are thereby so displaced from their normal relation to those of the upper jaw, as to preclude the possibility of their answering the purpose of mastication—which their worn condition proves them to have done,—had they occupied the same relative position during life.

The extreme distortion which this skull has undergone is still more apparent when looking on it at its base. The bone has been fractured, and portions of it have become detached under the pressure, while the mastoid processes are twisted obliquely, so that the left one is upward of an inch in advance of the right.

The circumstances under which this Indian skull was found tend to throw some light on the probable process by which its posthumous malformation was affected. It was covered by little more than two feet of soil, the pressure of which was in itself insufficient to have occasioned the change of form. The skull, moreover, was entirely filled with the fine sand in which it was embedded. If, therefore, we conceive of the body lying interred under this slight covering of soil until all the tissues and brain had disappeared, and the infiltration of fine sand had filled up the hollow brain-case; and then, while the bones were still replete with animal matter, and softened by being filled with moist sand and embedded in the same, if some considerable additional pressure, such as the erection of a heavy structure, or the sudden accumulation of any weighty mass, took place over the grave, the internal sand would present sufficient resistance to the superincumbent weight applied by nearly equal pressure on all sides, to prevent the crushing of the skull or the disruption of the bones, while these would readily yield to compression of the mass as a whole. The skull would thereby be subjected to a process in some degree analogous to that by which the abnormal developments of the Flathead crania are effected during infancy, involving, as it does, great relative displacement of the cerebral mass, but little or no diminution of the internal capacity. The discovery of numerous traces of domestic pottery, pipes, stone implements, and weapons, in the same locality, furnishes abundant proof that it was the site of the Indian village as well as the cemetery, and thereby demonstrates the probability of the erection of such a structure, or the accumulation of some ponderous mass over the grave, at a period so near to that of the original interment as would abundantly suffice to produce the change of form described. To some such causes similar examples of posthumous cranial malformation must be ascribed; as they are so entirely exceptional as to preclude the idea of their resulting from the mere pressure of the ordinary superincumbent mass of earth.

Another skull found in the same ancient Indian cemetery, apparently that of a female, and now in the collection of M. Guilbault, of Montreal, has also the appearance of having been modified in form by artificial means, whether posthumous or otherwise. The superciliary ridges are prominent, the frontal bone is receding, but convex, and the occipital bone has considerable posterior projection, which is rendered the more prominent by a general flattening of the coronal region, and a very marked depression immediately over the lambdoidal suture, probably the result of unequal posthumous compression. The abnormal conformation of this skull is shown in the proportions of the intermastoid arch, which measures only 11·75, while the normal mean, so far as ascertained by me from measurements of thirty-three examples of Algonquin crania, is 14·34, and of thirty-six examples of Huron crania is 14·70.

The great importance now justly attached to the form and relative proportions of the human skull, as elements of classification in physical ethnology, confers a new significance on all external forces affecting its normal ethnic condition. Influences artificially superinduced upon those conditions which, in relation to all other animals, would be regarded as their natural state, tend greatly to complicate that novel department of Natural History which deals with man as its peculiar subject; and in no respect is this more apparent than in the form of the human head. It is man's normal condition to be subjected to many artificial influences; and this fact must never be lost sight of by the ethnologist. In the rudest stage of savage life, which is sometimes, on very questionable grounds, characterised as a state of nature, man clothes and houses himself, makes and uses weapons and tools, and subjects his infant offspring to many influences dependent upon hereditary custom, taste, or superstitious obligations. All those tend to leave permanent results stamped on the individual, and, when universally practised, confer on the tribe cr nation some artificial ethnological characteristics which are nevertheless as essentially foreign to any distinctive innate peculiarity as tatooing, circumcision, or other similar operation admitting of universal application. The naturalist has to deal with nothing analogous to this among the most ingenious and constructive of the lower animals.

Diverse physical characteristics have been noted among the various tribes of mankind, but concurrent opinion points to the head and face as embodying the most discriminating tests of ethnic variety. Yet these are the very features most affected by artificial appliances. Tatooing, nose, lip, and ear piercing; filing, staining, and extracting the teeth; staining the eyelids, shaving and plucking the head and beard, all effect important changes on the physiognomy. Nor is the head more constant in its proportions. Undesignedly and with deliberate purpose alike, artificial means tend to modify the shape of the human skull, and so to introduce elements of confusion and error into any system of classification based on cranial conformation, in which such sources of change are overlooked. In one respect, however, the American ethnologist might seem to incur little risk of such oversight. The barbarous custom of giving artificial forms to the skull is practised as sedulously at the present day among the Flathead tribes of the Pacific, as by the Peruvians before the conquest of Pizarro, or on the shores of the Euxine among the Scythian Macrocephali in the days of Hippocrates. The effects resulting from this practice have accordingly assumed a prominent place among the phenomena specially distinctive of American ethnology. But, on this very account, such artificial cranial distortion, especially among ancient and modern American tribes, now receives so much attention from the craniologist, that we are apt not only to forget how entirely this barbarous practice had been lost sight of until the recent revival of the subject, as one necessarily involved in determining the true significance of generic forms of the human head in the deductions of physical ethnology; but also to ignore all other causes tending to produce corresponding results.

The possibility of artificial modifications of the form of the human skull, after having been denied by Sabatier, Camper, and Artaud, was reasserted in strong terms by Blumenbach, when describing a flattened Charib skull brought from the island of St Vincents. Nevertheless opinions oscillated with varying uncertainty on this disputed question; and even after the publication of Dr Morton's "Crania Americana" had furnished a complete history of the practice, and abundant illustrations of its results, the artificial origin of such cranial malformation was still denied by eminent anatomists and physiologists. The celebrated anatomist, Tiedemann, after careful inspection of the distorted skulls brought by Mr Pentland from the ancient sepulchres of Titicaca in Peru, still maintained that their singular forms were entirely due to natural causes; and this idea appeared to receive remarkable confirmation from opinions published by Dr Tschudi, after personal examination of numerous skulls and mummies exhumed during his travels in Peru. Without denying that some of the peculiarities of cranial conformation frequently observed in skulls found in ancient Peruvian graves are the result of artificial deformation, purposely superinduced by bandaging and mechanical pressure during infancy, Dr Tschudi maintains that diverse natural forms of skull pertain to different ancient races of Peru, and especially that one peculiar and extremely elongated form of head is a natural Peruvian characteristic; in confirmation of this he not only refers to mummies of children of less than a year old, belonging to the tribe of Aymaraes, exhibiting the dolicocephalic proportions observed in adult skulls, but the very same specialities which he had noted in adult crania of the Huancas came under his observation in more than one mummied fœtus, which could not have been subjected to any artificial apparatus for the purpose of modifying the cranial configuration. In proof of this, he makes special reference to a fœtus in his possession found enclosed in the womb of a mummy discovered in 1841, in a cave at Huichay, two leagues from Tarma, in Peru. Professor D'Outrepont, an experienced obstetrician, determined the age of the fœtus at about seven months; and Dr Tschudi refers to his illustrative drawing of it as affording interesting and conclusive proof, in opposition to opinions advanced by the advocates of mechanical pressure as the sole cause of the remarkable cranial forms recovered from Peruvian sepulchres. Similar proofs are also stated by him to be furnished by another mummy, preserved under the direction of Don Mariano Edward de Rivero, in the National Museum at Lima. The heads exhibit a flattened, receding forehead, and a remarkable posterior elongation; and these characteristics are no less markedly noticeable in another example, from the same Lima collection, figured by Dr Tschudi in his "Antiguedades Peruanas," of a mummied child of the Opas Indians. Its form, as shown both in profile and vertical view, is only comparable to the most depressed skulls of the Chinouk Indians; while in the vertical or front view, it is seen to be exceedingly unsymmetrical. The right side is considerably in excess of the left, as is frequently the case in the elongated skulls of the Flatheads of Oregon and British Columbia; and to those familiar with the irregular development of artificially compressed heads, the idea of mechanical pressure is at once suggested as the cause of some of the peculiar cranial characteristics of this Lima mummy.

There is conclusive evidence, I conceive, to prove that there were essentially distinct dolichocephalic and brachycephalic tribes among the ancient Peruvians; and that a markedly elongated head was common, apart from any artificial anterior depression and abnormal elongation to which it was frequently subjected. This question has been discussed, with varying results, in more than one of Dr Morton's papers, though latterly he appears to have rejected the idea of two or more distinct cranial types, in favour of his theoretical unity of the American race. I have been confirmed in the belief in the existence of such essentially diverse South American cranial types after examining numerous Peruvian crania, including those of the Morton Collection, along with later additions, in the cabinet of the Academy of Natural Sciences at Philadelphia; and especially from recent careful study of a collection of Peruvian mummies and skulls, including both normal and compressed dolichocephalic crania, brought from ancient cemeteries of South America, by Mr John H. Blake, and now preserved in his collection at Boston, along with other interesting illustrations of the ancient arts and customs of the Peruvians. This primary distinction in the forms of Peruvian crania, apart from the changes wrought on them by artificial means, must be borne in remembrance while estimating the bearings of such evidence as that adduced by Dr Tschudi from the Opas Indian mummy; for assuredly no conceivable amount of change in the progress from infancy to maturity could convert the elongated head figured in Rivero and Tschudi's Atlas into the brachycephalic cranium frequently pertaining to the ancient Peruvian adult. But while evidence derived from various sources tends to confirm the opinion that at least two, if not three, essentially distinct forms of head prevailed among the ancient Peruvians, the evidence produced by Dr Tschudi fails to prove that the examples referred to by him ought to be accepted as illustrations of a normal cranial type.

In this as in so many other departments of Ethnology, the naturalist cannot be too frequently reminded that the most primitive condition of man's savage life is an artificial one when compared with that of any of the lower animals. With man alone the osteologist finds his investigations complicated by altered forms produced by artificial means; and under this head must be included the accidental and undesigned, as well as the purposely superinduced changes effected on the human frame, and especially on the skull; while to causes thus operating to modify or counteract the normal vital functions, have to be added others, illustrated by the examples produced above, and clearly traceable to a posthumous origin.

The intra-uterine position of the Huichay Cave fœtus furnishes indisputable proof that its peculiar cranial development is not due to art—if by this is understood the application of mechanical pressure with an express view to the production of such configuration; but this by no means exhausts the possible sources of abnormal modification. It may be the undesigned result of mechanical pressure inevitable in the process of desiccation, accompanied as it invariably was, in the case of Peruvian mummies, with the forcing of the body into a crouching position, in which the legs were compressed upon the abdomen, and the arms folded across the chest. The naturalist who aims at applying the deductions of physical ethnology to the determination of ethnic classification, cannot content himself with accepting such osteological evidence as presents itself to him, in the unquestioning spirit which may be permissible in other branches of natural history. The most anthropoid of the inferior animals has not as yet been affirmed to cradle, bandage, or clothe its young; or to mummify or inter its dead. With rare exceptions, therefore, the comparative anatomist finds their skeletons in a uniform normal condition, and is justified in assigning a specific classification to distinctive cranial forms. But it is otherwise with the naturalist when he has man as the object of his study. Every scheme by which the ethnologist aims at systematising ethnic variations of cranial configuration, implies the recognition of national diversities in the form and proportions of the human head; but before attempting to determine their classification and significance, it is important to eliminate the various elements of extrinsic change. These, then, may be stated as follows:—

I. Undesigned changes of form superinduced in infancy by bandaging or other custom of head-dress; by the form of pillow or cradle-board; and by persistent adherence to any unvarying position in suckling and nursing.

II. Artificial deformation undesignedly resulting from the habitual carrying of burdens on the head, or by means of straps or bandages pressing on any part of the skull, when such is continued from early youth.

III. Artificial configuration designedly resulting from the application of mechanical pressure in infancy.

IV. Deformation resulting from posthumous compression, or any mechanical force brought into operation after death.

The first of those four classes has hitherto been overlooked, I believe; yet several remarkable instances have come under my own observation; and especially two examples of strikingly unsymmetrical heads, which appear to be clearly traceable to the fact that in both cases the mother was only able to suckle at one breast, and hence the infant skull, while still in a soft and pliant condition, was constantly subjected to lateral compression only on one side. Even the persistent habit of carrying and laying to sleep on the same side may permanently affect the form of the infant head.

In relation to the second class, my observations have been directed to the heads of Scottish fishwives and porters, and to

Indian squaws, all of whom carry heavy burdens by means of a strap over the head or across the forehead, and to Edinburgh bakers, who carry their bread-boards on the crown of the head. But it seems doubtful if the form of the skull is ever in any material degree affected, unless pressure is applied in very early life.

The third cause of artificial configuration is now universally recognised, though it is possible that, in referring to the mummy of the Opas child preserved in the national collection at Lima, Dr Tschudi ignores results produced even by this familiar source of cranial deformation; for the unsymmetrical form of the head figured by him is strongly suggestive of mechanical pressure, whether designedly or undesignedly applied during life, or arising solely from the rude processes of mummification. But, where the more general custom of inhumation prevails, another source of undesigned and posthumous compression comes into play, some results of which find striking illustration in the Indian skulls described above. To this neglected element of error in the ethnic value of cranial forms, attention was first directed by Dr Thurnham, in describing the skull of a man about sixty years of age, found, in 1850, at the village of Stone, near Aylesbury, Buckinghamshire, along with an iron spearhead and knife, the umbo of a shield, and other relics, clearly recognisable as of the common forms and characters pertaining to Anglo-Saxon pagan sepulture. This skull attracted attention from features of an unusual and striking character. It is marked by distortion, not only involving the most unsymmetrical deformity,—the whole right side of the skull having been thrust forward, and the left side proportionally thrown back, with great lateral protrusion of the right temporal and parietal bones,—but the articulating surface of the right temporal bone has been forced so much in advance of the left side as to render it no longer possible to replace the lower jaw, which retains its normal form. The remarkable distortion which this skull has undergone without the displacement or fracture of the bones of the calvarium, led at first to considerable difference of opinion as to the causes to which such singular malformation ought to be ascribed. But the impossibility of the essential vital functions of the jaws having been performed if the temporal bones had existed during life in the same unconformable relation to the lower jaw, left no room to doubt that the distortion had been produced subsequent to inhumation. Mr J. B. Davis has accordingly devoted special consideration to the general subject of "posthumous distortion," when treating, in the "Crania Britannica," of various sources of abnormal cranial conformation; and refers to it as "another and distinct mode which will in future be required to be taken into consideration in all investigations having reference to deformed crania." At the same time Mr Davis accumulates additional evidence in confirmation of the opinion that the artificial distortion of the human head is by no means limited to the savage tribes of the New World; and discusses not only its practice among the ancient Macrocephali, including the received theory of Hippocrates that such artificial forms may be at length perpetuated by natural generation, but also "the extraordinary fact, that the practice of distorting the skull in infancy is not yet extinct even in Europe." To this curious inquiry the attention of some of the distinguished physiologists and anatomists of France has been directed; and the result of the combined observations of MM. Foville and Gosse, along with those of M. Lunier, is to satisfy them that in different departments of France the practice of applying constricting coverings and bandages to the heads of infants still prevails; and that certain diversities of cranial configuration in some of the provinces, and especially in Normandy, Gascony, Limousin, and Brittany, are traceable to prevalent modes of infantile head-dress. It detracts considerably from the force of such conclusions, that the most remarkable examples produced by Dr Foville are derived from inmates of lunatic asylums; whereas the result of numerous independent observations on the Flathead tribes of the Pacific tends to prove, that whatever may be the increase of mortality in infancy produced by the barbarous practice of cranial deformation, the adults exhibit no mental inferiority to other Indians. On the contrary, they are objects of dread to the neighbouring tribes, among whom no such practice prevails, enslaving them, and retaining them in degrading servitude, while they rigorously exclude their slaves from the privilege of distorting the heads of their offspring, so that the normal head is with them the badge of servile inferiority. Mr Davis has figured a distorted skull of an aged French woman in his collection, believed to have been the inmate of a lunatic asylum in one of the Southern Departments of France. It is produced in illustration of the most usual variety of deformation, denominated by MM. Foville and Gosse the *tête annulaire;* but though of somewhat brachycephalic proportions, there is nothing in the profile view, which is the only one given, calculated to suggest the idea of abnormal configuration.

From the various aspects which this craniological department of physical ethnology thus discloses to the inquirer, it becomes obvious that it is a greatly less simple element of classification than was assumed to be the case by Retzius, Morton, or any of the earlier investigators of national forms of the human skull. To the *brachycephalic* and *dolichocephalic* types of Retzius have now been added the *kumbecephalic*, the *platycephalic*, and the *acrocephalic;* and to the disturbing element of designed artificial compression, it is apparent we have also to add that of posthumous distortion as another source of change, affecting alike the mature adult, even when old age has solidified the calvarium into an osseous chamber, from which nearly every suture has disappeared, and the immature fœtus, in which adhesion of the plates of the skull has scarcely begun. When more general attention has been directed to this element of abnormal cranial development, additional illustrative examples will no doubt be observed by craniologists; and the circumstances under which they are found will help to throw further light on the peculiar combination of causes tending to produce such results.

On some Phenomena connected with the Drifts of the Severn, Avon, Wye, and Usk. By the Rev. W. S. Symonds, F.G.S., Rector of Pendock, Worcestershire.*

Last February I delivered an address, at the request of Sir Charles Hastings and the Council, before the Natural History

* Read at the meeting of the British Association at Manchester, Sept. 1861.

Society of Worcester, "On the Geology of the Railway from Worcester to Hereford," and this address was afterwards published in the Edin. New Phil. Journal for April. Since the publication of my paper, I have enjoyed the opportunity of accompanying Mr Prestwich, a well known and distinguished authority on the tertiary and post-pliocene deposits, to several of the most important localities for studying the drift phenomena in the Vale of Worcester; and I am now convinced that, in common with several other geologists, I have committed a serious error in my correlation of one of the most important of our drift deposits. I have also examined carefully, within the last few weeks, the drifts of the Wye and Usk, which appear to me to furnish some important problems for the investigation of the geologist.

Alluvial Deposits.—The first point we remark is the great difference which at present obtains in the deposition of silt and alluvium by such rivers as the Severn and Avon, compared with swift-flowing streams like the Wye and Usk, which have a fall of as much as 2½ feet in a mile along their general course. In some localities, the Wye has shifted its course, filled up its former channel, and cut out a new bed, within the memory of man. Mr Charles Richardson, C.E., in his contribution to the Edinburgh New Phil. Journal, entitled "Chronological Remarks on the River Wye,"* mentions an instance of the shifting of the course of the Wye, as proved by an old map, which gives the position of the celebrated Ross Oak, now known as the Burnt Oak, and the river as it flowed a century and a-half ago. A broad surface of meadow land now sweeps where the Wye then flowed, and the river now runs some 70 or 80 yards from the former bank on which that old oak stood. Indeed, many of the old inhabitants of Ross lately assured me that the channel of the River Wye, near the town, has been very much changed since their own remembrance. This, however, is not the case with respect to the smoothly-flowing Severn and sluggish Avon to anything like the same extent; for a Roman funeral urn, containing the ashes of the dead, has been found buried on the river banks,

* Edin. New Phil. Journal, July 1857.

near the Haw Bridge, between Tewkesbury and Gloucester. The urn was open at the top, and the ashes must have been washed out had the urn been drifted; besides, I am assured by Mr Strickland of Apperley Court, who possesses this relic, that the urn was found *perfectly upright*, and had evidently *been buried* where it stood. Deerhurst Church, a little higher up, is known also to have been of Anglo-Saxon date, and stood in Saxon times much in the same position with respect to the Severn as at present. I therefore believe that the River Severn flows in much the same channel, between Worcester and Gloucester, as in the days of the Romans.

The point, however, to which I would direct attention is this, that all these rivers may alter their course and destroy and re-form their alluvia over and over again, for age after age, without in the slightest degree changing their courses, save as regards the level alluvial land. The results arrived at by Mr Richardson, from mathematical and arithmetical calculations, are, that the Wye has flowed between its boundary of the Old Red rocks of the Ross district for more than eleven millions of years. I do not pretend here to enter into the elaborate calculations on which Mr Richardson has come to this determination, but I must say that I have been lately very much impressed with the evidence of antiquity furnished by the alluvial deposits of our rivers of Worcestershire, Herefordshire, and Monmouthshire, and I do not see how we can deal with them in any way without allowing enormous periods of time.

The Lake Period.—It is well known that there was a time, antecedent to the present configuration of land and river surface, when the Severn, Avon, and Wye flowed, as the River Shannon does now, through a chain of lakes of various sizes, and which lakes are now silted up and form the celebrated "holms" or river meadows. I inferred that the relics of the great quadrupeds found so abundantly on the banks of the Avon, at Bricklehampton, and Cropthorne, and at Kempsey, and other localities on the Severn, were disinterred from banks of mud, silt, and gravel, which were formed on the *shores* of the ancient lakes. It is here that I would correct the inferences that might be drawn from my correlation of these drifts, which contain the remains of the hippopotamus, rhinoceros, elephant, cave hyena, and extinct oxen and deer, with the deposits of the *Lake epoch.* They belong to a *distinct epoch*, and offer a *distinct history.* Since I had the pleasure of seeing Mr Prestwich, I have examined all the evidence I could collect respecting the relics found in these old lake silts, but I cannot obtain one well-authenticated specimen of the bones of the *extinct mammalia* from the *lacustrine silts*, excepting the horns of *Bos longifrons.* We have many bones of existing animals, such as deer, sheep, and ox, from the lacustrine drifts, in Worcester Museum. During the cutting of the Tewkesbury Docks, the engineer, Mr Alfred Leader Williams, found a fine antler of red deer covered by upwards of 37 feet of lacustrine silt and alluvium. A jar of ancient pottery, which I believed to be Roman, but which I now think must be more ancient still, was also found by Mr Williams at the depth of thirty feet.* It was lying in a black silt, which also contained nuts and pieces of wood, and below which, at a depth of ten feet, was a bed of gravel. I also believe that the human skeleton which was disinterred at the depth of sixteen feet when the foundations of the Defford Bridge on the Avon, between Tewkesbury and Worcester, were laid, belongs to the *Lake period.* I do not see how we are to avoid the conclusion that man lived in the Lake period in Worcestershire.

Mr Prestwich has convinced me that certain drifts and gravel beds above the Avon, Severn, and other rivers, which he designates as "low level drifts," are altogether antecedent to, and independent of, the detritus which fills up the beds of the former lakes. They belong to a distinct epoch, and represent an entirely different water surface. Instead of dipping under or into the lacustrine deposits, in many localities they dip away from the old lake silts and are slightly upheaved. They are, in fact, the relics of broad, and probably rapid rivers, of which the former channel must have been 30 or 40 feet above the level of the silted-up lakes.

The period of the "low-level drift" was then anterior to that of the Lake epoch in this part of England; and it is in these

* This jar is in the possession of Sir Charles Lyell.

beds that the explorer finds such numerous relics of the extinct mammalia. It is in these beds, or in their equivalents, that M. Boucher de Perthes, Sir C. Lyell, Mr Prestwich, and many other geologists, have detected flint implements of human manufacture associated with the relics of the great mammals, now extinct on the continent of Europe; and it is from the study of the physical geology of these drifts that the best authorities in the world have been led to infer the very ancient creation of the human race. These beds are well developed near the Avon at Bricklehampton, and Cropthorne, at Upton on Severn, and near the Oxeye gate, about a mile from Tewkesbury, on the Ledbury high road. Near Worcester, they may be seen in various localities ranging above the margins of the former lakes. I find these drifts also well developed on the banks of the Wye near Hereford, and on the road to Hay. At Brecon, I found a most interesting old river margin of well stratified sand with rolled pebbles, on the slope of a hill, and at a height of 50 or 60 feet above the river Usk. The locality is Heolhîr, or the long Lane, a little way south of Llanfaes. The sand is now being quarried for the building of the new college; and my friend, the Rev. Reece Price, who conducted me to the spot, has promised to give every attention to mammalian remains or flint implements, if haply they should be found.

High-Level Drift.—I would finally call attention to certain gravels and drifts which are found at a *much higher* level above the river courses than the drifts just alluded to. These gravel beds cap the summits of very considerable hills in the vale of Worcester. They occur on Tunnel Hill at Upton on Severn, on the summit of Corsewood Hill, on Ryal Hill, and at Elmore near Gloucester. They are found along the flanks of the Malverns, where they have yielded the remains of *Elephas antiquus*, and *Rhinoceros tichorinus*, animals that lived during the glacial period, and are therefore properly associated with the northern drift. This drift was deposited, no doubt when the contour of Worcestershire and Gloucestershire was very different from that now presented to our view, and when the salt waves rolled over a sea strait, which reached from Malvern to the Cotteswoldes, the old Malvern Straits of of our distinguished President, Sir R. Murchison. I may here observe, also, that a fine molar tooth of *Elephas antiquus* has lately been found, by Henry Brooks, among the gravel which overlies the great masses of angular blocks heaped against the side of a hill, known as Clincher's Mill Wood near Ledbury. This angular debris I pointed out to Mr Prestwich, who agrees with me in attributing its deposition to the effect of coast ice drifting, during the glacial period, down one of the ancient Malvern bays.

I have also observed the *high-level drift* at several points in Herefordshire, the principal of which is an excellent section, near the Kite's Nest, on the Hay road, about four miles west of Hereford. There are many other subjects and localities, to which I would allude, but I have already trespassed upon your time, and sufficient has, I trust, been said, to correct the error I committed.

REVIEWS AND NOTICES OF BOOKS.

The Forests and Gardens of South India. By Hugh Cleghorn, M.D., F.L.S., Conservator of Forests, Madras Presidency. London: W. H. Allen & Co., 1861. Pp. 412, 12mo.

The conservancy and management of forests is a subject of great importance, not merely in reference to the supply of useful and valuable timber, but also as regards the climate of a country. The cultivation of good timber trees, which may be used in the construction of houses and ships, and for railway sleepers, demands the serious attention of all nations; and in countries where coal is wanting or deficient, the acquisition of wood for fuel is one of the necessaries of life. In many countries there has been too little attention paid to the preservation of trees, and valuable timber has been indiscriminately felled, while no steps were taken to replace what had been removed. Where new colonies have been planted in densely wooded countries, the first work of the settlers was necessary to clear land for the cultivation of crops; and as the population increased, the trees became less and less abundant. In some instances the felling has taken place in such a way as materially to injure the climate of the country, by diminishing the amount of moisture in the air, and by drying up the springs where water was obtained. In India, serious injury was done to the native forests from the want of proper regulations. Valuable forests of teak, sal, and sandal-wood were nearly exterminated from the want of judicious conservancy. The Indian government ultimately saw the importance of taking some steps in the matter, and they have most wisely appointed conservators in the different presidencies, whose duty it is to see that the trees are properly felled, and that the supply of timber is kept up by regular planting. Dr Cleghorn, who is the conservator in the Madras Presidency, and who is well known as an able botanist, has given in the volume now before us a full report of the forest operations under his control, and he has produced a work of great value, which ought to be in the hands of every one who takes an interest in forest cultivation, and in developing the resources of our Indian possessions. The following remarks, taken from the preface of the work, show what was required in the forest department in India:—

"It is only of late years that attention has been drawn to the importance of conserving tropical forests. The necessity of organising a system, whereby it would be possible to control the clearing of indigenous forests, did not at first present itself, especially as advancing civilisation and an increasing population apparently indicated an opposite course of procedure. The question, when viewed simply in its physical relations, and the propriety of clearing forest lands in order to enlarge the area of food-producing soil, pointed perhaps as much to extensive clearance as to vigilant conservancy. It is a fact, however, that moderate and prudent clearing is quite compatible with the maintenance of a profitable system of superintendence. The matter of complaint was, that throughout the Indian empire large and valuable forest tracts were exposed to the careless rapacity of the native population, and especially unscrupulous contractors and traders, who cut and cleared them without reference to ultimate results, and who did so, moreover, without being in any way under the control or regulation of authority. The results of this wholesale and indiscriminate denudation gradually became apparent, and rendered it imperative that measures should be taken to organise a system of forest administration, which would enable the authorities to economise public property for the public good.

"The subject was brought before the attention of the British Association for the Advancement of Science, which met at Edinburgh in 1850; and a committee of their number was appointed to consider the question, and report upon it. The matter was duly investigated, and the results of the committee's deliberations were laid before the Association at the ensuing meeting held at Ipswich in 1851. In the course of this inquiry, it was ascertained that neither the Government nor the community at large were deriving from the Indian forests those advantages which they were calculated to afford. Not only was there a most wasteful and uncalled-for destruction of useful material, but numerous products—valuable to science, and which might be profitably applied to the interests of social life—lay neglected within the depths of the forests. This report recorded evidence bearing on the state of the forests in Malabar, Canara, Mysore, Travancore, the Tenasserim provinces, the Indian Archipelago, and the wooded tracts which skirt the base of the Himalaya; and it was distinctly ascertained, that in Malabar, Burmah, and Sind, where some supervision had been exercised, considerable improvement was manifest."

In India, the forests in the Tenasserim province were early brought under a system of conservancy. Dr Wallich, in 1827, made a report on the Salween forest, north of Moulmein, and since that time rules have been framed to regulate and control the prospective condition of the forests. In 1846, the Bombay forest department was organised under the superintendence of Dr Gibson, and since his retirement it has been placed under the charge of Mr N. A. Dalzell.

In Madras, the forest department has been organised for upwards of four years, under the superintendence of the author of the present work. "The present volume was prepared at the instance of Government, principally for the purpose of furnishing a continuous view of forest conservancy in the Madras Presidency during the four years that the department has been in operation. One of the objects contemplated was to supply a manual to enable the forest assistants to act intelligently, and with good results to the State, in positions of responsibility. The want of such a hand-book has been frequently felt, not only in this department, but more or less by all who are practically interested in the natural products of India, and in their employment by different departments of public works.

"To the railway engineer, it is hoped that, even in its present form, it will prove of service, enabling him to acquaint himself with the various indigenous timbers, and their adaptation to the requirements of engineering in Southern India. The authorities of the several railway companies have repeatedly adverted to the want of a work such as the present, which could be placed in the hands of their *employés* arriving in the country ignorant of Indian woods, of their appearance, capabilities, and place of growth. Similar statements have been made by the authorities in England; and perhaps to some extent the present volume may supply the information required. The increasing opportunities and encouragement afforded for the development of European capital in India are calculated also to give a practical value to any work which will describe to the merchant or settler his exact relations to the Government, in regard to the forest products of the country."

The greater part of the contents of the volume are on record in the Archives of the Madras Government; but they are not easily accessible. Three annual reports are given, indicating the progress of the department, and these are followed by a memorandum on *Kumari*—an injurious practice, which destroys vast quantities of the most valuable timber, and which is thus described:—"Kumari is the name given to cultivation which takes place on forest clearings. A hill side is always selected, on the slopes of which a space is cleared at the end of the year. The wood is left to dry till the following March or April, and then burned. In most localities the seed is sown in the ashes on the fall of the first rains, without the soil being touched by implement of any kind; but in the tâluk of Bekul the land is ploughed. The only further operations are weeding and fencing. The crop is gathered towards the end of the year, and the produce is stated to be at least double that which could be obtained under the ordinary modes of cultivation. A small crop is taken off the ground in the second year, and sometimes in the third, after which the spot is deserted until the jungle is sufficiently high to tempt the kumari cutter to renew the process. In the south, where land is more scarce compared with the population, the same land is cultivated with kumari once in 12, 10, or 7 years; but in N. Canara, the virgin forest, or old kumari not cultivated within the memory of man, are generally selected."

The work contains important information regarding firewood and charcoal, trees for avenues, hedges, and wood for ship-building, furniture, and engraving. A report is given of the Bangalore and Utakamand gardens, with a catalogue of plants cultivated in the former. Suggestions are added relative to the establishment of soldiers' gardens in India. A useful bibliography is appended with reference to Indian plants, and a glossary of Indian terms. The book is illustrated by woodcuts, and by several lithographs executed by Mr M'Farlane, showing the character of the Anamalai Mountains, valley, and forests, the timber-slip, the Punachi Pass, an ancient cromlech, the Tangachi and Akka Mountains, the gathering of honey by the Kaders, and a Rattan chain for collecting honey, the mode of transporting timber, and the injury effected on wood by the agency of insects. A Sketch Map is given of South India, showing the distribution of teak, sal, and sandal-wood.

The work is a valuable contribution to our knowledge of Indian forests. It contains a large mass of information on this important subject, and promises to be of great service to the Madras Government. As a manual for those concerned in the forest department it is invaluable. The improvements carried out by Dr Cleghorn will confer a lasting benefit on India, and his judicious recommendations, if they receive due attention from Government, will tend to increase the economical resources of our possessions in the East.

PROCEEDINGS OF SOCIETIES.

British Association for the Advancement of Science, held at Manchester, Sept. 1861.

The thirty-first meeting of the British Association for the Advancement of Science was held this year at Manchester, under the presidency of William Fairbairn, Esq., C.E., LL.D., F.R.S., and in all its social bearings at least it has proved a great success. Upwards of 3000 members were enrolled, and the receipts amounted to L.3920. Last meeting at Manchester the members were only 1316, the receipts L.2161. The consequence is that the money recommended this year to be bestowed in the interests of science amounts to L.2363, while last year it was only L.1395. More than a half of the larger sum, however, is absorbed by these three objects, the Kew Committee, L.650; the Balloon Committee, L.200; and Index to Reports, L.600.

The first meeting was that of the General Committee, when Professor Phillips, the Assistant General Secretary, read the Report by the Council, and Mr Gassiot presented the Report of the Kew Committee. In the former, the point of chief interest is the retirement of Professor Walker, and the election of Mr Hopkins to be General Secretary, with the announcement of Professor Phillips, that it was necessary for him to prepare to withdraw also.

From the report of the Kew Committee, we make the following extract, which records the progress that was made in the deeply interesting field of heliography, during the grand solar eclipse of June 18, 1860:—

It will be remembered that, at the suggestion of the Astronomer Royal, the Admiralty had placed at the disposal of the expedition of astronomers H.M. ship Himalaya, and that the Government Grant Committee of the Royal Society had voted the sum of L.150 for the purpose of defraying the expenses of transporting the Kew heliograph, with a staff of assistants, to Spain. As the scheme became matured, it was deemed desirable to extend considerably the preparations originally contemplated, and actual experience subsequently proved that no provision which had been made could have been safely omitted. Originally it was thought that a mere temporary tent for developing the photographs might have answered the purpose; but on maturing the scheme of operations, it became evident that a complete photographic observatory, with its dark developing room, cistern of water, sink, and shelves to hold the photographs, would be absolutely necessary to ensure success. An observatory was therefore constructed in such a manner that it could be taken to pieces and made into packages of small weight for easy transport, and at the same time be readily put together again on the locality selected. The house, when completed, weighed 1248 lb., and was made up in eight cases. Altogether the packages, including house and apparatus, amounted in number to thirty, and in weight to 34 cwt. Besides the heliograph, the apparatus comprised a small transit theodolite for determining the position of the meridian, and ascertaining local time, and the latitude and longitude of the station; and also a very fine three-inch achromatic telescope, by Dallmeyer, for the optical observation of the phenomena of the eclipse. Complete sets of chemicals were packed in duplicate in separate boxes, to guard against failure through a possible accident to one set of the chemicals. Collodion of different qualities was made sensitive in London, and some was taken not rendered sensitive, so as to secure as far as possible good results. Distilled water, weighing 139 lb., had to be included; and engineers' and carpenters' tools, weighing 113 lb., were taken. Mr Cassella lent some thermometers and a barometer, and Messrs Elliott an aneroid barometer, to the expedition.

The preparations were commenced by Mr Beckley (of the Kew Observatory) early in the year 1860; and in June Mr De La Rue engaged Mr Reynolds to assist Mr Beckley in completing them. Mr Beckley and Mr Reynolds were charged with the erection of the observatory at Rivabellosa; and so well were the plans organised, that the observatory and heliograph were in actual operation on the 12th of July, the expedition having sailed from Plymouth in the Himalaya on the morning of the 7th. This could not, however, have been so expeditiously accomplished without the energetic co-operation of Mr Vignoles, who met the Himalaya in a small steamer he had chartered to convey the expedition and their apparatus into the port of Bilboa, and who despatched the Kew apparatus as soon as it was landed to the locality he and Mr De La Rue had agreed upon. This was situated seventy miles distant from the port of landing, and accessible only through a difficult pass. Mr Vignoles had also taken the trouble to make arrangements for accommodating the Kew party, and for the due supply of provisions—a matter of some importance in such a locality.

Besides Mr De La Rue, Mr Beckley, and Mr Reynolds, the party consisted of Mr Downes and Mr E. Beck, two gentlemen who gave their gratuitous services, and of Mr Clark, who acted as interpreter, and who also kindly assisted during the eclipse. Each of the party had only one thing to attend to, and thus rapidity of operation and certainty of result were secured. The total expenditure of this expedition amounted to L.512; the balance of L.362 over the amount granted by the Royal Society has been generously defrayed by Mr De La Rue.

Upwards of forty photographs were taken during the eclipse, and a little before and after it, two being taken during the totality, on which are depicted the luminous prominences with a precision impossible of attainment by hand drawings. The measurements which have been made of these prominences by Mr De La Rue show incontrovertibly that they must belong to the sun, and that they are not produced by the deflection of the sun's light through the valleys of the moon. The same prominences, except those covered over during the moon's progress, correspond exactly when one negative is laid over the other; and by copying these by means of a camera, when so placed, a representation is obtained of the whole of the prominences visible during the eclipse in their true relative position. The photographs of the several phases of the eclipse have served to trace out the path of the moon's centre in reference to the sun's centre during the progress of the phenomenon. Now, Rivabellosa being north of the central line of the moon's shadow, the moon's centre did not pass exactly across the sun's centre, but was depressed a little below it, so that a little more of the prominences situated on the north (the upper) limb of the sun became visible than would have been the case exactly under the central line, while, on the other hand, a little of those on the southern limb was shut off. It has been proved, by measuring the photographs, that the moon during the totality covered and uncovered the prominences to the extent of about 94″ of arc in the direction of her path, and that a prominence situated at a right angle to the path shifted its angular position with respect to the moon's centre by lagging behind 5° 55′. On both the photographs is recorded a prominence, not visible optically, showing that photography can render visible phenomena which without its aid would escape observation. Copies of the two totality pictures are being made to illustrate Mr De La Rue's paper in the report of the Himalaya Expedition by the Astronomer Royal. Positive enlarged copies of the phases of the eclipse, 9 inches in diameter, have also been made by means of the camera, and were exhibited at the Manchester meeting.

The heliograph has since been replaced in the Observatory, but few opportunities have occurred for using it, in consequence of the pressure of other work; latterly, however, Mr Beckley has been requested to carry on some experiments with the view of ascertaining whether any more details are rendered visible when the full aperture of 3 inches of the telescope is used, than when it is reduced to about one inch and a-half. Up to the present time no definite conclusion can be drawn from the results obtained; so that, at all events, an increase of aperture does not appear to give a strikingly better result when a picture of the same size is taken with various apertures of the object-glass. More experiments, however, are needed before this point—which is one of some importance in guiding us in the construction of future instruments—can be answered definitely. Mr Beckley has obtained sun pictures of great beauty during the course of these experiments.

The work of the Kew Observatory is now so increased that it has become absolutely imperative to make some provision for working the heliograph in a way that will not interfere with the current work of that establishment; and Mr De La Rue has been requested by his colleagues of the Kew Committee to take charge of the instrument at his observatory, where celestial photography is continously carried on. This request Mr De La Rue has kindly acceded to; and he will for a time undertake to record the sun spots at Cranford, as long as it is found not to interfere with his other observations. Mr De La Rue has contrived, and had made by Messrs Simms, at his own expense, an instrument for measuring the photographs, which will much facilitate the reduction of the results. It consists of a fixed frame, in which work two slides, moving at right angles to each other. Each is furnished with a vernier reading to $\frac{1}{1000}$th of an inch. The top slide works on the lower slide, and carries a hollow axis $4\frac{1}{2}$ inches diameter, on which rotates horizontally a divided circle reading to 10″, and this carries a second circle on the face of which are fixed four centering screws. An image intended to be measured is placed on the upper circle, and is centered by means of the adjusting screws; it is then adjusted by means of the upper circle in any required angular position with respect to the lower divided circle, so as to bring the cross lines of the photograph in position under a fixed microscope, supported on an arm from the fixed frame. By means of this instrument the sun pictures are measured so as to determine the diameter to $\frac{1}{2000}$th of the radius; the angular position of any part of a sun-spot, and its distance from the centre, are thus readily ascertained; or the differences of the right ascension and declination with respect to the centre are as easily read off to the same degree of accuracy.

Mr De La Rue has recently produced by his large telescope an image of a solar spot, and portion of the sun's disc, far superior to anything before effected, and which leads to the hope that a new era is opened in heliography, and that the resources of this observatory might be further developed in that direction.

In the evening the President delivered his inaugural address in the Free Trade Hall, which, spacious as it is, proved too small to accommodate the multitude who came to hear him. He confined his attention chiefly to the application of science to the arts, celebrating in a very courtly manner the members of the Association, as often as the introduction of their names could be at all justified. The discourse, as a whole, was highly respectable; but in those departments of engineering in which he is eminent he observed a remarkable reserve, and upon the whole, without injury to our readers, we may suffer it to pass without quotation. We may add, however, that a vote of thanks was very gracefully proposed and eloquently advocated by Lord Stanley.

SECTION A. (*Physical and Mathematical Science*) was opened by the Astronomer-Royal, G. B. AIRY, the president, by laying down the legitimate field of the Section, and rules for the guidance of authors who had papers to produce or remarks to make. His idea was, that after papers were read, conversation upon each, so far as time permitted, was not only allowed, but courted. And here perfect liberty was allowed to each to dissent from the opinions of others, and each was to receive in perfect good humour the unsparing slaughter of any of his opinions, however dear they might be in his own estimation. However, he wished to give two or three cautions, which would be found most useful: first, that science, pure science, was alone their object, and that more serious subjects were entirely forbidden; secondly, that each should, to avoid the slightest appearance of personality, address the meeting through the Chair; thirdly, that he must in that chair be a perfect despot; that his dictum must, for the time, be law; and, for an instance, they must not feel displeased if he peremptorily rejected all discussions about perpetual motion, the trisection of an angle, or any subject which would lead to the subversion of any of the well-established foundations of any of the exact sciences. One suggestion he would venture to throw out to those who had communications to make on the more transcendental branches of science, viz. to hold over for a more suitable occasion any subject which could not be made quite intelligible by an oral exposition. He exemplified this by reading the title of one of the papers proposed to be read to the Section, adding, that he had no doubt that the meaning of this was clearly understood by the author himself, but, for his part, he (the Astronomer Royal) had not a conception of its meaning. He need scarcely add, that he hoped authors, in avoiding this error, would not fall into the opposite, of beginning at the very first principles of the science connected with their subject.

The first paper in the Section was a report on the progress of celestial photography since the meeting at Aberdeen, by Warren de la Rue, the most interesting facts in which we have already given as an extract from the report of the Kew committee; to which it may be here added, that this most indefatigable photographer has also obtained good photographs of the fixed stars, and such constellations as Orion, and even the Pleiades, though comets have altogether refused to give pictures. A large photograph of the sun, three feet in diameter, was also exhibited. In the conversation which ensued, after an expression of admiration by Dr Robinson, and a hope that Mr De la Rue would be assisted in the heavy expense which his experiments involvéd, the Astronomer-Royal, following in a similar strain, took occasion to remark that the photograph now exhibited settled a point of much interest which had formerly been matter of controversy between him and M. Arago, the latter maintaining that the intensity of the sun's light did not decrease towards the edge of the disk, while he (the Astronomer-Royal) maintained the contrary—an opinion which the photograph settled in his favour.

There then followed a paper on the distribution of fog around the British islands, by Dr J. H. Gladstone, which was followed by an animated discussion, of which the upshot was a proposal by the Astronomer Royal, that as they could not agree what amount of obscuration of vision amounted to a fog, they should register a fog any day on which it was necessary to ring the fog-bell!

This paper was followed by others, among which was one by Mr Tomlinson of King's College, London, "On Lightning Figures," which we have presented to our readers in full at page 254. Another on the microscopic structure of copper, by W. Vivian, from which it appears that that structure is rather cellular than crystalline. Another on an electric-resistance thermometer with balancing coil, by C. W. Siemens. Another on a panoramic lens for photographic purposes, by T. Sutton, exhibited and explained by Mr C. Brooke. It consisted of a glass capsule containing water, with a diaphragm in the centre, and was affirmed to be perfectly achromatic when properly adjusted, and preventive of all distortion. Besides these, there was a paper by D. Vaughan, on cases of planetary instability indicated by the appearance of temporary stars, in which the author endeavoured to explain temporary stars, meteors, and other phenomena, by the approach of revolving planetary bodies to the central in a course of ages, and their breaking up into fragmentary portions. In reference to the speculation, the Astronomer Royal said that he would not attempt to decide on the possibility or impossibility of events occurring in a course of ages in accordance with those dwelt on by the essayist. Under ordinary circumstances, the preservation of the plane in which a planetary body moved, and the permanency of the eccentricity, were established facts; but some of the phenomena of the satellites and rings of Saturn showed that it would be hazardous to decide off-hand a subject so very speculative as that discussed in this essay.

On Friday, in this Section, the interest was chiefly about meteors, introduced by the reading by Mr Glaisher of the report of the committee on luminous meteors. He commenced by expressing his regret that so few observations had been made by members of the British Association, and then dilated on the labours of others, especially Mr Haidinger. The report was followed by a paper by this gentleman—viz., "An Attempt to explain the earlier Physical Conditions of Meteorites, as well as some of the Phenomena attending their Fall on our Planet."

Mr Haidinger, in a paper read on the 19th of April, 1860, spoke of a *typical* form of a meteor, as exemplified in the stone which fell at Stannern, in Moravia, on the 22d of May 1808, which on the foremost part appeared rounded off, the crust showing streaks parallel to the probable line of direction through the air, and was much puckered up, like kneaded dough, behind; and then observed that there must be a starting-point, from some fundamental considerations proved by the phenomona themselves, in order to arrive at an understanding of their forms and conditions. There are, first, the stone leaving the extra-terrestrial space as a solid; secondly, its velocity being greater on entering the earth's atmosphere; thirdly, it is retarded by the resistance of the air; fourthly, the fireball is formed by the compression of the air behind it, and the rotation of the stone resulting therefrom; fifthly, the termination of the first part of the path is marked by a detention from the so-called "explosion," caused by the collapse of the vacuum from the air rushing in with great violence.

The discussion on Meteorites was followed by a paper by Mr Gassiot "On the Deposit of Metal which takes place from the Negative Terminal of an Inductive Coil during the Elective Discharge in vacuo," the title of which contains the substance of it. And that was followed by others of a purely mathematical or else very questionable character.

Section B.—*The Chemical Section* was presided over by Professor W. A. Miller, who delivered an opening address on the progress of chemistry during the last year. This was followed by a report on the manufactures of the South Lancashire District, by Professor H. E. Roscoe, Dr Schunck, and Dr Angus Smith. Dr Andrews then read a paper "On the Effects of Great Pressures combined with Cold, on the Six Non-condensible Gases."

The gases, when compressed, were always obtained in the capillary end of thick glass tubes, so that any change they might undergo could be observed. In his earlier experiments the author employed the elastic force of the gases evolved in the electrolysis of water as the compressing agent, and in this way he actually succeeded in reducing oxygen gas to 1-300th of its volume at the ordinary pressure of the atmosphere. He afterwards succeeded in effecting the same object by mechanical means, and exhibited to the Section an apparatus by means of which he had been able to apply pressures, which were only limited by the capability of the capillary glass tubes to resist them; and while thus compressed the gases were exposed to the cold attained by the carbonic acid and ether bath. Atmospheric air was compressed by pressure alone to $\frac{1}{371}$ of its original volume and by the united action of pressure and a cold of 106° Fahr. to 1-675th; in which state its density was little inferior to that of water. Oxygen gas was reduced by pressure to 1-324th of its volume, and by pressure and cold to 1-554th; hydrogen by the united action of cold and pressure, to 1-500th; carbonic oxide, by pressure, to 1-278th—by pressure and cold to 1-278th; nitric oxide, by pressure to 1-310th, by pressure and a cold of 160° Fahr. to 1-680th. None of the gases exhibited any appearence of liquefaction even in these high states of condensation. The amount of contraction was nearly proportional to the force employed, till the gases were reduced to from about 1-300th to 1-350th of their volume; but, beyond that point, they underwent little further diminution of volume from increase of pressure. Hydrogen and carbonic oxide appear to resist the action of pressure better than oxygen or nitric oxide. The paper of Dr Andrews was followed by one "on the Thermal Effects of Elastic Fluids," by Dr Joule and Professor W. Thomson.

On Friday the President exhibited some photographs of different Spectra, and read a paper on the subject.—The apparatus by which the spectra may be photographed consists of an ordinary camera obscura attached to the end of a long wooden tude, which opens into a cylindrical box, within which is a prism glass, or a hollow prism filled with bisulphide of carbon. If the prism be so adjusted as to throw the solar rays, reflected from a heliostat, upon the screen of the camera and the wires which transmit the sparks from a Ruhmkoffer coil are placed in front of the uncovered portion of the slit, the two spectra are simultaneously impressed. The solar beam is easily intercepted at the proper time by means of a small screen, and the electric spectrum is allowed to continue its action for two or three, or six minutes, as may be necessary. He did not find that anything was gained in distinctness by interposing a lens of short focus between the slit and the wire which supplied the sparks, with the view of rendering the rays of the electric light parallel like those of the sun, owing to the absorbent action of the glass weakening the photographic effect; and the flickering motion of the sparks being magnified by the lens, rendered the lines less distinct than when the lens was not used. Although with each of the metals (including platinum, gold, silver, copper, zinc, aluminum, magnesium, iron), when the spark was taken in air, he obtained decided photographs, it appeared that in each case the impressed spectrum was very nearly the same, proving that few of the lines produced were those which were characteristic of the metal. The peculiar lines of the metal seemed chiefly to be confined to the visible portion of the spectrum, and these had little or no photographic power. This was singularly exemplified by repeating the experiment upon the same metal in air, and in a continuous current of pure hydrogen. Iron, for example, gave in hydrogen, a spectrum in which a bright orange and a strong green band were visible, besides a few faint lines in the blue part of the spectrum. Although the light produced by the action of the coil was allowed to fall for ten minutes upon a sensitive collodion surface, scarcely a trace of any action was procured; whilst, in five minutes, in the air, a powerful impression of numerous bands was obtained. It was remarked by Mr Talbot, that in the spectra of coloured flames, the nature of the acid did not influence the position of the bright lines of the spectrum, which he found was dependent upon the metal employed, and this remark had been confirmed by all subsequent observers. But the case was very different in the absorptive bands produced by the vapours of coloured bodies,—there the nature of both constituents of the compound was essentially connected with the production of absorptive bands. Chlorine, combined with hydrogen, gave no bands by absorption in any moderate thickness. Chlorous acid and peroxide of chlorine both produced the same set of bands, while hypochlorous acid, although a strongly coloured vapour, and containing the same elements, oxygen and chlorine, produced no absorptive bands. Again, the brownish red vapour of perchloride of iron produced no absortive bands; but when converted into vapour in a flame, this gave out bands independent of the form in which it occurred combined. These anomalies appeared to admit of an easy explanation on the supposition that, in any case, the compound is decomposed in flame, either simply by the high temperature, just as water is, as shown by Grove, or, in all other cases of the production of bright lines by the introduction of a metallic salt into a flame of burning bodies (as shown by Deville). In the voltaic pile, the decomposition must of necessity take place by electric action. The compound gases, protoxide and binoxide of nitrogen, gave, when electrified, the same series of bright bands (as Plücker had shown) which their constituents when combined furnish. Aqueous vapour always gives the bright lines due to hydrogen, and hydrochloric acid the mixed system of lines which could be produced by hydrogen and chlorine. The reducing influence of the hydrogen and other combustible constituents of the burning body would decompose the salt, liberating the metal, which would immediately become oxidized, or carried off in the ascending current. There was obviously a marked difference between the effect of intense ignition upon most of the metallic and the non-metallic bodies. The observations of Plücker upon the spectra of iodine, bromine, and chlorine, show that they give, when ignited, a very different series of bands to those which they furnished by absorption, as Dr Gladstone had already pointed out; but it was interesting to remark that, in the case of hydrogen, which, chemically, was so similar to metal, we have a comparatively simple spectrum, in which the three principal bright lines correspond to Fraunhofer's dark lines, C F and G. It was, however, to be specially noted, that the hydrogen occasioned no perceptible absorptive bands at ordinary temperatures in such thickness as we could command in our experiments; and the vapour of boiling mercury was also destitute of any absorptive action, although when ignited by the electric spark it gave a characteristic and brilliant series of dark bands. The following experiment suggested itself as a direct test of Kirchoff's theory. Two gas-burners, into which were introduced chloride of sodium on the wick of the spirit-lamp, were placed so as to illumine equally the opposite sides of a sheet of paper partially greased. The rays of the electric light screened from the photometric surface, suitably protected, were made to traverse one of the flames. If the yellow rays of the light were absorbed by the sodium flame, the light emitted laterally by the flame should be sensibly increased. The experiment, however, failed to indicate any such increase in the brilliancy of the flame, possibly because the eye was not sufficiently sensitive to detect the slight difference which was to be expected.

This paper was followed by others:—On the Emission and Absorption of Rays of Light by certain Gases, by Dr J. H. Gladstone. On an Aluminous Mineral from the Upper Chalk near Brighton, by Dr J. H. and Mr G. Gladstone. On the Chemical Composition of some Woods employed in the Navy, by Dr Grace Calvert. On the Chemical Composition of Steel, by Dr Grace Calvert. On the Solvent Powers of Weak and Strong Solutions of Alkaline Carbonates on Uric Acid Calculi, by Dr W. Roberts. On certain Difficulties in the way of separating Gold from Quartz, by Dr Smith (of Sydney). On Atmospheric Ozone, by Dr Moffat. On Sulphuretted Hydrogen as a Product of Putrefaction, by Dr Moffat. On the Composition and valuation of Superphosphates, by Professor Galloway. On Morin, and the Non-existence of Moro-tannic Acid, by Professor Delffs. On the Constitution of Paranaphthaline or Anthracine, and some of its Decomposition Products, by Professor Anderson. On Piperic and Hydro-piperic Acids, by G. C. Foster.

Section C. (*Geology*) was presided over by Sir R. I. Murchison, who gave an opening address of much interest on those primæval rocks with which his own researches had for many years been most connected, with some remarks on metamorphism. He now finds it impossible to refuse any longer to believe that a mechanical deposit may have become crystalline (while others of the same epoch continue mechanical still), and that without any exposure to such heat as could destroy organic remains. For such phenomena in metamorphism, indeed, he still finds himself unable to account; but if he will refer to an article in this journal so far back as November–January 1833, p. 132, he will find himself invited to such discoveries as he and other geologists are now making, the change from the confused and mechanical structure to the crystalline (or condition of molecular repose) being there shown to demand, in favourable circumstances, no more heat than that which specifically actuates all molecules. The other papers in the Geological Section were chiefly of a local character, recording observations on particular localities. These were—Sketch of the Geology of Manchester, by E. W. Binney. On the Recent Encroachments of the Sea on the shores of Torbay, by W. Pengelly. Hard Devonian limestones, fissile and round-jointed, formed, he said, the two projecting horns of Torbay. Sandstones and conglomerates form the hollow of the bay, and have been much worn away within the memory of man, especially at Livermead, which is only preserved by continual engineering labour. The process of erosion by the sea was explained by the author as something like a succession of honeycombing, sometimes by insulations of portions of the cliffs. On the slates and limestones the sea more slowly produced excavations and ledges, which storms enlarge. The effects of the severe storm of October 1859, on the cliffs, beach, roads, &c., of Torbay were described in detail, and the importance of such storms as modern agents of change was dealt upon. On the Excess of Water in the Region of the Earth about New Zealand: its Causes and Effects, by J. Yates. Notes on two Ichthyosauri to be exhibited to the Meeting, by C. Moore. On the Relation of the Eskdale Granite at Black Comb to the Schistose Rocks, by J. G. Marshall. On a Dinosaurian Reptile (*Scelidosaurus Harrisonii*) from the Lower Lias of Charmouth, by Professor Owen. On the Remains of a Plesiosaurian Reptile (*Plesiosaurus Australis*) from the Oolitic Formation in the Middle Island of New Zealand, by Professor Owen. On the Elsworth Rock and of the Clay above it, by H. Seely. On the Sandstones and their associated Deposits of the Valley of the Eden and the Cumberland Plain, by Professor Harkness. On some Phenomena connected with the Drifts of the Severn, Avon, Wye, and Usk, by Rev. W. S. Symonds, which we give in full at page 281. On the Pleistocene Deposits of the District about Liverpool, by G. W. Morton. Notice of some Facts in Relation to the Postglacial Gravels of Oxford, by Professor Phillips. On a New Bone-cave at Brixham, by W. Pengelly. Remarks on the Bone-caves of Craven, by T. W. Barrow. On the Red Crag Deposits of the County of Suffolk, by W. Whincopp. Palæontological Remarks upon the Silurian Rocks of Ireland, by W. H. Baily. In this paper, the author noticed the occurrence of Llandello flags in the county of Meath containing the characteristic graptolite *Didymograpsus Murchisonii*, and then proceeded to give a general review of the localities in Ireland from which fossils were obtained, as affording satisfactory evidence of the various sub-divisions of the Silurian rocks at present ascertained in that country. On the Geology of Knockshigowna, county Tipperary, by A. B. Wynne. On the Granite Rocks of Donegal, and the Minerals associated therewith, by R. Scott, M.A. On the Gold of North Wales, by T. A. Readwin. Comparison of Fossil Insects of England and Bavaria, communicated by Mr Sainton, by Dr Hagen.

SECTION D. (*Zoology and Botany*) had for its president C. C. Babington who did not give any formal opening address, but permitted the audience, soon after meeting, to listen to Professor Owen, who read two papers. Of these the first was on the "Cervical and Lumbar Vertebræ of the Mole," illustrated by diagrams of the structures described. The result of the paper was to show that the vertebral column of the mole combines two peculiarities which are separately given in the reptilian class,—viz. to the crocodilia and enaliosaura respectively, a curious fact not hitherto noticed in any systematic work or monograph in comparative anatomy. The Professor afterwards read a paper on some objects of natural history from the collection of M. Du Chaillu, of which the following is a summary. Professor Owen's first knowledge of the zoological collection was derived from a letter sent by M. Du Chaillu, dated Gaboon, June 13, 1859, and received in the British Museum in August 1859, in which M. Du Chaillu specified the skins and skeletons he had collected, offering them for sale, with other varieties, to the British Museum. Professor Owen replied, recommending the transmission of the collection to London for inspection, with which recommendation M. Du Chaillu complied, bringing with him all the varieties he had named, with other objects of natural history, from which he permitted selection to be made. The skins of the adult male and female of the young of the *Troglodytes Gorilla* afforded ample evidence of the true colouration of the species. In the male, the rufo-griseous hair extends over the scalp and nape, terminating in a point upon the back. The prevalent grey colour, produced by alternate fuscous and light grey annulations of each hair, extends over the back, the hair becoming longer upon the nates and upon the thighs. The dark fuscous colour gradually prevails as the hair extends down the leg to the ankle. The long hair of the arm and foream presents the dark fuscous colour ; the same tint extends from below the axilla downwards and forwards upon the abdomen, where the darker tint constrasts with the lighter grey upon the back. The scanty hair of the cheeks and chin is dark ; the pigment of the naked skin of the face is black. The breast is almost naked, and the hair is worn short or partially rubbed off across the back, over the upper border of the iliac bones, in consequence, as it appears, of the habit ascribed by M. Du Chaillu to the great male gorilla of keeping at the foot of a tree, resting its back against the trunk. The skin of the great male gorilla, as mounted in the British Museum, exhibits two opposite wounds,—the smaller in front on the left side of the chest, the larger close to the lower part of the right blade-bone. Two of the ribs in the skeleton of this animal are broken on the right side near where the charge had passed through the skin in its course outwards. These marks correspond with the account of the slaughter of the great gorilla given by M. Du Chaillu. Professor Owen proceeded to describe the colour of the female gorilla, which, it appears, was generally darker and of a more rufous tint than the male. In one female the rufous colour so prevailed as to induce M. Du Chaillu to note it as a red-rumped variety. In the young male gorilla, 2 feet 6 inches in height, 1 feet 7 inches in the length of the head and trunk, and 11 inches across the shoulder, the calvarium is covered with a well-dressed "skull-cap" of a reddish-coloured hair. The back part of the head behind the ears, the temples and chin are clothed with that mixture of fuscous brown and grey hair which cover with a varying depth of tint the trunk, arms, and thighs. The naked part of the skin of the face appears to have been black, or of a very dark leaden colour; a few scattered straight hairs, mostly black, represent the eyebrows. A narrow moustache borders the upper lip, the whole of the lower lip and sides of the head are covered with hair of the prevailing grey fuscous colour. The rich series of skulls and skeletons brought home by M. Du Chaillu illustrate some most important phases of dentition. These phases were specified by Professor Owen at length. The deciduous or milk dentition, it was remarked, were in the youngest specimen of the gorilla something similar to those of the human child, but an interspace equal to half the breadth of the outer incisor divides that tooth from the canine, and the crown of the canine descends nearly two lines below that of the contiguous milk molar. The deciduous molars differed from those of the human child in the more pointed shape of the first, and much larger size of the second. The dentition of the young gorilla corresponds best with that exemplified in the human child between the eighth and tenth years; the difference, however, is shown in the complete placing of the true molar, whilst the premolar series is incomplete. It was worthy of remark, also, that in both specimens examined the premolars of the upper jaw had preceded those of the lower jaw, and that the hind premolar has come into place before the front one. In the latter development of the canines and the earlier development of the second molars of the second dentition the gorilla differs, like the chimpanzee and the orangs, from the human order of dental development and succession. An opportunity of observing this order in the lower races of mankind is rare. Professor Owen availed himself of the opportunity in the case of the male and female dwarf Earthmen from South Africa, exhibited in London. He found dentition at the phase indicative of the age from seven to nine in the English child; other indications agreed with this evidence of immaturity. The children were dressed and exhibited as adults. Both showed the same precedency in development of canines and premolars which obtains in the whole race. Referring next to the variety of the chimpanzee brought by M. Du Chaillu from the Camma Country and from near Cape Lopez, Professor Owen remarked that this species accords specifically in its osteological and hirsute development with the *Troglodytes niger*. It is stated by M. Du Chaillu to be distinguished by the natives of Camma as the nschiegombovie from the common chimpanzee (*Troglodytes niger*), called by them the nschiego. From the character of the skins of the male and female specimens of this species brought by M. Du Chaillu to London, Professor Owen would have deduced evidence of a distinct and well-defined variety of Troglodytes.

The reading of this paper was followed by a discussion in which Professor Owen, Dr Lankester, and M. Du Chaillu took part. Professor

Owen, on being requested to point out the principal distinctions between man and the gorilla, drew attention to the fact of its inability to stand on its hind legs, and the multitudinous points of adaptation in structure which such an incapability demanded. He also went into the details of the anatomical structure of the brain in the monkey tribes, and insisted on the great differences of structure which that organ presented in man and the quadrumana. Independent of the great size of the brain in man, it possessed certain parts, as the hippocampus minor, which existed only in an undeveloped or rudimentary condition in the monkeys.

Dr Wright of Dublin then read a communication from Dr J. E. Gray, "On the Height of the Gorilla."

These papers were followed by others on the interesting results of dredging on various coasts; by one on the Anatomical Characters of Cyprea, by Dr T. Alcock, another on the relations between Pinnate and Palmate Leaves, by T. M. Masters; and a brief summary of a Report on the Flora of the North of Ireland, by Dr G. Dickie. During the Friday meeting, along with other points of interest, an animated discussion arose as to the principle of life suggested by papers by Dr Daubeny in vegetable physiology. The Doctor was favourable to the idea of life as some power distinct from the physical forces in which view he was opposed by Dr Lankester, and supported by Professor Williamson of Manchester, who begged to contradict Dr Lankester with all the force which might be considered parliamentary. This led on the part of the latter to an iteration of his former opinion stronger than before, and in which, in the language he used, he probably went farther than he intended.

In the sub-section of Physiology, Dr Davy presided, and himself read an interesting paper "On the Question, whether the Hair is or is not subject to Sudden Changes of Colour." This he decides in the negative, explaining away the evidence on which the contrary belief has become popular, and also maintaining with regard to seemingly analogous phenomena, such as the becoming white of the ptarmigan, and many animals and birds in winter, that it is through moult and not change of colour in feather or hair. Besides this, there was on Saturday a paper by Professor L. Beale on the Structure and Growth of the elementary parts (cells) of living Beings.

Section E. (*Geography and Ethnology*). Among other papers, Professor Owen read one of great interest on the "Osteology and Dentition of the Natives of the Andaman Islands." Having noticed the geography of the Andaman Islands, he quoted evidence to show that the diminutive black aborigines of these islands had no notions of a deity, of spiritual beings, or a future state; that both sexes went naked, without any sense of shame. He then gave an extract from the writings of Dr Mouatt in corroboration of the destitution of civilisation prevalent amongst the Andamanners. Their chief weapons were bows and arrows, some of the males also carrying a kind of spear. They appeared to be devoid of fear, were powerful for their size, were swift runners and excellent swimmers and divers. Three or four of them had been known (according to an account given by a Sepoy) to dive into deep water and bring up a fish six or seven feet in length, which they had seized. They were also gifted with extraordinary powers of vision. By their acute sense of smell they often detected afar off the existence of fruit in the neighbouring lofty trees. They span ropes, made wicker baskets, nets for catching turtle and fishes, and scooped out canoes with a small kind of adze. Thus for all their immediate wants invention had supplied the instruments called for by the nature of the surrounding objects and sources of food. But their life was still little beyond that of the brute animal; and their low grade of humanity, with the dwarfish stature and black colour of the Andamanners, had always made a further knowledge of their physical characters peculiarly desirable. He (Professor Owen) was enabled to contribute the present notice of their osteological and dental characters by the opportunity kindly afforded him by Dr Frederick J. Mouatt, inspector of Indian gaols, who had brought over the bones of an adult male native of the Andamans, and had now presented them to the British Museum. The bones presented a compact sound texture, with the processes, &c., well defined. The cranium was well formed. The teeth equalled in size those of Indo-Europeans. After minutely describing the whole of the bones, Professor Owen remarked that the dimensions of parts of the skeleton indicated that they were from an individual four feet ten inches in height. The Andamans or Mincopie were called by most of the observers who had described them "negrillos" or dwarf negroes. They had no knowledge, and appeared to have no idea, of their own origin. It had been surmised that they might be the descendants of African negroes imported by the Portuguese for slave labour, in their settlements at Pegu, and who had been wrecked on the Andamans. But the recorders of this hypothesis alluded to it as a mere hearsay. Neither the skull nor the teeth of the male Andaman above described offered any of the characters held to be distinctive of the African negroes. The cranium had not the relative narrowness ascribed to that of the negro. It presented nothing suggestive of lateral compression. It conformed to the full oval type, with a slight degree of prognatheism; and was altogether on a smaller scale than in the Indo-Europeans exhibiting that form of skull. It is to be presumed that the Portuguese would import from the Guinea Coast or other mart of negro slaves, individuals of the usual stature; and it was incredible that their descendants, enjoying freedom in a tropical locality affording such a sufficiency and even abundance of food as the Andamans were testified to supply, should have degenerated in stature in the course of two or three centuries to the characteristic dwarfishness of the otherwise well-made, well-nourished, strong, and active natives of the Andaman islands. He concluded, therefore, that they were aborigines, and merely resembled negroes in the blackness of the tegumentary pigment, which might be due to constant exposure in such a nude and primitive race. The observation of the hair of the scalp, though perhaps unsatisfactory with respect to a race which habitually shaved or eradicated the hair, were it exact in regard to the crisp, curly, or woolly character of the hair, would show a resemblance of the Andamanners to the Papuans and Australians, as well as to the African negroes. But the skull and dentition of the Andaman male was still more distinct from the Papuan-Australian type than from that of the west coast negro. From the present opportunity of studying the osteology and dentition of the Andamanner, the ethnologist derived as little indication or ground of surmise of the origin of the race in question from an Australasian as from an African continent; and there was scarcely better evidence of his Malayan or Mongolian ancestors. He was not cognisant of any anatomical grounds for deriving the Andaman people from any existing continent. He intended to give no encouragement, however, to a belief that they originated in the locality to which they were now limited. Dr Latham stated that their language showed them to belong to the same division with the Burmese of the opposite continent. These, however, showed the average stature of the Southern Asiatic men; and it would be as pure an assumption to affirm that they had been derived from the Andamanners as that these were degenerate descendants of the Burmese. The cardinal defect of speculators on the origin of the human species was the assumption that the present geographical condition of the earth's surface was anterior to, or at least co-existent with, the origin of such species. The Andamanners were, perhaps, the most primitive and lowest in the scale of civilisation of the human race. The animal appetites were gratified in the simplest animal fashion. They were not cannibals. Implacably hostile to strangers, they had made no advance in the few centuries during which their seas had been traversed by ships of higher races. Enjoying the merest animal life for centuries, why might they not have so existed for thousands of years? Antecedent generations of the race might have co-existed with the slow and gradual geological changes which had obliterated the place or continent of their primitive origin, whatever were the hypothesis adopted regarding it. The Andamanners approached the orangs and chimpanzees only in their diminutive stature; and this was associated with the well-balanced human proportions of trunk to limbs.

On Saturday evening a Telegraphic Soiree was held in the Free Trade Hall, which, as might be expected, attracted a numerous and brilliant gathering. The president introduced Mr Grove to the meeting, who gave a lecture on the History of Electric Telegraphs and Telegraphic Apparatus. This was followed by specimens of the working of telegraphs stationed in the hall, which came off with great eclat. The first telegram was in these terms:—*Question.* 8.32 P.M. "The Prince Consort, Balmoral, to the President of the British Association Meeting, Manchester. Is the meeting of the British Association successful?" *Reply.* 8.45 P.M. "The President of the British Association, Free Trade Hall, Manchester, to H.R.H. the Prince Consort at Balmoral. Your Royal Highness will be pleased to hear that the meeting is a great success. Upwards of 3000 members and associates." Another was sent to St Petersburg, and answered in one minute. *Question.* 8.51 P.M. "What is the weather, and how is the time?" *Reply.* 8.52 P.M. "Weather beautiful, sky clear, time 10.52 P.M., temperature 12½ Reaumur." After this the Moscow and Odessa lines were joined up, and answers obtained in one minute from the former city, in two minutes from the latter. It was intended to extend the line to Taganroc on the Sea of Azoff, which would have been a traverse of 3100 miles, but some electric storm prevented for the time transmission beyond Nicolaief. The company did not separate till nearly 11 o'clock.

On Monday evening there assembled in the Free Trade Hall perhaps the largest audience that ever science brought together, to hear a lecture by the Astronomer-Royal, on the Great Solar Eclipse of June 18, 1860. Happily Mr De la Rue was there to assist with his electric light and his magnificent photographs of the sun, which we have already mentioned, for Mr Airy's voice was quite inaudible save to a few around him. This is the more to be regretted, because the lecture was really popular and highly instructive. Having explained the causes of eclipses in general, and given historical notices of the more eminent eclipses of the sun, he proceeded to discuss the points of greatest scientific interest in connection with the eclipse of last year.

Referring to large diagrams he had prepared, he commenced by describing the appearances of the corona, and he said he must confess that the various accounts presented great discordances. He particularly pointed out two drawings—namely, that of Mr Bonomi and that of Lieut. Oom, an officer in the Portuguese navy, but at present attached to the Imperial Observatory of Pulkowa, in Russia. These two drawings were, he considered, corroborative one of the other, and extremely fair representations of the corona; and both were, moreover, confirmed by the drawings of Mr Weedon, a talented engineer on Mr Vignoles' staff. The corona was very bright near the edge of the dark moon, and gradually diminished until its outline vanished in the surrounding darkness;

but it was not bounded by a regular outline, for there were several streamers and also curved rays, which were observed and depicted by several observers. Mr Bonomi observed the planets Venus and Jupiter, close to the obscured sun, shining with great brilliancy. Under no other conditions could these planets be viewed so close to the sun; for in whatever manner the sun might be shut off from view, the atmospheric illumination would drown these planets in light. Mr Galton's careful drawing presented several strange horns of light, supported in part by Mr Murray's. Mr Weiler's presented strange appearances, which it was difficult to reconcile with the others. M. Plantamour of Geneva, who made his observations near the eastern coast of Spain, made three successive drawings of the corona during the eclipse. The appearances depicted led the speaker to think that they could only be accounted for on the supposition that an atmosphere capable of reflecting light extended nearly from the earth to the moon. It was clear they could not be produced by our atmosphere.

He would show experimentally that there were means of detecting the difference between reflected and non-reflected light; for this purpose he would, with Mr Ladd's assistance, throw a beam of light on to the screen by means of the voltaic lamp; then, as he interposed a doubly-refracting prism, the beam would be divided into two beams, one of which would revolve round the other without alteration of intensity as he caused the prism to rotate. He then would interpose an unsilvered glass reflector in the path of the ray, and again place the doubly-refracting prism in the path of the ray. On rotating the prism, the two beams of light not only revolved the one round the other, but each became alternately obscured, thus proving that there is a difference between ordinary light and reflected light; the reflected light being what is termed polarised. By ascertaining, therefore, if the light of the corona were polarised, it could be ascertained with great probability whether it came direct to the eye or whether it had been bent by some reflecting medium. An English observer had proved beyond doubt that the light of the corona was polarised, and a foreign observer, M. Prazmowski, had even gone further, and had shown that the position of the plane of polarisation passed through the sun, the corona, and the eye of the observer. When this was ascertained, it went a long way towards proving that the light of the corona was reflected by something like an atmosphere, or at all events a medium capable of reflecting light intermediate between the earth and the moon. Was there an atmosphere extending from the earth to the moon? The speaker stated that he knew not; but he knew of no other hypothesis which would account for the appearances presented by the corona.

The Astronomer-Royal now returned to the red prominences, which he stated were seen in great beauty during the eclipse of 1860. As he had stated in the early part of his lecture, the question had been raised whether they belonged to the sun or to the moon. By means of the moving model, he showed that if they belonged to the moon they would follow her as she moved onward; but if they belonged to the sun, those on the left would be shortened and those on the right lengthened as the moon moved from right to left; as they were actually found so to do, it was a strong *primâ facie* argument that they belonged to the sun. M. Faye had also pointed out the following fact. Suppose there was a prominence on the top of the sun at the commencement of the eclipse, it was evident that it must be at that moment to the left of the moon's centre; at the middle of the eclipse it would be just over the centre, and on the right of the centre at the end of the eclipse. It was not at all probable, if the prominence were an illusion resulting from the sun's light shining through the valleys on the moon's limb, that all parts of the edge could produce the same identical figure.

It would be therefore seen that, besides measuring the increase and decrease of luminous prominences in the path of the moon, it was important also to ascertain if any prominence changed its angular position with respect to the moon's centre. The Astronomer-Royal stated, that in order to do so he had had certain lines ruled on one face of the reflecting prism, which was placed in the focus of his telescope, which was a refractor four inches aperture, mounted on a sort of altazimuth stand of a very portable kind; this was exhibited to the audience. Mr De la Rue had used somewhat similar means, and being very skilful in making hand-drawings of heavenly bodies, in which he had great practice, he completed two drawings, which were exhibited on the diagrams in connection with the nicrometer lines he had employed; one of these drawings was made towards the commencement, the other towards the end of the totality. Now it was perfectly obvious, on looking at these drawings, that the prominence and red cloud situated at the top of the sun, and nearly at right angles to the path of the moon, had shifted their angular position during the period of the eclipse. Dr Bruhn, of Leipsic, who went to the east of Spain, not being provided with any means of measuring the angular position of a protuberance, profited by the circumstance that one of the prominences became visible before the totality, and remained so for several minutes afterwards, to make measurements of the distance of the protuberance from the cusps. Now the position of the cusps could be calculated to the utmost degree of accuracy for any particular time, and Dr Bruhn found that, if the prominence belonged to the moon, the cusp must have shifted 26° from its first position on the moon's limb; but that if it belonged to the sun, the cusp had not shifted 1° during the time he was observing. This was most conclusive evidence that the prominence belonged to the sun.

The Astronomer-Royal then pointed out other drawings of the prominences, particularly a very beautiful one by Mr Fearnley, of Sweden, which, as far as it went, confirmed Mr De la Rue's drawings of the prominences. He then went on to say, that, in 1851, M. Busch took a daguerreotype of the corona and prominences, but it was not a very successful attempt. Since that period photography had made great progress, and it occurred to Mr De la Rue and others that it would be extremely desirable to get photographs of the eclipse. Mr De la Rue took with him the Kew photoheliograph, and obtained two large photographs of the totality. Father Secchi, of the Collegio Romano, had obtained five small photographs, and through the kindness of Señor Aguilar he had obtained photographic copies of them. The photographs of Mr De la Rue and Father Secchi, though made at widely different localities, agreed very closely. In both, the changes in the angular position of the prominences had been measured, and they agreed entirely with the supposition that they were connected with the sun.

Father Secchi had explained, in striking language, his reason for preferring photographs to eye-observations. And he had shown that certain observations, on which M. Plantamour had founded an idea that the changes of magnitude of the prominences were not explained by the moon's motion, were entirely disproved by the photographs.

Some British officers stationed on the western coast of America observed the totality from Puget Sound, when the sun was only 2° above the horizon; and he had received some excellent drawings from Captain Richards and Captain Parsons. On comparing the drawings of the prominences made on the west coast of America with those made in Spain, he was unable to reconcile one with the other,—but there was an interval of two hours between the two observations, and it was quite possible that in that interval of time fresh prominences had come into view; and if the sun was constantly boiling up, and these protuberances were fumes, it could not be wondered at if there was a change during that period. There was no perceptible change, however, during the short interval of time between the observations in Spain.

If the prominences belonged to the sun, the question arose, could we see them at other times than during a total eclipse? With the assistance of Mr Nasmyth, who had contributed the most important part of the apparatus, he had made many attempts, but had not succeeded. The apparatus had been lent to Prof. Piazzi Smyth when he went to the Peak of Teneriffe, but he failed to see the prominences. These negative results did not in the least detract from the evidence of the prominences belonging to the sun, because we never could get rid of the effect of the highly illumined atmosphere through which we viewed the sun, and which, do what we would, extinguishes even brighter objects than the luminous prominences.

The Astronomer-Royal then said, that time had run out faster than he had anticipated, but he would, nevertheless, ask Mr De la Rue to exhibit his photographs by means of the electric light. Mr De la Rue complied with the request; but being called upon by the audience to explain the photographs, Dr Tyndal kindly took charge of the electric lamp.

Besides these evening meetings the first week, there was also on Tuesday evening a Natural History Soiree, in which the hall was adorned by a fine exhibition of botanical and zoological specimens, contributed by members of the Manchester Field Naturalists' Association, at which Dr Lankester was requested to address the meeting on this interesting subject. This he did in a very pleasing and appropriate manner, closing with some remarks on the connection between science and religion. It may be safely said, that the interest both of the general meetings and sections was maintained to the last. And so zealous were the local reporters, that upwards of 250 quarto columns were devoted to reports of the meetings in some of the Manchester papers. In the foregoing pages, however, along with the papers which we publish in full, will, we believe, be found the most interesting facts, of a purely scientific nature, which were brought forward.

The next meeting is appointed for Cambridge, under the presidency of Professor Willis, but the date has not yet been fixed upon.

Botanical Society of Edinburgh.

Thursday, July 11, 1861.—Professor Balfour, V.P., in the Chair.

Dr Balfour stated, that in a recent letter received from Mr A. G. More of Bembridge, the death of Mr Albert John Hambrough of Steephill, near Ventnor, Isle of Wight, is recorded. Mr Hambrough was a distinguished naturalist in that part of England, and was always ready to assist botanists who visited the island. He made important additions to the flora of the island, and his name is noticed frequently in Mr W. A. Broomfield's "*Flora Vectensis.*" Mr More says,—"His death is a sad loss to natural history in this island. In him I have lost a most kind and valued friend, the only fellow botanist in the island." Mr Hambrough became a non-resident Fellow of the Edinburgh Botanical Society on 14th February 1839, and he contributed many valuable plants to the herbarium.

The following Communications were read :—

1. *Notice of a Botanical Trip to Ben Lawers and Schihallion in September* 1860. By William Keddie, Esq., Lecturer on Natural Science, Glasgow.

Professor Balfour having taken up his autumn residence at Aberfeldy last year, the writer gladly accepted of an invitation from his old friend and teacher to join him in a quiet botanical ramble to Ben Lawers and Schihallion. At Aberfeldy they were joined by William Bell, who was commissioned from the Botanic Garden, Edinburgh, to collect ferns. We devoted the 4th and 5th of September to the exploration of Ben Lawers, and after strolling through the grounds and garden of Taymouth Castle on the 6th, visited Schihallion on the 7th. A notice of our excursions, however pleasing the recollection may be to our small party, will, it is feared, possess little interest to the Society, yet may not be altogether unprofitable, if it should induce any of the members who have not visited that delightful district, to follow the course we pursued. With the aid of the morning coach from Aberfeldy, we were at the foot of Ben Lawers at a seasonable hour, and having engaged our lodging at a comfortable inn, situated on Loch Tay, at a spot convenient for commencing the ascent, we at once buckled on our vasculums and began our journey. Ben Lawers is known to be one of our loftiest Scottish mountains, being 4015 feet high, and consisting of mica-slate mingled with chlorite-slate, and exhibiting remarkably contorted forms where the surfaces are exposed in the upper precipices. The water-courses below show beds of limestone interstratified with the schist. The mountain is equally celebrated for its alpine plants and the extensive and varied views obtained from its summit. Dr Macculloch gave the palm to Ben Lawers, after having ascended almost every principal mountain in Scotland; and, oddly enough, he mentions that on the hill he met "two missionaries from the Edinburgh garden, with huge tin boxes slung over their shoulders, who seemed to be in a perfect ecstacy of happiness." The lapse of some forty or fifty years since then had, on the present occasion, diminished neither the bulk of the boxes, the gaiety of their bearers, nor the prospects with which they made their way directly over the shoulder of the hill to the corrie overlooking Loch-na-Chat, the field of their operations for the day. The following were among the plants collected this day :—*Draba incana*, *Cerastium alpinum*, *Cherleria sedoides*, *Silene acaulis*, *Sagina sabulata*, *Rubus saxatilis*, *R. Chamæmorus*, *Sibbaldia procumbens*, *Epilobium alpinum*, *E. alsinifolium*, *Cornus suecica*, *Hieracium alpinum*, *Saussurea alpina*, *Erigeron alpinus*, *Arctostaphylos Uva-ursi*, *Polystichum Lonchitis*, and *Polypodium alpestre*. Various cliffs and crevices were examined for *Cystopteris montana*, not a vestige of which could be detected in its old haunts, but *Woodsia hyperborea* was found in considerable quantity on the precipitous face of the corrie, which was ascended by Bell with the fearlessness of a cragsman. The ascent to the summit was reserved for the succeeding day. The corrie occupies a secluded recess in the north-eastern declivity, where the view is closed in on the south by a ridge of the mountain, and only some glimpses of the distant heights of Strath Tay are revealed. The snow of the previous winter still lay in thick wreaths among the crevices of the rocks. The lofty cliffs overhanging the corrie were cast into shade by the mists drifting down the ravines from the upper ridges, unvisited by the sunshine which, in the valley below, was diffusing cheerfulness and warmth over the green strath and the yellow corn fields. The weathered micaceous rocks, twisted into a thousand fantastic forms, and grouped in fanciful combinations, imparted additional wildness to the scene.

Next day we started betimes, and took a straight course for the summit of the hill, which was reached after a stiff climb without our meeting with many plants which we had not picked the day before. With the exception, perhaps, of Ben Lomond, the view from the top of Ben Lawers is not equalled by that of any other mountain in the Highlands, and the day was favourable for enjoying it. Although the lake below appeared without a ripple on its surface, the mountain top was swept by a strong breeze, which rendered it difficult to maintain one's footing on the more exposed ridges. The sun shone brightly, and the mountain and vale were disclosed in the clear atmosphere as far as the eye could reach. The fertile banks of the loch lay extended below, from the rich woods of Killin to where the sylvan beauties of Taymouth mingle in the view with the remoter hills and plantations of Tayside. Ben More is the most prominent mountain to the westward, beyond which rise the peaks of Ben Lomond and the other hills overlooking Loch Lomond. Schihallion is recognised by its graceful outline and isolated position on the north; and far beyond, in the same direction, may be descried the rounded summit of Ben Cruachan and the conical peaks of the hills overlooking Glencoe and Loch Etive. The eye could take in on the north-east the outlines of the snow-capped summits of the mountains surrounding the sources of the Dee, and southwards were discernible the ranges of Strathmore and Strathearn, the Sidlaws and the Ochils. We proceeded to explore the disrupted rocks in the cavity to the south-west of the summit, the part exposed to the prevailing winds, and where the storms of ages have worn the ridge into the appearance of a volcanic crater. The moist rocks on this unpromising height have long been known as a station for *Saxifraga cernua*, one of the rarest of British plants. We were fortunate in obtaining a few specimens, which, as is usually the case, were in an immature state, but readily identified by their bulbiferous stem and well-marked leaves. *Saxifraga rivularis* we did not observe, although it has been found on the mountain. *Draba rupestris* occurs also sparingly in the crevices of these exposed rocks. *Thalictrum alpinum*, and some of the more common alpines, are comparatively plentiful. Following the course of the bare inhospitable ridge to the northward, we again sought the productive cliffs of the corrie, and examined the side opposite to that which occupied our attention on the previous day. Here, in the channels of the rills and the crevices of the dripping rocks, were found quantities of *Myosotis alpestris*, which, although not absolutely amongst the rarest, was by far the most beautiful of our alpine treasures. The first sight of this lovely *Myosotis*, with its bright azure flowers glistening in the spray, would have been an ample reward for more than the toil of twice ascending Ben Lawers; and its frequent recurrence on the moist cliffs—sometimes within reach, sometimes (happily for our too eager acquisitiveness) beyond it—was a source of ever new delight. Haunting the same humid rocks were *Saxifraga nivalis* and *S. stellaris*.

On the 6th the party examined the grounds of Taymouth, under the guidance of Mr Peter Murray, the head gardener. On the 7th they visited Schihallion, without any definite idea of its botanical character, but with a lively interest in the hill itself, not only as forming a conspicuous and imposing feature in the scenery of the district, but still more particularly on account of its having been chosen by Dr Charles Hutton and Dr Maskelyne for their experiments to determine the density of the earth, and also from the subsequent observations of Professor Playfair on its geological structure. The lower part of the hill exhibits, in sections cut by the streams, beds of micaceous and hornblende slate interstratified with crystalline limestone, but the upper part, forming the great bulk of the hill, consists of granular quartz, compact and homogeneous, and capable only of supporting a meagre vegetation. The summit, which terminates in a narrow plain about a mile in length, is covered almost exclusively with lichens and a few mosses. To the botanist it affords probably as few attractions as any mountain in Scotland. The plants gathered on the flanks and lower slopes were the following, viz.—*Thalictrum alpinum, Genista anglica, Rubus Chamæmorus, Hippuris vulgaris, Saxifraga aizoides, S. hypnoides, var., S. stellaris, Cornus suecica, Vaccinium Myrtillus, Pyrola secunda, Empetrum nigrum, Salix arbutifolia, Listera cordata, Tofieldia palustris, Carex rigida, Festuca ovina, var. vivipara*, and *Lycopodium Selago.* A specimen of *Polystichum Lonchitis* was gathered, having 130 fronds. At the summit, the rocks were crusted over with *Lecidea geographica*, and amongst other lichens, *Cetraria Islandica, Scyphophorus bellidiflorus*, and *Cladonia rangiferina* were not unfrequent. Among the mosses—*Pogonatum alpinum, Dicranum fuscescens, Andreæa rupestris, Hypnum denticulatum, Trichostomum lanuginosum*, and *Fissidens osmundoides.*

The remainder of the paper was occupied with an account of a visit to the Tummel, Killicrankie, Fortingal, Glen Lyon, and the Falls of Moness.

2. *On some of the Stages of Development in the Female Flower of* Dammara Australis. By Alex. Dickson, M.D., Edinburgh.

(This paper appears in the present number of the Journal.)

3. *On the Homologies of the Floral Organs of the Phanerogamous and higher Cryptogamous Plants.* By John Lowe, M.D., Lynn.

In this paper the author attempts to explain homologies which exist between the Phanerogams and Phylloid Cryptogams. He says—"My view is briefly this: that the spores of ferns should be regarded strictly as flower-buds, containing in embryo the reproductive organs, which behave just as we might imagine a phanerogamous floral bud to do if detached from the parent tree, and made to complete its development afterwards. The prothallus I regard as the calyx or phylloid expansion, protecting the male and female organs; the rootlets of it as the nutrient vessels of the buds, true roots not being produced until the development of the embryonic cell. That this view is a correct one I am strongly led to believe, from having observed since I wrote out the above idea a singular monstrosity in the spores of *Adiantum tenerum.* These I have found developed as terminal *buds* from the extremities of the veins of the pinnules. The buds, which are covered by and produced from the under surface of the spore case, which is distinctly shown to be a folding of the margin of the leaf, are now developed into living plants instead of spores, and were in the initial state surrounded by paraphyses.

4. *Notice of Localities in Scotland for some Rare Plants.* By Professor Balfour.

Chelidonium majus, near Hopetoun; *Alyssum calycinum*, Lochleven; *Silene noctiflora* and *Carduus arvensis*, var. *setosus*, St Andrews; *Mentha sylvestris*, near Perth; *Carex irrigua*, along with *Carex limosa*, Methven Bog; *Hordeum pratense*, St Andrews (Mr Howie).

5. *List of Plants growing in the Bangalore Garden, Mysore.* By Dr CLEGHORN.*

I. PHANEROGAMS.

a. DICOTYLEDONS.

1. *Ranunculaceæ.*
Naravelia zeylanica, *Dec.*
Clematis Gouriana, *Roxb.*
coriacea, *Dec.*
Adonis autumnalis, *L.*
Nigella damascena, *L.*
Aquilegia vulgaris, *L.*
Delphinium Consolida, *L.*
Ajacis, *L.*

2. *Dilleniaceæ.*
Dillenia speciosa, *Thunb.*

3. *Magnoliaceæ.*
Michelia Champaca, *L.*
Nilagirica, *Zenker.*

4. *Anonaceæ.*
Uvaria sp. (*Anamalais.*)
Anona squamosa, *L.*
reticulata, *L.*
muricata, *L.*
Artabotrys odoratissimus, *Br.*
Guatteria longifolia, *Wall.*

5. *Berberaceæ.*
Berberis aristata, *Dec.*

6. *Nymphæaceæ.*
Nymphæa Lotus, *L.*
Nelumbium speciosum, *Willd.*

7. *Papaveraceæ.*
Papaver Rhœas, *L.*
somniferum, *L.*
dubium, *L.*
Argemone mexicana, *L.*
Chryseis californica, *Lindl.*
tenuifolia, *Lindl.*
Glaucium luteum, *Sm.*

8. *Fumariaceæ.*
Fumaria parviflora, *Lam.*, var. Vaillantii.

9. *Cruciferæ.*
Matthiola annua, *R. Br.*
Cheiranthus Cheiri, *L.*
Nasturtium officinale, *L.*
Capsella Bursa-pastoris, *L.*
Iberis umbellata, *L.*
Iberis odorata, *L.*
Malcomia maritima, *L.*
var. alba.
Erysimum Peroffskianum, *F.* et *M.*
Lepidium sativum, *L.*
Brassica oleracea, *L.*
Raphanus sativus, *L.*
Heliophila arabioides, *Sims.*
Schizopetalon Walkeri, *Sims.*

10. *Resedaceæ.*
Reseda odorata, *L.*

11. *Capparidaceæ.*
Gynandropsis pentaphylla, *Dec.*
Cleome purpurea, *L.*

12. *Bixaceæ.*
Bixa Orellana, *L.*

13. *Cistaceæ.*
Cistus purpureus, *Lam.*
Helianthemum vulgare, *Gært.*

14. *Violaceæ.*
Viola odorata, *L.*
tricolor, *L.*
Walkeri, *Wight.*
Ionidium suffruticosum, *Ging.*

15. *Droseraceæ.*
Drosera intermedia, *Hayn.*

16. *Polygalaceæ.*
Polygala speciosa, *Dec.*
arvensis, *Willd.*

17. *Pittosporaceæ.*
Pittosporum flavum, *Hook.*
undulatum, *Vent.*
coriaceum, *Ait.*
salicinum, *Lindl.*

18. *Caryophyllaceæ.*
Gypsophila elegans, *Bieb.*
Stellaria media, *L.*
Cerastium vulgatum, *L.*
Dianthus barbatus, *L.*
deltoides, *L.*

* Drawn up at Dr Cleghorn's request by Mr Wm. New, superintendent.

Dianthus Caryophyllus, *L.*
var. plena.
plumarius, *L.*
sinensis, *L.*
var. plena.
Saponaria calabrica, *Bieb.*
Silene Armeria, *L.*
quinquevulnera, *L.*
pendula, *L.*
Viscaria oculata, *Lindl.*
Lychnis Chalcedonica, *L.*

19. *Linaceæ.*
Linum usitatissimum, *L.*
var. alba.
grandiflorum, *Desf.*
trigynum, *L.*

20. *Malvaceæ.*
Malope trifida, *Cav.*
Malva sylvestris, *L.*
Althæa rosea, *Cav.*
Urena lobata, *L.*
Pavonia odorata, *Willd.*
Lavatera Thuringiaca, *L.*
Hibiscus tricuspis, *Cav.*
Lindleyi, *Wall.*
vitifolius, *L.*
cannabinus, *L.*
Rosa-sinensis, *L.*
rubro-plenus.
flavo-plenus.
carneo-plenus.
grandiflorus.
radiatus, *Cav.*
mutabilis, *L.*
var. plena.
Sabdariffa, *L.*
syriacus, *L.*
var. plena.
liliiflorus, *Cav.*
Lampas, *Cav.*
esculentus, *L.*
vesicarius, *Cav.*
Thespesia populnea, *Corr.*
Gossypium herbaceum, *L.*
Barbadense, *L.*
acuminatum, *L.*
Abutilon striatum, *Dicks.*

21. *Bombaceæ.*
Adansonia digitata, *L.*
Eriodendron anfractuosum, *Dec.*
Ochroma Lagopus, *L.*
Bombax malabaricum, *Dec.*
Helicteres Isora, *L.*
Kleinhovia hospita, *L.*
Guazuma tomentosa, *H. B. K.*
Dombeya palmata, *Cav.*
Brachychiton acerifolium, *Schott.*
Visenia ve lutina, *Voigt.*

22. *Tiliaceæ.*
Corchorus acutangulus, *Lam.*
Triumfetta angulata, *Lam.*
Grewia asiatica, *L.*
Berrya Ammonilla, *Roxb.*
Elæocarpus serratus, *L.*

23. *Ternströemiaceæ.*
Cochlospermum Gossypium, *Dec.*
Thea viridis, *L.*
Camellia japonica, *L.*

24. *Aurantiaceæ.*
Atalantia monophylla, *Dec.*
Triphasia trifoliata, *Dec.*
Glycosmis pentaphylla, *Corr.*
Bergera Kœnigii, *L.*
Murraya exotica, *L.*
Feronia Elephantum, *Corr.*
Ægle Marmelos, *Corr.*
Citrus decumana, *L.*
Aurantium, *Risso.*
Bergamia, *Risso.*
Limonum, *Risso.*
medica, *Risso.*

25. *Hypericaceæ.*
Hypericum mysurense.

26. *Guttiferæ.*
Calophyllum inophyllum, *L.*
Calysaccion longifolium, *Wight.*
Garcinia coniocarpa, *Wight.*

27. *Erythroxylaceæ.*
Sethia indica, *Dec.*

28. *Malpighiaceæ.*
Malpighia punicifolia, *Dec.*
heteranthera, *Wight.*
Banisteria laurifolia, *L.*
Stigmaphyllon aristatum, *A. de J.*
Hiptage Madablota, *Gært.*

29. *Sapindaceæ.*
Cardiospermum Helicacabum, *L.*
Sapindus emarginatus, *Vahl.*
fruticosus, *Roxb.*
Nephelium Litchi, *W.* et *A.*

30. *Meliaceæ.*
Melia Azedarach, *L.*
Azadirachta indica, *Juss.*
Munronia Nilagirica, *Wight.*

31. *Cedrelaceæ.*
Cedrela Toona, *Roxb.*
Chloroxylon Swietenia, *Dec.*

32. *Ampelidaceæ.*
Vitis quadrangularis, *Wall.*
vinifera, *L.*
Ampelopsis Roylii, *Hort.*

33. *Geraniaceæ.*
Pelargonium inquinans, *Ait.*
Radula, *L'Herit.*
zonale, *Willd.*

34. *Tropæolaceæ.*
Tropæolum majus, *L.*
minus, *L.*
canariense, *L.*
Lobbianum, *Hook.*

35. *Balsaminaceæ.*
Balsamina hortensis, *Dec.*
var. plena.

36. *Oxalidaceæ.*
Averrhoa Bilimbi, *L.*
Oxalis corniculata, *L.*
variabilis, *Jacq.*
sensitiva, *L.*

37. *Zygophyllaceæ.*
Guaiacum officinale, *L.*

38. *Rutaceæ.*
Diosma virgata, *Thunb.*
Ruta graveolens, *L.*

39. *Ochnaceæ.*
Ochna squarrosa, *L.*

40. *Coriariaceæ.*
Coriaria nepalensis, *L.*

41. *Celastraceæ.*
Celastrus emarginata, *Willd.*
Ilex cornuta, *Lindl.*

42. *Rhamnaceæ.*
Zizyphus Jujuba, *Lam.*
Ceanothus triquetrus, *Dec.*

43. *Homaliaceæ.*
Aristotelia Macqui, *L.*

44. *Terebinthaceæ.*
Odina Wodier, *Roxb.*
Rhus lanceolata, *L.*
Mangifera indica, *L.*
Anacardium occidentale, *L.*
Semicarpus Anacardium, *L.*
Spondias Mangifera, *Pers.*

45. *Moringaceæ.*
Moringa pterygosperma, *Gært.*

46. *Leguminosæ.*
Piptanthus nepalensis, *Don.*
Podalyria sericea, *Lam.*
Lupinus Hartwegii, *Benth.*
mutabilis, *Sweet.*
luteus, *L.*
pubescens, *Benth.*
polyphyllus, *L.*
Crotalaria juncea, *L.*
retusa, *L*
bifaria, *L.*
verrucosa, *L.*
laburnifolia, *L.*
mysorensis, *Roxb.*
Rothia trifoliata, *Pers.*
Ulex nanus, *Willd.*
Spartium junceum, *L.*
Cytisus albus, *L.*
Laburnum, *L.*
intermedium, *Marn.*
Lotus jacobæus, *L.*
Trifolium pratense, *L.*, var.
Trigonella Fœnum-græcum, *L.*
Medicago sativa, *L.*
Indigofera enneaphylla, *L.*
hirsuta, *L.*
pulcherrima, *L.*
atropurpurea, *Ham.*
violacea, *Roxb.*
Tephrosia candida, *Dec.*
Wistaria sinensis, *Dec.*
Robinia pseudo-acacia, *L.*
Sesbania ægyptiaca, *Pers.*
Agati grandiflorum, *Desv.*
var. alba.
Clianthus puniceus, *Sol.*
Sutherlandia frutescens, *Br.*
Swainsonia galegifolia, *Salisb.*
Cicer arietinum, *L.*
Pisum sativum, *L.*
Vicia Faba, *L.*
Lathyrus grandiflorus, *L.*
odoratus, *L.*
Arachis hypogæa, *L.*
Æschynomene aspera, *L.*
Desmodium triflorum, *L.*
Hedysarum coronarium, *L.*
Onobrychis sativa, *L.*
Clitoria ternatea, *L.*

Kennedya rubicunda, *Ven.*
monophylla, *Ven.*
Canavalia gladiata, *Dec.*
Mucuna prurita, *Hook.*
Erythrina indica, *L.*
var. alba.
ovalifolia, *Roxb.*
Blakii, *B. N.*
secundiflora, *Brot.*
suberosa, *Roxb.*
laurifolia, *Jacq.*
Butea frondosa, *Roxb.*
Dolichos uniflorus, *Lam.*
Lablab vulgare, *Savi.*
Psophocarpus tetragonolobus, *Dec.*
Cajanus indicus, *Spreng.*
Cantharospermum pauciflorum, *W.* et *A.*
Abrus precatorius, *L.*
Pterocarpus marsupium, *Roxb.*
Brachypterum scandens, *Bth.*
Pongamia glabra, *Vent.*
Dalbergia latifolia, *Roxb.*
Sissoo, *Roxb.*
Edwardsia grandiflora, *Salisb.*
Sophora tomentosa, *L.*
Virgilia capensis, *L.*
Castanospermum australe, *A. Cunn.*
Hæmatoxylon campechianum, *L.*
Parkinsonia aculeata, *L.*
Poinciana pulcherrima, *L.*
var. lutea.
regia, *Bojer.*
elata, *L.*
Cæsalpinia Sappan, *L.*
sepiaria, *Roxb.*
coriaria, *Willd.*
digyna, *Rottl.*
Cathartocarpus Fistula, *Pers.*
Roxburghii, *Dec.*
Cassia alata, *L.*
florida, *Vahl.*
auriculata, *Roxb.*
glauca, *Lam.*
Amherstia nobilis, *Wall.*
Jonesia Asoca, *Roxb.*
Tamarindus indica, *L.*
var. in occ.
Bauhinia purpurea, *L.*
var. alba.
acuminata, *L.*
variegata, *L.*
tomentosa. *L.*
Adenanthera pavonina, *L.*
Prosopis spicigera, *L.*
Mimosa rubicaulis, *L.*
Acacia robusta, *Burch.*
lophantha, *Willd.*
mucronata, *Willd.*
verticillata, *Willd.*
speciosa, *Willd.*
suaveolens, *Willd.*
longifolia, *Willd.*
stricta, *Willd.*
Albizzia Julibrissin, *Durazz.*
Inga Hæmatoxylon, *Willd.*
Houstoni, *Willd.*
dulcis, *Willd.*

47. *Rosaceæ.*

Amygdalus persica, *L.*
Armeniaca vulgaris, *Lam.*
Prunus domestica, *L.*
Kerria japonica, *Dec.*, var. plena.
Geum coccineum, *L.*
Rubus biflorus, *Ham.*
rosæfolius, *Sm.*, var. plena.
Fragaria virginiana, *Mill.*
Rosa Damascena, *Mill.*
rubiginosa, *L.*
indica, *L.*
multiflora, *Thunb.*
moschata, *Mill.*
centifolia, *L.*
Lawrenciana, *Sweet.*
pomponia, *Dec.*, var. De Meaux.
Eriobotrya japonica, *Lindl.*
Cotoneaster affinis, *Lindl.*
buxifolia.
microphylla.
Pyrus communis, *L.*
Malus, *L.*

48. *Granateæ.*

Punica Granatum, *L.*

49. *Combretaceæ.*

Terminalia Catappa, *L.*
Belerica, *Roxb.*
Poivrea purpurea, *Commers.*
Combretum densiflorum.
grandiflorum, *G. Don.*
comosum, *G. Don.*
Quisqualis indica, *L.*

50. *Onagraceæ.*

Fuchsia serratifolia, *Hook.*
corymbiflora, *Lindl.*
(many vars.)
Gaura Lindheimerii, *Spach.*
Eucharidium concinnum, *F.* et *M.*
Clarkia pulchella, *Pursh.*

Godetia Lindleyana, *Spach.*
Œnothera suaveolens, *L.*

51. *Haloragaceæ.*
Myriophyllum intermedium, *Dec.*

52. *Lythraceæ.*
Ameletia indica, *Dec.*
Cuphea platycentra, *Benth.*
Lawsonia inermis, *L.*
Lafoensia Vandelliana, *Dec.*
Lagerströemia indica, L.
var. alba.
Reginæ, *Roxb.*

53. *Myrtaceæ.*
Psidium pyriferum, *L.*
var. variegata.
pomiferum, *L.*
Cattleyanum, *Sabine.*
Acklandæ.
Eucalyptus robusta, *Sm.*
concinna.
globulus, *Lab.*
perfoliata, *Desf.*
virgata, *Sieb.*
Myrtus communis, *L.*
Rhodomyrtus tomentosus, *Dec.*
Jambosa vulgaris, *Dec.*
malaccensis, *Dec.*
Barringtonia speciosa, *Forst.*
racemosa, *Blum.*
Careya arborea, *Roxb.*

54. *Cucurbitaceæ.*
Zanonia indica, *L.*
Bryonia scabrella, *L.*
Momordica Charantia, *L.*
Benincasa cerifera, *Savi.*
Lagenaria vulgaris, *Ser.*
Cucumis Melo, *L.*
sativus, *L.*
Trichosanthes anguina, *L.*
palmata, *Roxb.*
Cucurbita maxima, *Duch.*
Citrullus, *L.*
ovifera, *L.*

55. *Papayaceæ.*
Carica Papaya, *L.*
Modecca palmata, *L.*

56. *Passifloraceæ.*
Passiflora alata, *Ait.*
minima, *Jacq.*
Leschenaultii, *Dec.*
quadrangularis, *L.*
Passiflora laurifolia, *L.*
serratifolia, *L.*
cuneifolia, *Cav.*
cærulea, *L.*
kermesina, *Sk.* et *Otto.*
var. purpurea.
fœtida, *Cav.*
Middletoniana, *Paxt.*
Murucuja ocellata, *Pers.*

57. *Turneraceæ.*
Turnera ulmifolia, *L.*
var. angustifolia.

58. *Loasaceæ.*
Bartonia aurea, *Sims.*
Blumenbachia insignis, *Schr.*
Cajphora lateritia, *Hook.*

59. *Portulaceæ.*
Portulaca quadrifida, *L.*
Thellusonii, *Dec.*
grandiflora, *Hook.*
oleracea, *L.*
Calandrinia Lindleyana, *Dec.*

60. *Crassulaceæ.*
Kalanchoe crenata, *Haw.*
Bryophyllum calycinum, *Sal.*
pinnatum, *Hook.*
Sempervivum tabulæforme, *Haw.*

61. *Ficoideæ.*
Mesembryanthemum tricolor, *L.*
crystallinum, *L.*
pomeridianum, *L.*
Glinus trianthemoides, *Heyne.*
Tetragonia expansa, *L.*

62. *Cactaceæ.*
Opuntia Dillenii, *Haw.*
spinosissima, *Haw.*
cochinellifera, *Haw.*
Cereus erectus, *Haw.*
Cereus crenatus, *Hook.*
Epiphyllum truncatum, *Pfeiffer.*
Pereskia Bleo, *H. B. K.*

63. *Saxifragaceæ.*
Hydrangea hortensis, *L.*
japonica, *L.*

64. *Umbelliferæ.*
Hydrocotyle asiatica, *L.*
Didiscus cæruleus, *Dec.*
Apium graveolens, *L.*
Petroselinum sativum, *Hoffm.*
Carum Carui, *L.*

Fœniculum vulgare, *Adans.*
Pastinaca sativa, *L.*
Daucus Carota, *L.*
Coriandrum sativum, *L.*

65. *Araliaceæ.*
Panax fruticosum, *L.*
cochleatum, *L.*
Hedera Helix, *L.*

66. *Caprifoliaceæ.*
Cornus macrophylla, *Wall.*
Benthamia fragifera, *Lindl.*
Lonicera Leschenaultii, *Wall.*

67. *Loranthaceæ.*
Loranthus loniceroides, *L.*

68. *Rubiaceæ.*
Spermacoce hispida, *L.*
Chasalia thyrsiflora, *Thwaites.*
Coffea arabica, *L.*
Pavetta indica, *L.*
Ixora coccinea, *L.*
parviflora, *Vahl.*
Bandhuca, *Roxb.*
undulata, *Roxb.*
Chiococca racemosa, *Jacq.*
Hamelia patens, *Jacq.*
Pentas carnea, *Benth.*
Rondeletia speciosa, *Lodd.*
Bouvardia triphylla, *L.*
Manettia glabra, *L.*
Cinchona Calisaya, *L.*, vars.
Nauclea parviflora, *Roxb.*
Randia dumetorum, *L.*
Gardenia florida, *L.*
var. plena.
Mussænda frondosa, *L.*

69. *Valerianaceæ.*
Centranthus ruber, *Dec.*
macrosiphon, *Dec.*

70. *Dipsacaceæ.*
Scabiosa atropurpurea, *L.*
Knautia orientalis, *L.*

71. *Compositæ.*
Ageratum mexicanum, *L.*
Aster amelloides, *L.*
Callistephus chinensis, *Dec.*
Vittadenia triloba, *Dec.*
Bellis perennis, *L.*
Brachycome iberidifolia, *Benth.*
Centauridium Drummondii, *Tor.* et *Gray.*
Pluchea indica, *L.*
Eclipta prostrata, *L.*
Dahlia variabilis, *Desf.*
Siegesbeckia orientalis, *L.*
Melampodium macranthum.
Xanthium orientale, *L.*
Zinnia elegans, *L.*
var. plena.
Guizotia oleifera, *Dec.*
Rudbeckia digitata, *Ait.*
Dracopis amplexicaulis, *Cass.*
Gymnopsis uniserialis, *Hook.*
Calliopsis bicolor, *Rchb.*
Drummondii, *Hook.*
coronata, *Hook.*
Coreopsis lanceolata, *L.*
Helianthus tuberosus, *L.*
annuus, *L.*
Bidens chilensis, *L.*
Spilanthes oleracea, *L.*
Ximenesia encelioides, *Cass.*
Sanvitalia procumbens, *Juss.*
Tagetes patula, *L.*
erecta, *L.*
Gaillardia picta, *Hook.*
Gutierrezia gymnospermoides, *Tor.* et *Gray.*
Helenium tenuifolium, *Nutt.*
Galinsoga brachystephana, *R.* et *Pav.*
Sogalgina triloba, *Dec.*
Sphenogyne speciosa, *R. Br.*
Madia viscosa, *Dec.*
Madaria elegans, *Dec.*
Cladanthus proliferus, *Dec.*
Achillea Millefolium, *L.*
Leucanthemum vulgare, *Dec.*
Pyrethrum Parthenium, *L.*
Chrysanthemum indicum, *L.*
tricolor, *L.*
Argyranthemum frutescens, *Webb.*
Dimorphotheca pluvialis, *Dec.*
Cotula australis, *Hook. fil.*
Cenia turbinata, *Commers.*
Artemisia indica, *Willd.*
Abrotanum, *L.*
Ammobium alatum, *R. Br.*
Humea elegans, *Sm.*
Rhodanthe Manglesii, *Lindl.*
Acroclinium roseum, *Hook.*
Helichrysum bracteatum, *Don.*
var. alba.
Cacalia sempervirens, *Vahl.*
Cineraria lanata, *Willd.*, var.
Senecio Cineraria, *Dec.*
Jacobæa, *L.*
Calendula arvensis, *L.*

Osteospermum spinosum, *L.*
Echinops echinatus, *Roxb.*
Xeranthemum cylindraceum, *Dec.*
Centaurea Cyanus, *L.*
Amberboa moschata, *Dec.*
Carthamus tinctorius, *L.*
Onopordum Acanthium, *L.*
Cynara Scolymus, *L.*
Cichorium Intybus, *L.*
Tragopogon porrifolius, *L.*
Lactuca sativa, *L.*

72. *Lobeliaceæ.*
Lobelia Erinus, *L.*
heterophylla, *Cav.*
syphilitica, *L.*
Pratia angulata, *Hook. fil.*

73. *Campanulaceæ.*
Campanula Vidalii, *H. C. Wat.*
rapunculoides, *L.*
Specularia Speculum, *Dec.*
Trachelium cæruleum, *L.*

74. *Gesneraceæ.*
Gesneria tubiflora, *L.*
Achimenes longiflora, *Hook.*
pedunculata, *Benth.*
Gloxinia speciosa, *Bot. Reg.*

75. *Myrsinaceæ.*
Ardisia crenulata, *Ven.*
polycephala, *Wall.*
Jacquinia ruscifolia, *L.*
Corynocarpus lævigatus, *Forst.*

76. *Sapotaceæ.*
Achras Sapota, *L.*
Mimusops Elengi, *L.*
Bassia latifolia, *Roxb.*
longifolia, *L.*

77. *Ebenaceæ.*
Diospyros Sapota, *Roxb.*

78. *Oleaceæ.*
Noronhia emarginata, *Poir.*
Ligustrum sinense, *Hort.*

79. *Jasminaceæ.*
Jasminum Sambac, *Ait.*
var. plena.
latifolium, *Roxb.*
auriculatum, *Vahl.*
ligustrifolium, *Wall.*
trinerve, *Vahl.*
heterophyllum, *Roxb.*
Jasminum revolutum, *Sims.*
officinale, *L.*
Nyctanthes arbor tristis, *L.*

80. *Asclepiadaceæ.*
Cryptostegia grandiflora, *R. Br.*
Hemidesmus indicus, *R. Br.*
Calatropis gigantea, *R. Br.*
Sarcostemma brevistigma, *W.* et *A.*
Oxystelma esculentum, *R. Br.*
Gomphocarpus fruticosus, *R. Br.*
Asclepias curassavica, *L.*
Tylophora asthmatica, *R. Br.*
Pergularia odoratissima, *L.*
Stephanotis floribunda, *Thouars.*
Hoya carnosa, *Browne.*
imperialis, *Hook.*
ovata.
Ceropegia ensifolia.
Jacquemontiana.
fimbriata, *E. Mey.*
juncea, *Roxb.*
Boucerosia umbellata, *W.* et *A.*
Stapelia revoluta, *Mass.*

81. *Apocynaceæ.*
Allamanda cathartica, *L.*
Schottii, *Pohl.*
Thevetia neriifolia, *Juss.*
Cerbera Odollam, *Gærtn.*
Tabernæmontana coronaria, *R. Br.*
Vinca rosea, *L.*
var. alba.
Plumieria acuminata, *Ait.*
alba, *Jacq.*
Vallaris dichotoma, *Wall.*
Beaumontia grandiflora, *Wall.*
Wrightia mollissima, *Wall.*
antidysenterica, *R. Br.*
Nerium odorum, *Ait.*
var. plena.
Echites suberecta, *Willd.*
picta.
paniculata, *Roxb.*

82. *Strychneæ.*
Strychnos Nux-vomica, *L.*
potatorum, *L.*

83. *Pedaliaceæ.*
Sesamum indicum, *L.*
Pedalium Murex, *L.*
Martynia fragrans, *L.*
craniolaria, *Swz.*

84. *Bignoniaceæ.*
Bignonia suberosa, *Roxb.*

Bignonia venusta, *Ker.*
gracilis, *B. Cav.*
xylocarpa, *Roxb.*
Amphilophium Mutisii, *H. Birk.*
Spathodea adenophylla, *Wall.*
crispa, *Wall.*
campanulata, *Bot. Mag.*
Stereospermum suaveolens, *Dec.*
chelonoides, *Dec.*
Tecoma capensis, *Lindl.*
jasminoides, *G. Don.*
stans, *Juss.*
Eccremocarpus scaber, *Ruiz* et *Pav.*

85. *Cobæaceæ.*

Cobæa scandens, *Cav.*

86. *Polemoniaceæ.*

Phlox Drummondii, *Hook.*
Collomia linearis, *Nutt.*
Gilia tricolor, *Benth.*
Leptosiphon densiflorus, *Bth.*
aureus, *Benth.*
Ipomopsis elegans, *Rich.*

87. *Convolvulaceæ.*

Evolvulus alsinoides, *L.*
Porana volubilis, *Burm.*
Convolvulus parviflorus, *Vahl.*
tricolor, *L.*
var. alba.
Jacquemontia violacea, *Chois.*
Exogonium Purga, *Chois.*
Calonyction Roxburghii, *Chois.*
Ipomœa sinuata, *Ort.*
Pes-capræ, *Sweet.*
sessiliflora, *Roth.*
coccinea, *L.*
Nil, *L.*
Quamoclit phœniceum, *Choisy.*
var. alba.
Batatas edulis, *Choisy.*
betacea, *Choisy.*
Pharbitis hispida, *Choisy.*
cærulea, *Choisy.*
Argyreia speciosa, *Swt.*
cuneata, *Ker.*

88. *Cuscutaceæ.*

Cuscuta reflexa, *Roxb.*

89. *Boraginaceæ.*

Cerinthe major, *L.*
Echium vulgare, *L.*
Nonea lutea, *Dec.*
Myosotis arvensis, L.
palustris, *L.*
Borago officinalis, *L.*
Trichodesma indicum, *R. Br.*
Tiaridium indicum, *Lehm.*
Heliotropium peruvianum, *L.*
Omphalodes linifolia, *Lehm.*

90. *Cordiaceæ.*

Cordia Myxa, *L.*
Sebestena, *L.*

91. *Hydrophyllaceæ.*

Nemophila insignis, *Dougl.*
maculata, *Benth.*
atomaria, *Fisch.*
discoidalis, *Fisch.*
Eutoca viscida, *R. Br.*
Whitlavia grandiflora, *Harv.*
Phacelia congesta, *Hook.*

92. *Solanaceæ.*

Habrothamnus elegans, *Endl.*
Petunia nyctaginiflora, *Juss.*
Nicotiana Tabacum, *L.*
Datura Stramonium, *L.*
fastuosa, *L.*
chlorantha, var. plena.
Nicandra physaloides, *Gærtn.*
Capsicum annuum, *L.*
frutescens, *L.*
Physalis peruviana, *L.*
flexuosa, *L.*
Solanum arboreum, *H.* et *B.*
Balbisii, *Duval.*
tuberosum, *L.*
nigrum, *L.*
giganteum, *Jacq.*
Lycopersicum esculentum, *Mill.*
Brugmansia suaveolens, *Wen.*

93. *Scrophulariaceæ.*

Browallia elata, *L.*
demissa, *L.*
Brunsfelsia americana, *L.*
Salpiglossis sinuata, *R.* et *P.*
Schizanthus pinnatus, *R.* et *P.*
Calceolaria hybrida, *Hort.*
Verbascum Thapsus, *L.*
Alonsoa Warcewitzii.
Angelonia salicariæfolia, *Kth.*
Linaria bipartita, *Desf.*
Antirrhinum majus, *L.*
Maurandia Barclayana, *Ldl.*
Lophospermum scandens, *Hook.*
Phygelius capensis, *Mey.*
Collinsia bicolor, *Bth.*

Collinsia grandiflora, *Bth.*
Pentstemon Hartwegii, *Bth.*
campanulatus, *Willd.*
Russelia juncea, *Zucc.*
multiflora, *H. B. K.*
Mimulus moschatus, *L.*
Torenia asiatica, *L.*
var.
cordifolia, *Roxb.*
Digitalis purpurea, *L.*
Veronica spicata, *L.*
Franciscea eximia, *Scheidw.*
uniflora, *Pohl.*
Crescentia alata, *H. B. K.*

94. *Labiatæ.*
Ocimum canum, *Sims.*
basilicum, *L.*
sanctum, *L.*
Plectranthus tuberosus, *Roxb.*
Coleus barbatus, *Bth.*
aromaticus, *Bth.*
Lavandula vera, *Dec.*
Salvia argentea, *L.*
sclarea, *L.*
coccinea, *L.*
officinalis, *L.*
splendens, *Sello.*
patens, *L.*
Salvia bicolor, *Lam.*
Horminum, *L.*
Monarda didyma, *L.*
Origanum Majorana, *L.*
Thymus vulgaris, *L.*
citriodorus, *Pers.*
Hyssopus officinalis, *L.*
Leonurus tataricus, *Burm.*
Holmskioldia sanguinea, *Retz.*
Mentha Piperita, *L.*
Melissa officinalis, *L.*

95. *Verbenaceæ.*
Aloysia citriodora, *Ort.*
Verbena venosa, *Hook. et Gill.*
urticifolia, *L.*
melindres, *Hook*, var.
officinalis, *L.*
Stachytarpheta mutabilis, *Vahl.*
jamaicensis, *Vahl.*
Lantana indica, *Roxb.*
melissæfolia, *Ait.*
aculeata, *L.*
mixta, *Spreng.*
Vitex trifolia, *L.*
Premna latifolia, *Roxb.*
Tectona grandis, *L.*
Gmelina asiatica, *L.*
Volkameria Kæmpferii, *Willd.*
Clerodendron fragrans, *Ait.*
var. plena.
siphonanthus, *R. Br.*
sp. ? (Mauritius).
roseum, *Wall.*
Duranta Ellisia, *L.*
Plumieri, *L.*
Petræa volubilis, *L.*
Callicarpa Reevesii, *Wall.*

96. *Acanthaceæ.*
Thunbergia grandiflora, *Roxb.*
alata, *Hook.*
laurifolia, *Hook.*
Meyenia erecta, *Nees.*
Hawtayneana, *Nees.*
Hexacentris coccinea *Nees.*
mysorensis, *Hook.*
Ruellia formosa, *Andr.*
Goldfussia isophylla, *Nees.*
Asteracantha longifolia, *Nees.*
Barleria Gibsoni.
cristata, *L.*
acuminata, *Wight.*
nov. sp ? (Anamalais).
Crossandra axillaris, *Nees.*
infundibuliformis, *Ait.*
Aphelandra cristata, *Ait.*
aurantiaca, *Lindl.*
Graptophyllum hortense, *Nees.*
var. picta.
var. atropurpurea.
Gendarussa vulgaris, *Nees.*
Eranthemum pulchellum, *Andr.*
Rhinacanthus communis, *Nees.*
Dicliptera spinosa, *Nees.*
Peristrophe lanceolaria, *Nees.*

97. *Primulaceæ.*
Anagallis indica, *L.*

98. *Plumbaginaceæ.*
Plumbago zeylanica, *L.*
rosea, *L.*
capensis, *Thunb.*

99. *Nyctaginaceæ.*
Boerhaavia erecta, *L.*
Abronia umbellata, *Juss.*
Mirabilis Jalapa, *L.*
Bugainvillea spectabilis, *Commers.*
Pisonia aculeata, *L.*
morindifolia, *R. Br.*

100. *Plantaginaceæ.*
Plantago asiatica, *L.*

101. *Amarantaceæ.*
Gomphrena globosa, *L.*
Achyranthes aspera, *L.*
Pupalia orbiculata, *Wight.*
Amaranthus polygamus, *L.*
spinosus, *L.*
caudatus, *L.*
hypochondriacus, *L.*
Celosia argentea, *L.*
cristata, *L.*

102. *Chenopodiaceæ.*
Atriplex hortensis, *L.*
Spinacia oleracea, *L.*
Beta vulgaris, *L.*
Chenopodium ambrosioides, *L.*

103. *Basellaceæ.*
Basella alba, *L.*
Boussingaultia baselloides, *H. B.*

104. *Begoniaceæ.*
Begonia fuschioides, *Hook.*
dipetala, *Graham.*
nitida, *Ait.*
discolor, *Ait.*
ulmifolia, *Haw.*
palmata, *Don.*
tomentosa, *Schott.*
ricinifolia.

105. *Polygonaceæ.*
Rheum rhaponticum, *L.*
Polygonum orientale, *L.*
Fagopyrum, *L.*
rivulare, *Rott.*
Rumex sanguineus, *Sm.*
vesicarius, *L.*
Acetosa, *L.*

106. *Lauraceæ.*
Cinnamomum Cassia, *L.*
Persea gratissima, *Gœrt.*
Tetranthera monopetala, *Roxb.*
ferruginea, *R. Br.*

107. *Proteaceæ.*
Leucadendron argenteum, *R. Br.*
Grevillea robusta, *A. Cunn.*
linearis, *R. Br.*
Telopea speciosissima, *R. Br.*
Stenocarpus Cunninghamii, *R. Br.*

108. *Santalaceæ.*
Santalum album, *L.*

109. *Aristolochiaceæ.*
Aristolochia labiosa, *Ker.*
Aristolochia bracteata, *Retz.*
indica, *L.*

110. *Euphorbiaceæ.*
Pedilanthus tithymaloides, *Neck.*
Euphorbia neriifolia, *L.*
Tirucalli, *L.*
Bojeri, *Hook.*
antiquorum, *L.*
pilulifera, *L.*
Poinsettia pulcherrima, *Grah.*
var. alba.
Hura crepitans, *L.*
Stillingia sebifera, *Willd.*
Sapium indicum, *Willd.*
Acalypha indica, *L.*
Aleurites triloba, *Forst.*
Jatropha panduræfolia, *Roxb.*
multifida, *L.*
glandulifera, *Roxb.*
Curcas purgans, *Adans.*
Janipha Manihot, *Kth.*
Ricinus communis, *L.*
Codiæum variegatum, *L.*
var. longifolia.
Rottlera tinctoria, *Roxb.*
Trewia nudiflora, *L.*
Croton Tiglium, *L.*
Phyllanthus Niruri, *L.*
Emblica officinalis, *Gœrt.*
Cicca disticha, *L.*
Securinega nitida, *Commers.*
Buxus sempervirens, *L.*
Reidia floribunda, *Wight.*

111. *Urticaceæ.*
Urtica scabrella, *Roxb.*
Boehmeria sp. (Sikkim.
Cannabis sativa, *L.*
Humulus Lupulus, *L.*

112. *Moraceæ.*
Morus indica, *L.*
Ficus elastica, *Roxb.*
repens, *L.*
Carica, *L.*
religiosa, *L.*
indica, *L.*

113. *Artocarpaceæ.*
Artocarpus integrifolia, *L.*
incisa, *L.*

114. *Piperaceæ.*
Chavica Betle, *Miq.*

115. *Amentiferæ.*
Salix indica, *L.*

Corylus Avellana, *L.*
Quercus Robur, *L.*

116. *Casuarinaceæ.*

Casuarina muricata, *Roxb.*
equisetifolia, *Forst.*

117. *Coniferæ.*

Pinus longifolia, *Roxb.*
Pseudo-strobus, *Lindl.*
sylvestris, *L.*
Araucaria excelsa, *R. Br.*
Cunninghami, *Ait.*
Bidwilli, *Hook.*
Cookii, *R. Br.*
Dammara orientalis, *Lam.*
robusta.
Juniperus recurva, *Ham.*
Thuja orientalis, *L.*
var. Warcana.
Cryptomeria japonica, *Hook.*
Cupressus torulosa, *Don.*
cashmeriana.
funebris, *Endl.*
lusitanica, *Thunb.*
Lawsoniana, *Murr.*
sempervirens, *L.*
Callitris quadrivalvis, *Vent.*
Podocarpus longifolia, *Hort.*
Frenula Gunnii, *Hook. fil.*
sp? (Sydney.)

118. *Cycadaceæ.*

Cycas revoluta, *Thunb.*
Macrozamia sp.?

b. MONOCOTYLEDONS.

119. *Dioscoreaceæ.*

Dioscorea sativa, *L.*
alata, *L.*
bulbifera, *L.*
Batatas, *Thunb.*

120. *Smilaceæ.*

Smilax ovalifolia, *Roxb.*
deltoidea.

121. *Roxburghiaceæ.*

Roxburghia gloriosioides, *Dryander.*

122. *Orchidaceæ.*

Dendrobium chrysanthum, *Wall.*
Eria densiflora, *Wall.*
Bletia hyacinthina, *Lindl.*
Vanda spathulata, *Spreng.*
Roxburghii, *R. Br.*
teres, *Lindl.*
Aerides odoratum, *Lour.*
Cymbidium ensifolium, *Sw.*
Satyrium sp? (Nilgiris.)
Cœlogyne media, *Wall.*
Vanilla aromatica, *Swz.*

123. *Zingiberaceæ.*

Alpinia calcarata, *Roscoe.*
nutans, *Roscoe.*
Zingiber Zerumbet, *Roscoe.*
officinalis, *Roscoe.*
Kæmpferia ovalifolia, *Roxb.*
Amomum angustifolium, *Son.*
Curcuma longa, *Roxb.*
Costus speciosus, *Sm.*

124. *Marantaceæ.*

Canna indica, *L.*
lutea, *Roscoe.*
edulis, *Ker.*

125. *Musaceæ.*

Musa sapientum, *Roxb.*, var. superba.
Strelitzia regina, *Banks.*

126. *Iridaceæ.*

Iris germanica, *L.*
florentina, *L.*
Pardanthus sinensis, *Ker.*
Tigridia Pavonia, *Juss.*
Antholyza æthiopica, *L.*
Tritonia crocata, *Ker.*
Crocus speciosus, *L.*

127. *Hæmadoraceæ.*

Anigozanthus rufus, *R. Br.*

128. *Hypoxidaceæ.*

Curculigo orchioides, *Roxb.*

129. *Amaryllidaceæ.*

Amaryllis formosissima, *L.*
psittacina, *Ker.*
Zephyranthus candida, *Herb.*
Nerine sarniensis, *Herb.*
Crinum asiaticum, *Herb.*
Hæmanthus coccineus, *L.*
Cyrtanthus obliquus, *Ait.*
Pancratium zeylanicum, *L.*
Narcissus Tazetta, *L.*
Alströemeria aurea, *L.*

Bomarea salsilla, *Mirb.*
Doryanthus excelsa, *R. Br.*
Agave americana, *L.*
var. variegata.
vivipara, *L.*

130. *Liliaceæ.*
Tulipa suaveolens, *L.*
Lilium longiflorum, *Wall.*
Gloriosa superba, *L.*
Agapanthus umbellatus, *L'Herit.*
Polianthes tuberosa, *L.*
var. plena.
Kniphofia Uvaria, *Hook.*
Phormium tenax, *Forst.*
Sanseviera zeylanica, *Ros.*
cylindrica.
Aloe indica, *Royle.*
Yucca gloriosa, *L.*
angustifolia, *Pursh.*
Allium fragrans, *L.*
Cepa, *L.*
sativum, *L.*
Porrum, *L.*
Ornithogalum elatum, *B. Rep.*
Hyacinthus orientalis, *L.*
Asphodelus fistulosus, *L.*
Asparagus sarmentosus, *L.*
officinalis, *L.*
Dracæna ferrea, *L.*
terminalis, *Willd.*

131. *Bromeliaceæ.*
Ananas sativus, *Schult.*

132. *Pontederaceæ.*
Pontederia dilatata, *Haw.*

133. *Commelynaceæ.*
Tradescantia discolor, *L.*
Commelyna cœlestis, *L.*
bengalensis, *L.*
Cyanotis fasciculata, *Rom.* et *Sch.*

134. *Palmæ.*
Areca oleracea, *L.*
Seaforthia elegans, *R. Br.*
Caryota urens, *L.*
Borassus flabelliformis, *L.*
Corypha umbraculifera, *L.*
australis, *R. Br.*
Livistona mauritiana, *Wall.*
Chamærops humilis, *L.*
Phœnix sylvestris, *Roxb.*
Cocos nucifera, *L.*
Arenga saccharifera, *Lab.*

135. *Pandanaceæ.*
Pandanus odoratissimus, *L. fil.*

136. *Araceæ.*
Colocasia odora, *Roxb.*
Amorphophallus campanulatus, *Roxb.*
Caladium bicolor.
Dracontium polyphyllum, *L.*

137. *Orontiaceæ.*
Calla æthiopica, *L.*
Acorus Calamus, *L.*

138. *Pistiaceæ.*
Pistia Stratiotes, *L.*

139. *Gramineæ.*
Oryza sativa, *L.*
Zea Mays, *L.*
Coix Lachryma, *L.*
Panicum miliaceum, *Willd.*
jumentorum, *Pers.*
Spinifex squarrosus, *L.*
Cynodon Dactylon, *L.*
Eleusine coracana, *Gært.*
Lagurus ovatus, *L.*
Avena sativa, *L.*
Poa annua, *L.*
Briza maxima, *L.*
Dactylis glomerata, *L.*
Lamarckia aurea, *Mönch.*
Festuca duriuscula, *L.*
Bambusa arundinacea, *L.*
Lolium italicum, *Braun.*
Triticum hybernum, *L.*
Saccharum officinarum, *L.*
Andropogon Schœnanthus, *L.*
Sorghum saccharatum, *Pers.*
vulgare, *Pers.*

II. CRYPTOGAMS.

140. *Filices.*
Drynaria quercifolia, *Bory.*
Hemionitis cordata, *Roxb.*
Platycerium alcicorne, *Gaud.*
Cheilanthes farinosa, *Kaulf.*
Pellæa geraniifolia, *Fee.*
Adiantum caudatum, *L.*
Capillus-Veneris, *L.*
Onychium auratum, *Kaulf.*
Pteris longifolia, *L.*
arguta, *Vahl.*
serrulata, *L.*

Blechnum orientale, *L.*
Asplenium præmorsum, *Sw.*
Nidus, *L.*
Nephrodium molle, *R. Br.*
Nephrolepis hirsutula, *Presl.*
Gleichenia dichotoma, *Hook.*
Lygodium scandens, *Sw.*

141. *Ophioglossaceæ.*
Ophioglossum vulgatum, *L.*

142. *Marsileaceæ.*
Marsilea quadrifolia, *L.*

6. *List of some of the Rarer Plants observed in the vicinity of Perth.* By Mr Francis B. W. White.

In reference to observations on the effects of frost last winter, already reported, Mr Thomas Thomson states that the pinetum of Balgowan is 200 feet, and that of Keillour 560 feet above the level of the sea. The state of the thermometer placed on the snow at Balgowan during the week when the frost was most severe was as follows, viz. :—Dec. 24, 1860, 6° below zero ; 25th, 3° below zero ; 26th, 4° below zero ; 27th at zero ; 28th, 6° above zero ; 29th, 3° above zero; 30th, 10° above zero. The thermometer on the north wall of the garden invariably indicated 2½° higher. In ordinary circumstances there is no difference between these thermometers.

Various monstrosities of roses have been sent to the Botanic Garden this summer. At St Colm, Trinity, by Edinburgh, Mr W. A. Parker reported that almost all the roses were proliferous, producing numerous grown buds from the receptacles, and all surrounded by a common calyx. From Broomhall Park, Sheffield, Mr James Allan sent similar teratological specimens. In some of them the calyx was developed in the form of large leaves, like the ordinary ones of the rose.

SCIENTIFIC INTELLIGENCE.

BOTANY.

Welwitsch on the Vegetation of the Plateau of Huilla in Benguela ; with Remarks by M. De Candolle,—M. Welwitsch has just finished a series of most peculiar journeys, having been engaged for several years in traversing the territories of Angola and Benguela, the climate of which is usually fatal to Europeans, and from which we have not as yet received any important collection of plants. He has sent a letter on the subject to M. De Candolle, which has been published in the "Bibliotheque Universelle" of Geneva for July 1861.

M. Welwitsch says,—"At Benguela, 12°–13° Lat. S., we begin by finding *Zygophyllaceæ*, *Loranthaceæ*, and *Sesameæ* in great quantity. On the banks of the streams, the small tree *Herminiera Elaphroxylum* is not rare. The Acacias and Capparids become more common ; a species of *Cressa* and the *Salsoleæ* appear in the saline marshes. Around Mossamedes we see a *Tamarix* (*T. senegalensis ?*) very abundant. It is a small tree, and bears on it a *Cassytha ;* a species of *Hydnora* grows on a leafless *Euphorbia ;* several *Phytolaccaceæ* (*Limeum*, *Gisekia*, &c.) live on the *Zygophyllaceæ*, two *Mesembryanthemums*, a *Vogetia*, and several species of *Sesuvium* on the moving sands. More to the south, towards Cape Frio, Lat. 15° 40′ S., I have found, over nine geographical miles of coast, a beautiful *Hyphæne*, which is probably my only new Palm. In the elevated sandy region occurs the new dwarf tree which I have called *Tumboa*, and which is probably the type of a new family, and which has affinities in structure with *Coniferæ*, *Casuarineæ*, and *Proteaceæ*. Near Mossamedes (Lat. 15° S.), in the interior, there are calcareous mountains covered in part with *Acacias* and *Capparidaceæ*. Over sixty geographical miles of coast there are beautiful virgin forests of *Sizygium*, *Nauclea*, *Mimoseæ*, *Cæsalpinieæ*, *Combretaceæ*, *Spondiaceæ*, &c., with twining plants and epiphytic orchids. Over the last of these dark green forests there rises to the height of about 4000 feet (French) above the sea, the majestic chain of Serra de Xella, covered to its summit with a light shade. It has a varied arborescent and herbaceous vegetation. On Golungo Alto (near St Paul's de Loanda, Lat. 9°–10° S.), I found a pretty *Oncoba* (*O. spinosa ?*) forming here and there small forests, and in the midst of most gigantic trees there rise like phantoms the triangular leafless stem of Euphorbia. At the summit of the mountain we met with *Proteaceæ*, *Tarchonanthus*, *Echinodiscus* (with a Rafflesiaceous parasite), *Sapotaceæ*, *Parinarium*, *Combretaceæ*, *Brehmia* (one of the Strychneæ), *Nathusia*, *Hymenodyction*, and species of *Loranthus*, with gorgeously coloured flowers. We thus reach the plateau of Huilla, the vegetation of which indicates an elevated and new region. A perpetual spring reigns on this extended plateau on the eastern side. On the borders of streams are found species of *Salix*, *Rubus*, two *Epilobiums*, a *Nasturtium*, a *Rumex*, a *Juncus*, two species of *Triglochin ;* in the streams, three *Potamogetons*. In the midst of European forms we see two *Ottelias*, a *Blyxa* (like a Valerian), a beautiful blue *Nymphæa*, and various *Utricularias*. A *Serpicula* creeps in the marshy places associated with *Lobeliaceæ ;* five species of *Drosera*, eight or nine *Gentianaceæ*, an *Albuca*, and a *Kniphofia*. On the soft surface of a mass of *Sphagnum* flourish numerous minute species of *Scrophulariaceæ*, ten species of *Eriocaulon*, a *Burmannia*, a *Cyphia*, two *Trifoliums*, a *Ranunculus*, two *Scabiosas*, and a gigantic *Limosella*, chiefly differing from the European species in the enormous size of its leaves. There are also small *Cyperaceæ*, a small *Isœtes*, and a primulaceous plant allied to *Jiresekia*. In elevated moist places above, small species of *Hypericum*, *Centunculus*, *Phyllanthus*, *Commelyna*, *Polygala*, *Xyris*, *Hypoxis*, *Oxalis*, *Striga*, *Rhamphicarpa*, and numerous delicate *Rubiaceæ*, there rises in a pompous manner a *Protea* with a large head, while near the streams are pretty *Melastomaceæ*. In the small lakes there is a *Richardia* (with a yellow spathe), two species of *Iris*, several species of *Moræa* and *Gladiolus*. The great Lake of Ivantala presents a species of *Cabombaceæ* (*Barteria africana*, Welw.), not unlike *Villarsia nymphæoides* in its leaves and *Butomus* in its flowers. In the elevated meadows, about 5500 feet (French) above the level of the sea, we meet with copses composed of *Duranta*, *Cyclonema*, *Vitex*, *Lantana*, and other *Verbenaceæ*, shrubby *Mimosas*, *Carissa*, *Solanum*, *Strophanthus*, and two *Anonaceæ*, &c. In this region we have the forms and colours of a subalpine zone ; but we find associated, in a limited space, representations of different and widely separated zones. The moist meadows present *Polygala*, *Crotalaria*, *Lythrum*, several *Compositæ*, and a species of *Gloriosa ;* several *Gladioluses*, twenty-two species of *Orchideæ* (all terrestrial except one). The dry slopes and hillocks are clothed principally with woody or shrubby species of *Labiatæ*, *Acanthaceæ*, *Hypoxideæ*, *Convolvulaceæ*, and *Papilionaceæ ;* beautiful *Liliaceæ* (chiefly *Asphodeleæ*), *Daphnoideæ*, *Compositæ*, *Euphorbiaceæ*, *Gramineæ*, *Cyperaceæ*, and *Santalaceæ ;* but the greatest ornament are several beautifully flowering *Selagineæ* and two species of *Clematis* with large, pale, violet flowers. The valleys traversed by the water-courses contain more than thirty species of ferns, amongst which European ferns, as *Pteris arguta* and *Osmunda regalis*, are associated with arborescent species of *Cyathea*, and *Gymnogrammas* with yellow and white fronds, and species of the genera *Anæmia* and *Gleichenia*. Some pretty pines are found in moist rocks, and amongst them new species of *Streptocarpus* (*S. monophylla*, Welw.) On the border of the wood are numerous small *Asclepiadaceæ* and some *Apocynaceæ*. Erect species of *Cissus* are also common. Out of three *Geraniaceæ* there is one *Monsonia*. A species of Ficus, one to two and a-half feet high, yields an edible fruit.

"The dry forests are composed principally of *Pittosporum*, *Tarchonanthus*, *Echinodiscus*, *Acacia*, *Strychneæ* (Brehmia?), *Cassia*, *Combretaceæ*, and *Proteaceæ*, while the humid forests are formed by *Parinarium*, *Syzygium*, *Erythrina*, *Nathusia*, *Ficus*, several *Olacineæ*, and a tree allied to *Poinciana*, but which constitutes another genus. I have only met with two *Ericaceæ*, and the woody *Rubiaceæ* are only represented by a species of *Ancylanthus* and one of *Gardenia*. There are many woody *Euphorbiaceæ* not yet determined. A small *Phyllanthus* grows like *Salix herbacea*, and a *Myrsine* is found in the less umbrageous forests.

"The people inhabiting the region are a fine race of hospitable negroes, who cultivate the soil and rear cattle. The cereals raised are *Zea*, *Sorghum*, *Eleusine*, and *Penicillaria*."

M. de Candolle, in reporting this letter of Mr Welwitsch, remarks :—

"The families most abundant at the Cape (*Iridaceæ*, *Amaryllidaceæ*, *Santalaceæ*, *Compositæ*, *Lobeliaceæ*, *Euphorbiaceæ*, &c.), or, most characteristic of Southern Africa (*Selaginaceæ*, *Cyphiaceæ*, *Proteaceæ*, &c.), are prolonged towards the equator along the western coast, on account of the elevation of the mountains. It is quite different, however, with the eastern coast of Africa, where the equatorial vegetation extends towards Port Natal (Lat. 30° S.) on account of the warm and humid climate. The analogies seem to be less intimate between the elevated parts of Benguela and the western part of Southern Africa, than in the eastern part between Mozambique and Port Natal. In truth, according to the indications of Mr Welwitsch, the analogy seems, in the first of them, to be founded on the families and genera, and rarely on the species; while in the case of the eastern coast, as in all coasts, the same species extends sometimes very far. We may therefore expect to find in the collections from Huilla many absolutely new species belonging to genera of different countries.

"If any species are found identical with those of the Cape, Abyssinia, or even the region of the Mediterranean Sea, it will in all probability be in the case of Aquatics, or plants of moist places, or amongst plants having a very extended range, as the Cyperaceæ and Gramineæ. M. de Candolle has already determined the identity of *Myrsine africana* of the Cape, the Azores, and Abyssinia; it is not astonishing that we should find it also on the mountains of Benguela. There are also some representations of American plants as regards families and genera. The presence in Africa of *Cactaceæ* (of the genus *Rhipsalis*), of *Eriocaulons*, *Vellosia*, and *Rafflesiaceæ*, is an unexpected fact. It seems to point to a far distant geological epoch, when there existed a general southern vegetation, the remains of which are found in New Holland, South America, and South Africa, under the form of *Proteaceæ*, *Xyridaceæ*, *Hæmodoraceæ*, *Eriocaulonaceæ*, *Santalaceæ*, *Compositæ*, *Campanulaceæ*, *Lobeliaceæ*, *Leguminosæ*, &c.—a vegetation once very rich, but reduced in each of the three continents to outposts under the form of isolated species."

On the Composition of the Cone of the Coniferæ. By M. Ph. Parlatore.—The scales of the cone of Coniferæ have been examined by many botanists, and various theories have been advanced to explain their nature. Botanists have considered the scales of the cones as being a single organ modified in different species; some with L. C. Richard, regarding them as bracts, others with R. Brown considering them as carpellary leaves; while others, as Mirbel and Baillon, look upon them as bracts in the cypress and as flattened peduncles in pines. The researches of Parlatore on the different genera of Abietineæ and Cupressineæ have led him to consider the scales as being most frequently the result of the union of two different organs; that is to say, of the bract and the scaly organ, which are distinct and separate only in a small number of genera. He concludes that in the cases of Abietineæ and Cupressineæ there are always bracts, which are either free or united with the scaly organ which is in their axil; and the scale is most frequently formed of the bract and the scaly organ united, the extent of union varying in different genera; and hence arise the different forms of cones which the Coniferæ present. It is probable that the scales of the cones of Cycadaceæ result also, in some genera at least, from a union of the bract and the scaly organ, and this view is confirmed by the occurrence of two points in the form of horns at the end of the scales in the genus *Ceratozania.* A similar view in regard to the bracts and scales of Coniferæ has been already advocated by Dr Alexander Dickson of Edinburgh in papers published in this Journal.

ZOOLOGY.

Salmon.—Report to the Tweed Commissioners, 2d and 3d September 1861.—" In consequence of powers granted to me at the general meeting of last year, I beg to lay before you the following Report:—

" 1*st,* In regard to the '*blacktail,*' I have to report that, owing to the continuous floods in the river after the 1st of October 1860, the small nets would not work; consequently I was only enabled to mark 108 of these fish, none of which, so far as I can ascertain, have been recaptured. Upon the 16th March 1861, I received a letter from Mr John Weatherston of Horncliffe, enclosing a copper wire (which I produce) taken from the nose of a whitling caught near that village on that date; weight 1½ or 2 lbs. I identify this wire as one of sixty-six used in marking the 'blacktail' on the 14th and 19th of October 1859. When marked, these fish were from 8 to 12 ounces in weight, thus showing, from that and former experiments, that at all events this species (so far as the River Tweed is concerned) takes a longer time of arriving at maturity than has hitherto been generally imagined.

" 2*d,* As to the condition, quality, and number of fish landed after the 14th September 1860, when the annual close time for nets commences, I have to report that, at different periods, comprising the 1st October, 5th and 21st of November, there were landed, under my superintendence, 21 salmon, 15 grilse, and 375 trout, making a total of 411. The weight of these fish would average respectively 17 lbs., 7½ lbs., and 5½ lbs. each; and the whole, with a few exceptions, were in first-class condition, more like spring than autumn fish. I wish particularly to draw attention to our proceedings upon the 1st of October 1861. Upon that day, when upon one of my farms adjoining the banks of the river, I discovered that the river was flooded, upon which I mustered a boat's crew, and commenced operations at Scotch Newwater. In a short space of time we landed 15 salmon, 8 grilse, and 73 trout. These fish were captured upon the *ford*, when they were coming from the sea with the run of the tide. In the evening I was again upon the river side, when I saw not hundreds but thousands of splendid fish going back to the sea. This I attribute to the flood being from the River Till; and the tide fish meeting this flood, they turned at Norham, and brought those lying in the river with them. In consequence of this, immense numbers were congregated at the mouth and within the statutory limits of the river, and hence commenced the active, diligent, and lucrative proceedings of the poachers. Before leaving this subject I may mention, that, upon the 21st November, the day was dreadfully wet and cold; and the men having commenced work before daylight, and being completely soaked and in a state of starvation, I killed a 'bull trout,' 14 lbs. weight, and cooked it for them: he was quite black; but a better fish of his kind was never eaten, showing the absurdity of imagining a fish unwholesome because dark in the skin. On this day we landed 131 trout, 1 salmon, and 1 grilse.

"I would also draw attention to the enormous proportion of bull trout to that of salmon and grilse. I am afraid, if the present legislative enactments remain in existence, that in a few years we shall have the Tweed an entire trout river, like those south of it; although at one time those rivers, as well as the Tweed, abounded with salmon proper.

"I have now to report regarding the *kelts*. Of these there were marked this spring, under the surveillance of our superintendent, between the 14th March and 13th June, 27 salmon, not one grilse, but 302 trout, with galvanized wire in the under lip. None of these fish so marked have been recaptured, so far as I am aware. Of the 1028 marked in the spring of 1860 with labels and wires through the gill-cover (I produce one of the wires), I have ascertained three only to have been retaken—one at South Bells upon the 1st July last—one at Scotch Newwater on the 9th of the same month—and one at Hugh Shiel upon the 21st of last month. These fish weighed respectively 6 lbs., 6½ lbs., and 6¼ lbs.; they were all of the trout species, and in excellent condition. From the above remarks, and former observations, it leads one almost to the conclusion, that the kelts only return to the river every alternate season, and that too at a late period. I may also remark, that the return of the kelts to the sea appears to be annually becoming later, especially the salmon; of grilse there are few or none. Of the 27 salmon marked this spring, none were marked before the 14th May, and so many as ten upon the 13th June; showing, apparently, that early closing does not tend to create an early return to the sea.

"The next subject which my report embraces is that connected with *salmon fry*. During the last spring, upon the 26th April, the 11th, 17th, and 25th of May, and the 1st and 4th of June, I made repeated trials between Wilford and the mouth of the River Whitadder, and upon each of these days we landed many thousands of smolts. Upon the two first, although the river was literally alive with bull trout smolts, there were few or no salmon or grilse smolts. Upon the third day there was only one draught where salmon and grilse smolts prevailed, although at every shot we landed thousands of bull trout smolts. Upon each of the succeeding days the same result ensued; and upon the last two we only got five smolts of salmon and grilse, the bull trout being still most abundant. The trout smolts this season were stronger and larger than I ever recollect of seeing them, many resembling the smaller class of 'Blacktail.' I cut some open, and in each and all found some of the 'fry;' in one as many as seven. I may also mention one peculiarity in regard to the experiments of the past season, viz., that large numbers of '*perch*' (on some days many hundreds) were captured during several of the days of experimenting, and also to the extraordinary circumstance of a *pike* 5 or 6 lbs. weight being caught by myself when angling for salmon upon the 7th June, nearly a quarter of a mile below the Union Bridge, and where the tide flows daily. Pike in the lower parts of the Tweed were never before known. What is to be the consequence to the salmon if these fish increase to any extent?

"At the annual meeting in 1858, I received permission to mark a species of fish locally called 'Blacktail,' which are generally captured in the tideway, and which, by the old fishermen, are held to be adult fish. I was likewise empowered by the same meeting to follow out the marking of the *Kelts* in the spring—to try and ascertain, if possible, at what period they return from the sea to the river as clean fish.

"First, in regard to the *Blacktail*, I may mention that I cannot state the exact number marked in the autumn of 1858, owing to our late superintendent, Mr Mitchell, having kept the statistics, and which by some means have fallen aside, but which, to the best of my recollection, amounted to somewhere about 240. These were all marked with galvanized wire in the upper part of the nose. In the autumn of 1859 I marked 166 in all, 100 of which were marked with silver wire as before, and the remaining 66 with copper wire, in consequence of the supply of silver wire running short.

"Of the 240 marked in the autumn of 1858, none, to my knowledge, have been recaptured in the Tweed; but I have received information of three that were caught in the north of Scotland—one near Montrose, one in the River Don near Aberdeen, and one at the Cove fishing on this side of the same town. I may mention that one of these (about $2\frac{3}{4}$ lbs. weight) was forwarded to the late Mr Paulin, when in London in July last, by a Mr Johnston of Montrose, with the wire in its nose, and which I would call a fine whitling or sea-trout, but which there, I believe, goes by the name of 'Finnock' or 'Herling.' As to the 166 marked last autumn, I can trace four marked with the galvanized wire, and one marked with copper wire, recaptured in the Tweed, all of which were caught in the tideway. One of those marked with silver wire I got an account of as having been caught in the North Esk during last week. I produce specimens of the wires taken out of these fish. I may mention, when these fish were marked in the months of October and November, they would weigh from 8 to 12 ounces; and when retaken in the succeeding summer months, their weight varied from $1\frac{1}{2}$ lb. to $2\frac{3}{4}$ lbs.

"As to the *Kelts*, from the disturbed state of the Commission in the spring of 1859, nothing was done. During the last spring I have marked and caused to be marked 54 salmon, 9 grilse, and 965 trouts; in all, 1028. A part of these were marked by an ivory label attached to the gill-cover by a wire, of which label I now produce a specimen. Those not marked with labels were marked with wire attached to the same place. Up to the present day there has not, so far as I can ascertain, been one of these fish recaptured as clean fish on their return from the sea—showing the same result as in 1858. I may mention that these fish were marked from the fishery of Wilford downwards, or about six miles from the mouth of the river; and as it would have been impossible to have marked this large number without considerable expense to the Commissioners, I would recommend that this meeting vote Mr Paxton, superintendent of the Berwick Shipping Company's fishermen, a sum of L.5 as a remuneration to himself and others for the trouble he and they have taken in assisting to mark the kelts.

"I may also state that in May last I accompanied our superintendent to the river to point out to him the different kinds of fish which it was illegal for persons to capture by the rod. Of course, in doing this, we had to use the small net, when the quantity of bull trout smolts brought ashore were to me and to all quite miraculous, but I am sorry to say those of the salmon proper were very meagre. In opening some of the trout smolts I found as many as five or six of the salmon-fry in their stomachs; and I much fear, if this fish is allowed to increase as at present, they will soon banish the salmon and grilse from the river. Before leaving this subject, I have again to ask permission to continue to mark the blacktail in autumn and the kelts in spring, as well as power to try the river with the long net to ascertain the quality of the fish, and more especially to see if we cannot capture some of the marked kelts. This will be attended with little expense, as the nets for the purpose are still in existence.

"Geo. Smith, *Superintendent.*"

GEOLOGY.

Slate in India.—Mr Oldham, superintendent of the Geological Survey of India, has written a long memorandum on the use of slates in India generally, and on the slabs of the Kurnool district particularly. After explaining, at length, the nature of true slate, namely, that it is "capable of almost infinite division, thin plates or slabs splitting with tolerably even surfaces of considerable size," he goes on to show that the Kurnool slabs and the same material found in other parts of India are incapable of this infinite division, &c. And he is of opinion that "the Kurnool slabs referred to by Lieutenant Beckley and the Madras Government are entirely unfitted for sloping roofs; that they cannot be procured in slabs dividing naturally of such size and thickness as would adapt them for such roofs; that sawing them would, even if practicable, be too expensive; that the slabs thus procured would be either too thin to give the requisite strength, or, if of sufficient strength, would be too heavy and thick for economical or effective use. But for flat roofs or floors he thinks they may be used with advantage. Mr Oldham adds,—"I would further urge that such stone slab floors, where the proper material can be procured with a moderate amount of carriage, and at a fairly reasonable rate, will prove much more durable, economical, more cleanly, and in every respect better floors than either wood or 'pucka' for barracks, hospitals, court-houses, or any place where there is constant intercourse, and also for the verandahs of such buildings. I have just alluded to the cleanliness of such floors; and I consider this to be by no means a trifling advantage. They can be mopped out with clean water, or washed with soap and water in the same way as ordinary wooden floors, and can thus be kept sweet, clean, and free from vermin with the smallest amount of labour. There are several localities in Bengal and the North-Western Provinces where such slabs could be obtained as would be suited for flooring. The hills to the south of Monghyr, the Sikkim Hills (poor), the Soane Valley, the Kumaon Hills, &c., the Gwalior Hills. But in few cases will such materials admit of any great length of carriage; and they can therefore only be used economically when procured within a reasonable distance of the works where they are required."

MISCELLANEOUS.

The Great Comet of 1861.—On Sunday evening, June 30th, between eight and nine o'clock, there was observed at New Haven, in the northern part of the heavens, in an opening between the clouds, and at an elevation of about ten degrees, a nebulous body of unusual brilliancy. Its appearance was similar to that of the planet Jupiter shining through a thin mist; and it was nearly as conspicuous an object in the heavens as Jupiter, although this was due not wholly to the intensity of its light, but partly to its extent of surface, its apparent diameter being about equal to that of the full moon. It was at once suspected that this body was a comet; but this conclusion was adopted with some reserve, on account of the unusual brilliancy and sudden apparition of the meteor. This light was soon concealed by a cloud; but about half an hour later, a larger opening in the clouds disclosed the tail of the comet, in the form of a bright streamer, with sides nearly straight and parallel, and pretty sharply defined. The head of the comet was now invisible; but a little later both head and tail were seen simultaneously, forming together one of the most brilliant comets of the last fifty years, and astonishing every one by the suddenness of its development. Mr R. W. Wright of this city marked the position of the comet's head upon a star chart as accurately as he was able, and hence concludes that about a quarter before nine o'clock, June 30, its R. A. was 108° and Dec. 47° N.

On Monday it was ascertained that on Saturday evening several individuals had noticed in the north a bright streamer, rising to a great height above the horizon, and it was at once concluded that this was the tail of the same comet. The daily newspapers report, that the head of the comet was seen on Saturday evening at Columbus, in Ohio; but it is not known that any one made any accurate determination of its place.

On Monday night, at New Haven, the sky was overcast; but on Tuesday evening, July 2d, the sky was mostly clear, and the comet very conspicuous; although it was thought that its head was not as brilliant as it had been on Sunday evening. At 9^h 31^m P.M., the position of the head was in R. A. 8^h 41^m, and Dec. 63° 5′ N. Seen through a telescope of five inches aperture, with a power of 55, the head was fully thirty minutes in diameter. Near the centre of the nebulosity appeared a very brilliant nucleus, from which emanated a luminous sector, whose opening was about 90°, one side being nearly vertical, and the other or right side was nearly horizontal. This brush of light extended two minutes from the nucleus. The tail of the comet could be traced to a distance of 90° from the head.

On Wednesday evening the sky was again clear, and the comet was observed to great advantage, but its brilliancy had palpably declined since Sunday evening. At 9^h 5^m P.M., its head was in R. A. 9^h 52^m, and Dec. 60° 10′ N. Seen through the telescope, the coma had about the same extent as on the preceding evening, but the luminous sector already mentioned had changed very noticeably. The sides of the sector were curved, the concavity being outwards, and the opening of the sector amounted to 136° when measured to the extremities of its arc; but the initial directions of the two sides formed an angle at the nucleus of about 90°. From the nucleus to the edge of the sector was 1′ 34″. Beyond this, there was a dark arch or band concentric with the nucleus; and beyond the dark band a luminous arch or envelope, faint and misty, the middle line of which was 2′ 52″ from the nucleus. Beyond this there were faint indications of a second envelope, with an intervening dark arch, the whole forming a series of nearly concentric light and dark arches, similar to those observed in Donati's comet in 1858, and in Halley's comet in 1835. The tail of the comet on Wednesday evening could be traced through an arch of 95°; and the deviation of its axis from the position of direct opposition to the sun was about 12°; and toward the east the axis produced cuttin g the ecliptic about 8° behind the sun's place.

The tail of the comet was carefully observed on several clear evenings, but the observations were more detailed and complete on the evening of July 3d. The northern edge grazed the star Lambda Draconis, passed about 15′ to the south of Kappa Draconis, and continued on through Iota Draconis, and far beyond it, in an arc of a great circle. The southern edge passed just to the north of H. 32, Ursæ Majoris, grazed H. 30, Ursæ Majoris, and continued on through the stars 3 and 8 Draconis. (According to the B. A. Catalogue, these stars are Nos. 3496, 3358, 3968, and 4347.)

It broke off, or suddenly became faint, before it reached the distance of Alpha Draconis, at about 20° from the nucleus. From that point the tail continued as a much fainter milky band, decreasing very gradually in luminosity, and varying but little in apparent breadth. This breadth was less than one-half the breadth of the extremity of the brighter portion, which was about 3°. The southern edge of the narrower and fainter stream passed through Alpha Draconis, and grazed the stars Tau, Sigma, and Eta Herculis. The decreasing light of this stream vanished in the immediate vicinity of the Milky Way, to the east of β Ophiuchi. The extreme length of the tail was about 95°. The train of the comet was apparently made up of two distinct streams of luminous matter, differing greatly in width and length. The northern edges of the two were in the same line, but the extreme breadth of the shorter stream was much greater than that of the other. Its southern edge was badly defined, and somewhat concave outward. A very faint diffused light, rapidly widening out, could be traced far beyond the point where the sudden falling off of brightness occurred. This diffused light extended, on the evenings of July 4th and 5th, to the vicinity of Corona Borealis, or more than 40° from the nucleus, and attained to a width of 12° or 15°. Its southern edge passed just to the north of the star Theta Bootis. The breadth of the tail, as distinctly seen, at its broadest part, was about 3°. On the evening of June 30th, the estimated breadth was 5°; but a faint light on the south side was traced 5° farther, giving an extreme breadth of 10°. On July 4th, the tail was visibly forked about 2° below the star Alpha Draconis, or 15½° from the nucleus. On the following evening, the point of forking was 3° or 4° above the same star. The nucleus had advanced 5½° toward it in the interval.

It was also observed, on the evening of July 4th, that by examining carefully it could be discerned that the long narrow stream increased in breadth about in proportion to the distance from the nucleus. At the point where first seen as a distinct stream, its breadth was about 1½°.

Since July 5th the tail of the comet has decreased, from night to night, in brightness, as well as in length and breadth.

The following places of the comet, as observed at the U. S. Naval Observatory, Washington, have been communicated by Lieut. J. M. Gillies, Superintendent of the Observatory. The observations were made by Mr Ferguson with the large equatorial.

	M. T. Washington.	No. of Comp.	α	δ
1861, July 2,	$9^h\ 55^m\ 19^s{\cdot}3$	10	$8^h\ 43^m\ 6^s{\cdot}97$	$+63°\ 12'\ 14''{\cdot}7$
3,	8 46 46 ·3	2	9 51 41 ·15	66 9 52 ·5
3,	9 10 7 ·3	5	9 52 52 ·55	66 11 6 ·0
4,	8 51 20 ·5	12	10 58 36 ·26	66 54 20 ·6
6,	9 0 52 ·5	4	12 31 12 ·57	64 51 7 ·6

On the night of the 3d, it was observed on the meridian with the transit instrument by Professor Robinson, U. S. N., and with the mural circle by Professor Hubbard.

	M. T. Washington.	α	δ
July 3,	$15^h\ 21^m\ 46^s{\cdot}7$	$10^h\ 11^m\ 7^s{\cdot}25$	$66°\ 33'\ 31''{\cdot}5$

From the observations of the 2d, 4th, and 6th, the following elements of its orbit were computed by Prof. Hubbard:—

Perihelion passage 1861. June 11.43955.	Washington mean time.	
Longitude of the Perihelion,	249° 11′ 28″·4	Mean eqx. 1861·0
Longitude of ascending node,	278 58 32 ·1	
Inclination of the orbit,	85 37 35 ·5	
Perihelion distance,	0·821531	
	Motion direct.	

These elements give for the middle observation

$$\Delta l = -15''{\cdot}7\ (c-o)$$
$$\Delta b = -10\ {\cdot}6$$

It is obvious, from these elements, that this comet is not the same as the comet of 1556 (called Charles the Fifth's comet), whose return has been anticipated for several years; nor do these elements bear any resemblance to those of any comet in the published catalogues. We must conclude, then, that this comet is a new one, whose orbit has never before been computed.

The Comet, as seen at the Observatory of Harvard College, Cambridge, Mass. Communicated by G. P. Bond, Director.—The comet was first seen at the observatory of Harvard College in the early twilight, on the evening of Tuesday, July 2d. The sky was clouded on the 1st and on the 30th. On Saturday the 29th of June the air was hazy, preventing the usual sweeping for comets, although observations near the meridian were prosecuted until about 11^h P.M. Had the sky been clear, the tail of the comet would probably have been seen. A day or two previous, the western twilight had been explored with an opera-glass; but at this time only the upper part of the tail could have been in sight, and it must have been too faint to attract notice. The condition of the theory of cometary formation makes it very desirable that astronomers should devote more attention than they have hitherto been accustomed to do to the accurate delineation of the curve of the tail among the stars. The present opportunity has been improved at the observatory of Harvard College, by making careful tracings of the boundaries of the rays through their entire extent upon star-charts. The *Uranometria Nova* of Argelander was found to be especially convenient for the purpose, both from the exactness of the projection, and the care taken in giving the proper magnitudes to the stars, which greatly facilitates their identification. An uninterrupted series of clear nights, from the 2d of July to the present time, has very much favoured us in preserving the continuity of the phenomena, which is a condition of the utmost importance for their future discussion.

The suddenness of the apparition of the comet in northern latitudes was one of the most impressive of its characteristics. On the 2d of July after the twilight had disappeared, the head, to the naked eye, was much brighter than a star of the first magnitude, if only the effective impression be taken into account, although as to intensity it was far inferior to α Lyræ, or even to α Ursæ Majoris. I should describe the head as nearly equal in brightness to that of the great comet of 1858 between the 30th of September and the 5th of October; it should be considered however that the present comet was better situated, from its higher position above the horizon at the end of twilight.

The aspect of the tail suggested a resemblance to the comet of March 1843. It was a narrow, straight ray projected to a distance of one hundred and six degrees (106°) from the nucleus, being easily distinguishable quite up to the borders of the milky way. The boundaries for the most part were well defined and easily traced among the stars. It was not until after two or three hours of observation that I could gain a clear comprehension of the structure of the tail or tails as they presented themselves to the naked eye and through a small opera-glass. It was then evident that a diffuse, dim light, with very uncertain outlines, apparently composed of hazy filaments, swept off in a strong curve towards the stars in the tail of Ursa Major—the southern edge directed as low as towards Mizar. This was evidently a broad curved tail, intersected on its curved side at the distance of a few degrees from the nucleus by the long straight ray which at the first glance, from its greatly superior brightness, seemed alone to constitute the tail. The two were in fact counterparts of the principal tail and the supplementary rays of the great comet of 1858, with this remarkable difference, that in the latter the straight rays were so far inferior in brightness to the curved tail as to have been recognised at only three observatories—those of Poulkova, Göttingen, and Cambridge, U.S.—while with the present comet the predominating feature was the straight ray, to which the curved tail seemed scarcely more than a wisp-like appendage.

On further scrutiny, with the aid of an opera-glass, two sharply cut and very narrow dark channels, bounding the principal ray, could be traced for ten or fifteen degrees from the nucleus; while outside of them, on either side, were two additional faint rays. The whole issue of nebulous matter, from the nucleus far into the tail, was curiously grooved and striated. It was noticed that both the principal ray and the dark channels penetrated within the outline of the curved tail, the latter being clearly separated from the principal ray, even to the naked eye, by a dark cleft just above their intersection. The well-defined margin of the principal ray admitted of a very exact delineation, even as far as α Ophiuchi, 100° from its origin.

On the 3d, the bright rays and dark channels were traced to a distance of 40° from the nucleus, the principal ray to nearly 100°. Five or six alternations were distinguished, besides the hazy filaments constituting the curved tail. Some of the streaks could be traced quite up to the nucleus. The rays were not only separated by the dark channel parallel to their axes, but they were disconnected at intervals in the direction of their length.

On the 4th, there were two or more regions of contrary flexure on the north following margin of the ray, which, in a theoretical point of view, are of very great interest when taken in connection with the direction of the ray almost precisely in a great circle from the sun continued through the nucleus. This peculiarity presented itself still more decisively on the 5th, when the tortuous path of the ray could not be overlooked.

The very singular aspect of the northern edge of the principal ray for the first thirty or forty degrees of its course attracted particular attention, and the charts were revised with all possible care. The sky was perfectly clear, and the outlines so distinct that there could be no room for doubt as to the reality of the reflexure of the curve. Subsequently, on projecting an arc of a great circle from the sun through the nucleus, it was found to lie clearly within the margin of the ray as far as a distance of thirty degrees (30°) from the nucleus, and there was still haziness beyond it, almost to the distance of sixty degrees (60°). The charts on other dates indicate similar results, but the data cannot be properly discussed without requiring more labour than be at present devoted to them.

Within the last few days the principal ray in the part near the nucleus, has assumed a more regular sweep in the direction opposed to that of the diffuse tail, which now reaches nearly to the centre of Corona Borealis, scarcely changing the course of its southern limit between κ and ι Bootis and ζ Coronæ Borealis from night to night.

The telescope phenomena, though interesting, have not presented equally strongly defined features with those which characterised the great comet of 1858. We should perhaps except from this remark their structure for a day or two after their first emission from the nucleus. In this stage they were intersected by jets of luminous matter projected from the nucleus, and these limits were clearly outlined.

On the 2d, portions of three were visible; the inner one showing a variety of details. In its outline and general aspect it was, like others which followed it, almost a *fac simile* on an enlarged scale of some of those exhibited by the great comet of 1858. They rapidly faded, or were lost in the surrounding haze, and their places were filled with new ones. Latterly, two, at most, could be seen at one time. It is quite important to remark that the successive envelopes resembled their predecessors not only in their general aspect but quite closely in the details of their structure; the luminous jets not issuing at random from all points alike of the nucleus, but continuing to follow a nearly similar course at each new discharge from its surface.

The most natural inference from this would seem to be that the nucleus, if it rotates at all upon an axis, does so very slowly. Of the pendulum-like vibrations of the luminous sectors ascribed by Bessel to the comet of Halley, nothing was seen; although the opportunity of witnessing them, had they existed, was very favourable, as the sectors were well displayed.

The nucleus was throughout brilliant, and, to appearance, solid, with a diameter of from 2″ to 3″.

The disposition of the nebulosity, in the part of the tail contiguous to the head, was nearly uniform throughout; the axial darkness being scarcely distinguishable, excepting on one occasion, July 3d.

The following positions have been derived from comparisons with neighbouring stars:—

1861.	Cambridge Mean Solar Time.	α	δ
July 2, . .	8^h 28^m 38^s	8^h 37^m 43^s.22	+62° 51′ 17″·1
„ 3, . .	8 21 33	9 49 15 85	66 6 15 ·3
„ 3, . .	10 39 52	9 56 6 58	66 16 05 ·1
„ 4, . .	10 39 18	11 2 7 ·48	66 53 26 ·4
„ 5, . .	12 9 26	11 57 9 ·67	66 3 22 ·0
„ 6, . .	9 17 39	12 21 2 ·60	64 51 33 ·3
„ 8, . .	10 20 5	13 21 36 ·05	61 46 13 ·7
„ 9, . .	10 40 47	13 37 37 ·88	60 21 45 ·2
„ 10, . .	9 39 12	13 49 26 ·80	59 9 34 ·1
„ 12, . .	11 57 47	14 8 0 ·59	56 54 47 ·2
„ 13, . .	9 47 55	14 13 59 ·24	56 5 25 ·7

The nucleus admitted of very precise observations; indeed it is a curious fact, that it would be quite possible, by means of proper comparisons with neighbouring stars, to obtain the differences of terrestrial longitudes of the principal points at which it was observed, with a degree of precision only surpassed by the more refined methods known in astronomy.

The near approach of the present comet to the earth, and the sharply defined point of its nucleus, illustrates the practicability of a method of determining the solar parallax with perhaps greater exactness than can be attained by any other means. Many comets have stellar points for their nuclei, visible in the larger telescopes, which admit of as accurate comparisons with neighbouring stars as is practicable in measurements among the stars themselves. Many such have appeared within the last fifteen years. Suppose such a comet to be suitably placed so as to be observed simultaneously in different quarters of the globe, when at a distance from the earth of less than one-twentieth of the sun's distance: under favourable circumstances it would not be hazarding too much to say, that in the course of its apparition the probable error of the solar parallax could be reduced within smaller limits than is possible by means of transits of Venus or of any other method. Such an opportunity might possibly afford an improved value of the mass of the earth.

The following elements of the comet have been computed at the Observatory by Messrs Safford and Hall:—

Elements of Comet II., 1861. By T. H. Safford.

T = 1861, June 11.1878	Cambridge m. t.
log. q =	9·91299
$\pi - \Omega$ =	329° 10′·81
Ω =	278 59 ·28
i =	85 41 ·43
	Motion direct.

By A. Hall:—

T = June 11.280. Washington m. t.
π = 248° 51′ 50″
☊ = 278 59 23
i = 85 41 27
log. q = 9·91352
Motion direct.

From the above, Mr Safford finds the following approximate ephemeris for $10^h\ 24^m$ m. t. Washington, Δ and r representing the distances from the earth and sun respectively.

1861.	α	δ	log. Δ	log. r.
July 5, . . .	178° 42′	+66° 8′	9·3404	9·9716
„ 6, . . .	188 21	64 45	...	...
„ 7, . . .	195 24	63 13	9·4281	9·9800
„ 8, . . .	200 37	61 42	...	...
„ 9, . . .	204 34	60 18	9·5051	9·9887
„ 10, . . .	207 39	59 2	...	...
„ 11, . . .	210 5	57 54	9·5722	9·9975
„ 12, . . .	212 5	56 52	...	...
„ 13, . . .	213 44	+55 57	9·6313	0·0066

The following, computed by Mr Hall for Washington mean midnight, will give an idea of the path of the comet previous to its becoming visible in the northern hemisphere:—

W. m. t.	α	δ	log. Δ.
June 12·5, ...	61° 39′·1	−26° 32′·3	9·7222
„ 16·5, ...	63 16 ·3	23 18 ·4	9·6182
„ 20·5, ...	66 4 ·9	17 11 ·6	9·4831
„ 24·5, ...	71 56 ·9	− 3 45 ·4	9·3105
„ 28·5, ...	85 17 ·9	+27 41 ·5	9·1420
July 2·5, ...	132 15 ·9	63 34 ·0	9·2027
„ 6·5, ...	188 53 ·9	64 38 ·6	9·3884
„ 10·5, ...	207 50 ·1	+58 56 ·5	9·5420
June 29·0, ...	89 30 ·4	+33 8 ·4	9·1330

The comet passed its ascending node June 28·086, Washington m. t., when the difference between the heliocentric longitude of the comet and of the earth was 2° 0′. The difference between the geocentric longitude of the comet and of the sun was 12° 29′. Log. of distance of the comet from the earth = 9·1529. Calling its brilliancy unity on July 2·5, we have,—

June 12·5,	brilliancy =	0·11
„ 16·5,	„	0·18
„ 20·5,	„	0·33
„ 24·5,	„	0·69
„ 28·5,	„	1·41
July 2·5,	„	1·00
„ 6·5,	„	0·50
„ 10·5,	„	0·18

computed by the equation, brilliancy $= \frac{1}{r^2\Delta^2}$.

It will be seen that the comet, at about the time of its perihelion, must have been well situated for observation at the Cape of Good Hope and other points in southern latitudes. The *calculated* brilliancy is indeed much less than on the 2d of July, being only about one-tenth; but it is well known that the formula cannot be relied upon for the variations of the light of comets, which is greatly influenced by their positions relatively to their perihelia.

It is probable that at least the head of the comet was much brighter at the middle of June than it was after the 1st of July, and we shall wait with much interest for accounts of it from southern observatories, especially from the Cape of Good Hope, which has often, in similar emergencies, proved itself the most important astronomical position occupied by any existing observatory.

From the above elements, the diameter of the nucleus may be variously estimated at from 150 to 300 or 400 miles. On July 2d the breadth of the head at the nucleus was 156,000 miles, the height of the inner envelope 11,500 miles, and the length of the tail about 15,000,000 miles.

The comet was seen between one and two o'clock on Sunday morning, June 30th, by Dr Brunnow, at the Observatory of Ann Arbor. This is the earliest authentic account of its visibility which has come to my notice. The head could not have been seen on Friday evening, although observations to that effect have been reported. The extremity of the tail, however, must have been within view for some time previous, though too faint to attract notice.

The reports current of the identity of the comet with those of 1264 and 1556 are without any foundation. (*From the advanced sheets of "Silliman's Journal" for September* 1861.)

The Livingstone Expedition.

Kingare Mouth, Zambezi,
21st January 1861.

My dear Mr Young,—The discovery we have made of abundance of coal existing on the Zambezi above Kelvabassa will be of importance some day, when the obstacles thrown in the way of civilisation by the Portuguese have been removed. The first coal-field is that at Chicova, just where the river becomes narrowed by the hills; it is to be seen when the river is low, being then disclosed in the bed on the north side; it seems of good quality—burns freely without requiring a furnace. Strange the people seem to have no name for it. It has been broken up by trap-rock being forced in among it; but I have no doubt it may be had nearer the surface through the whole of the Chicova plain. The next seam is that near "Mangenene Hill," where it crops out on the face of the rock on the south of the river. On the north we found coal and shale in the bed of a stream coming from the hills, but failed to reach the seam itself; but we found pipe-clay which had undergone the action of fire. Pipe-clay is very common in the country.

Again, in the country beyond the Kafue, there is abundant evidence of coal at the foot of the hills to the north, and in the Batoka country, where we left the Zambezi. As we ascended the River Zangue, we came to beds of alum slate, covered with an efflorescence of the salt, under this was shale and coal containing large stems of vegetables, which seemed like Stigmarias; but I was unable to gather fossils, showing anything definite. From the sections we saw in that ascent, I was quite satisfied that the schist rocks of this country are modifications of the sandstone and slates altered by heat, and tilted up by the igneous rocks of granite, syenite, and massive quartz, which have been injected. The latest change has been the eruption of trap; but this seldom changes the position of other rocks. It has been forced through holes and between strata, but seems not to have possessed sufficient heat to render the rocks plastic. To this belongs the change which has caused the great Victoria Falls, the real wonder of the world. As to the great central lake, which seems to have existed in the centre, there is a good deal yet to be proved; for the country at Lesheke, composed of calc tufa, is on a higher level than the rocks at the falls; and therefore the dyke which would be necessary to confine the water must be sought for in front; and as we did not follow the Zambezi there, we cannot speak positively, but I think it will be found that the Batoka highlands will prove to be continuous with others leading to the Matebele country; and that the Zambezi now flows in a chasm between these elevated plains. When we left the Zambezi, only six miles below the falls, the chasm had deepened both by the fall in the river bed, which was very steep, and the rise of the surrounding country above that at the falls. A thorough examination of the river in this part of its course will well repay the trouble.

The Batoka highlands are composed of syenite rocks. On the south the slopes are steep, and present many peaks, forming a ridge to the plains; these peaks consist of quartz rocks, and are in immediate contact with the gneiss mica schist, and ending near the Zambezi in sandstone. The Batoka plains are about 3000 to 4000 feet; the surface is undulating. To the west, there is no steep slope, but a gentle fall in the country; for whereas the Zambezi valley to the south is only 1000 feet above the sea, that above the falls is 3000 feet, being only a difference of 1000 feet; yet that small amount is accompanied by a different climate. The valley above the falls is most unhealthy, as the missionary party found, by losing six out of nine of the Europeans in little more than a month; but the highlands are very healthy, and seem quite free of the fevers.

It is a great pity that the Makololo are so far from the coast; they are the people of whom most could be made. The coast tribes are all very suspicious of strangers.

Prizes offered by the Society of Arts and Sciences of Utrecht.—The Society in 1861 has given its gold medal to the following naturalists:—1. Dr Carl Semper of Altona, for a Memoir on the Development of *Ampullaria polita*, Desb.—2. Dr E. Clarapède of Geneva, for Researches on the Evolution of Spiders.

The following are proposed as subjects for Prizes in 1862 and 1863:—

1. An *exposé* of the principles which, from the time of the Treaty of Munster up to the present day, have been announced and applied on the occasion of the recognition of the independence of people who had been under a yoke, or of changes made in the form of government.

2. In reviewing the history of the Greeks and Romans, to ascertain the influence which the ideas and theories of philosophers exercised on the views and political conduct of statesmen, and to demonstrate the consequences of this influence in their attempts at political and social reform.

3. Historical Sketch of the state of our knowledge regarding the Island of New Guinea.

4. The determination in the most exact manner, and as much as possible by various methods, of the atomic weight of two elements at least, chosen by preference from those which have not been already published in the researches of M. Stas.

5. Account of the evolution of one or more species of Invertebrate animals whose history has not been already described; accompanied by illustrative plates.

The Prizes for each Memoir, if deemed satisfactory, will be a Gold Medal of the value of 300 Dutch Florins (about £24 sterling). The Memoirs may be written in English, French, Dutch, German, or Latin. They must be addressed (free by post), before 30th November 1862, to

Dr J. W. Gunning, Secretary of the Society at Utrecht. The memoirs on questions 3 and 4 must be given in not later than 30th November 1863.

It is recommended that the Essays should not be written in the authors' handwriting. They must be accompanied by a sealed letter, containing the name of the author, and bearing on the address the letter L, if he is a member of the Society. The Memoirs which are deemed worthy of prizes will be inserted in the Memoirs of the Society.

PUBLICATIONS RECEIVED.

Proceedings of the Academy of Natural Sciences, Philadelphia. January to March 1861.—*From the Academy.*

Annual Report of the Geological Survey of India. Calcutta, 1860.—*From Professor Oldham.*

Memoirs of the Geological Survey of India. Vol. II. Part II. By Thomas Oldham.—*From the Author.*

Journal of the Asiatic Society of Bengal. No. I. for 1861.—*From the Secretaries.*

Schriften der Konigl. Physikalisch œkonomischen Gessellschaft zu Konigsberg, Erster Jahrgang. 1st and 2d Part. Konigsberg, 1860–61. —*From the Society.*

The Climate of England. By George Shephard, C.E.—*From the Publisher.*

The Quarterly Journal of the Chemical Society. July 1861. *From the Editor.*

The Forests and Gardens of South India. By Dr Hugh Cleghorn, F.L.S., Conservator of Forests, Madras.—*From the Publishers.*

Dublin Quarterly Journal of Science. No. III. July 1861.—*From the Editor.*

Proceedings of the Literary and Philosophical Society of Liverpool. 1860–61. No. XV.—*From the Society.*

The Canadian Naturalist and Geologist. February, April, June, and August 1861.—*From the Editor.*

A Short Treatise on the Construction of Steam-boilers, &c. By J. R. Smith, Engineer, Devon.—*From the Author.*

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END OF VOLUME FOURTEENTH—NEW SERIES.

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