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EDITED BY

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THE TECHNOLOGIST.

NOTES ON THE PROPERTIES OF WOOD.

BY JOSEPH JUSTEN.

Trees cut in summer give lighter wood than when felled during winter time. The cause for this may probably be ascribed to the fact that in winter a large amount of nourishment is stored in the trunk, which during the spring and summer is spent for the formation of bloom and leaves.

We call hardness in wood the resistance which it opposes when another body enters it. If wood were an equal body like minerals, we should be able to determine its resisting power or hardness ; but it being differently built, and, whilst trying its hardness, other properties interfering, we cannot arrive at a decisive result.

Sometimes a wood has very hard fibres but very little body ; that is, it is lighter built than another wood with soft fibres and a full body ; it is therefore unadvisable to judge the hardness of a wood according to its fibres. Experiments to ascertain its hardness should be made across the stem and not upon a longitudinal section ; and although there is no instrument which leads us at once to a definite result, we can generally arrive with a saw at a fair conclusion. Many persons constantly employed on wood are of the opinion that it becomes harder if it is worked or barked whilst green.

Wood, as a porous body, contains in its natural state—whether dead or alive—a certain amount of moisture ; by the loss of that moisture or increase of the same, the bulk of the wood either contracts or expands.

If we have a piece of wood where this action takes place only upon one side, it is obvious that the piece will alter its form or shape.

The consequence of the loss of moisture is also the warping and splitting of the wood. The inner structure of a stem is irregular ; for instance, we find the inner moisture of a yearly ring to be more than on its outer side; this causes the splits on the exterior, after the wood is dry, and it also accounts for the impossibility of forming out of green wood a regular body which shall not lose its weight or shape. The time during which the evaporation of the moisture takes place depends upon the state of the atmosphere. Several authors are of opinion that the contraction is regulated by the specific weight. This, as a rule, cannot be adopted; for instance, lilac and oak, being both heavy and hard, contract quickly, whilst the double American maple, which is equally hard, contracts slowly. It is evident, however, that the fuller of sap a tree is, the greater will be the contraction. This will account for the fact, that we find on cut timber the cracks extend from the exterior towards the centre, because the sap-wood will contract more than the heart-wood.

Planks turn with their sides upwards; that is, the edges rise from the level of the centre line. This explains why we turn the inside of a plank towards the joists whilst we lay a floor, which prevents the twisting. The contraction and action of the wood cannot be checked altogether. Among the means to prevent it stands foremost the one of putting the tree into water; but when taken out it must not be stored in a place where it dries too soon, as it would burst if done; nor must it be left too long in the water, as this will injure the quality of the wood.

All the wood which is used is never quite dry; besides this, it works a little in itself under the changes of the atmosphere; and therefore attention must be paid to the selection of timber for the same purpose, for the heart-wood is less subject to such action than sap or splint-wood. This is an important point with the furniture makers. The expansion or contraction is less apparent in the length of the fibre than in the cross section of the wood.

The elasticity of the wood is called its property of return to its original form and shape after these have been altered by another cause. With this quality is connected the valuable fitness of some woods to transmit sounds, for which reason they are much used by musical instrument makers. The elasticity has its limit; and the more a piece of wood can be bent without breaking, the greater its elasticity.

The resistance of wood depends upon the three following conditions; —1st. Two pieces of equal length and height offer different resistance with reference to their breadth. 2nd. Two pieces of equal length and breadth offer different resistance with regard to their height. 3rd. Two pieces of wood of equal height and breadth offer different resistance with regard to their length.

Again, experience has proved that a piece of wood resting freely with its two ends will carry from one-third to one-half less weight than if the ends are fixed or built in a wall. Old wood has less elasticity than young, and heart-wood is less elastic than sap-wood. The same difference is found with wood from the lower stem compared with that from the upper crown. The elasticity diminishes with the progress of the specific dry weight. Square-cut timbers laid horizontally with their yearly rings have not by far such bearing power as when laid perpendicularly.

Green wood has considerable elasticity. Young stems, although they suffer sometimes by the wind, will regain their original position in a short time. Here it is necessary to mention that where young stems or branches have been bent through snow for a longer period, they will not return to their former form.

I submit the following as the result of some experiments relative to the bearing capacity of various woods. The pieces were all 3 feet long, and 2 inches by 1 inch, and air-dry. The constants arrived at were the following:—

	Constant.	Wet.	Weight, per C. Ft.
Yellow Pine	358·5	. . . .	25·687 lb.
Baltic Pine	444·	. . . .	29·062 „
Red Pine	467·	. . . .	33·437 „
Ash	517·75	53·875	41·812 „
English Elm	595·25	. . . .	37·312 „
Pitch Pine	629·	. . . .	45·750 „
American Elm	631·5	. . . .	45·312 „
American Oak	653·5	. . . .	44·875 „
African Teak	673·5	. . . .	60·562 „
Mora	691·	. . . .	71·250 „
Sabicu	854·25	. . . .	59·687 „
African Oak	869·5		
Greenheart	1,079·5	. . . .	69·750 „
English Oak	—	. . . .	53·312 „
Indian Teak	—	. . . .	38·125 „
Ironwood	—	. . . .	73·500 „
English Larch	—	. . . .	32·562 „

Formula to find the breaking-weight of a piece of timber:—*c* constant, *b* breadth in inches, *d* depth in inches, *l* length in feet, *w* breaking-weight in pounds.

$$\frac{c \quad b \quad d^2}{l} = w.$$

The adaptability of greenheart for hydraulic construction, dock-gates, &c., cannot be over-estimated. I may refer to an instance where a clough was taken out of a sewer after sixteen years: it had been made half of oak and the other half of green-heart; the oak was completely worm-eaten, whilst the green-heart was in its original condition. This certainly contrasts with the fact mentioned by Mr. Burnell in his paper, that he has a piece of green-heart riddled by the teredo; and it would be interesting to ascertain under what circumstances the teredo will attack or not attack this kind of wood. My experience proves that green-heart is exempt from the erosion by the teredo ; but there is a mollusc in this timber which we find alive in it when it arrives here from the West Indies. The worm is found in sizes from the lymexylon to the teredo ; but is of a different species, and seems not to live in this wood when used in such constructions as dock-gates, &c., in this country.

Green sap-wood will not retain its form and bend if it is suspended horizontally by its two ends. The same will occur in timber constructions where green wood has been used. I may mention that the artificial process of drying wood should not be extended beyond 10 per cent., because it will cause it to become brittle and totally useless. A close examination of a beam supported by its two ends will tell that the upper half of the fibres are stowing while the lower fibres are extending. The centre of gravity lies in the middle of the cross section. All woods do not offer the same resistance, and we can increase it by strengthening the centre of gravity. M. Duhamel describes in his work, "De la Force des Bois," the following experiment in elucidation of this fact: he took twenty-four sticks cut from young willows of equal strength ; each stick was 3 feet (Paris) long, and $1\frac{1}{2}$ inch square. Six of these broke in the centre, with an average weight of 256·909 kilogrammes (1 kilogramme equals 2·205 lb. English.) In two other pieces he made a cut across, $\frac{1}{3}$ inch deep in the centre, and filled it up with a piece of oak ; they broke with an average weight of 269·718 kilogrammes. Two more were cut $\frac{1}{2}$ inch deep, and otherwise treated in the same manner; they broke with 259·312 kilogrammes. Five were cut $\frac{3}{4}$ inch, and broke with 265·764 kilogrammes. From this it results that the smaller piece of harder wood fixed across the centre, considerably increased the strength of the stems when put in half and even three-quarters of the thickness. It is also the reason why a beam composed of several smaller pieces will bear as much as if of one entire piece. And again, as the bearing power of the timber varies, some advantageous results may be obtained by putting stronger and weaker wood together in a construction.

A round or square piece of a stem will offer about the same resistance from each side ; but if we compare a timber cut with the yearly rings vertically, with another having the rings horizontally, we find that the former will bear more than the latter.

The sap which protects the wood does not prevent its decay. Turpentine, which is often in the sap, prolongs the preservation of the fibre. According to Baron Liebig, the decay of wood takes place in the three following modes : first, oxygen in the atmosphere combines with the hydrogen of the fibre, and the oxygen unites with the portion of carbon of the fibre, and evaporates as carbonic acid. This process is called decomposition. Secondly, we have to notice the actual decay of wood which takes place when it is brought into contact with rotting substances ; and the third process is called putrefaction. This is stated by Liebig to arise from the inner decomposition of the wood itself; it loses its carbon, forms carbonic acid gas, and the fibre, under the influence of the latter, is changed into white dust.

As an example of this, I may instance the wooden ceilings of houses which after some time go into that state. The chief cause is, that the free access of the air to the wood is prevented, and the little dampness occasioned by washing is sufficient to promote the dry rot.

The sap of wood contains some saccharine matter, which will naturally decompose in itself, and this is noticed in timber stores from the sour taste and smell of such woods.

The actual time which wood lasts depends in a great measure on the time when it was felled, and in how far the soil in which it grew was suitable for its development. As a rule, wood cut in summer is less durable than that felled during the winter months.

It will also be the case with trees which remain a longer period before their removal in the forest after being cut; however, a great difference does not exist between ripe woods, whether they are felled in the summer or winter time, because the formation of the leaves and the blossoms affects only the sap-wood and the bark of the tree; therefore, if the sap-wood is cut off, and the heart-wood is properly treated and seasoned, the quality of the summer wood would be equal to that cut in winter time. In support of this, I may mention that most of the trees in Southern Italy are felled in July and August.

The pines in the German forests are cut down mostly in summer, and their wood is generally very sound. The opinion that this causes dry-rot is, I think, unfounded, for I believe whenever this takes place, it is in consequence of unseasoned timber being used. Considering the large quantity of timber imported into this country, I must mention that my experience tends to show that the North American woods, with the exception of red pine, are less durable than those from the north of Europe. The latter are stronger, superior, and not so much subject to dry-rot as the former.

In the earlier portion of this paper, I had occasion to mention some enemies of the wood which attack it while growing; it is lucky that they are neutralized and destroyed to a great extent by other animals in the forest; and among those doing great service in this respect let us remember the woodpeckers, finches, swine, hedgehogs, badgers, frogs, and many others.

Dry or dead wood has also some terrible foes, which at times cause alarming ravages; and unfortunately no effectual means have as yet been found to check them: the most dangerous of these are the *Termites*, the *Lymexylon*, the *Sirex gigas*, the *Teredo*, and the *Lymnoria terebrans*.

It is sometimes difficult to distinguish good from bad timber, and I would therefore draw notice to some illustrations from a work published by the French Government,—"Instructions sur le Bois de Marine," with special reference to the oaks, and to which the following explanation may serve.

Plate 43, figure 1, represents English oak, of the best quality. To this kind of oak belongs the *Quercus pedunculata*, and the *Quercus sessiliflora*. The fresh cut of such is a yellow straw colour, sometimes of a rose colour. The annual rings show a fine glossy grain which allows it to take a fine polish. The horny layer of three to five millimetres is quite distinct from the cellular portion, and the pores are very little to be seen.

This kind of oak is very sensible to the influence of the atmosphere. In damp weather it swells, and in dry weather it contracts considerably. This makes it liable to split; but notwithstanding this it is excellent wood, and the best suited for the ribs in a ship. The fibres hold together with a great longitudinal and even transversal tenacity which gives it a great resisting power.

Plate 43, figure 3, shows the cross section of an inferior quality. It is spongy; has large pores of a pale colour, sometimes brown or reddish; its deficiency has been caused by too wet a soil, by want of nourishment, or of fresh air, or of some other condition requisite for its full development. If such wood be ruptured it will break clean off, and a fibre may be rubbed into dust between two fingers. A valuable property of this kind of oak is, that it alters very little by the changes in the atmosphere, and it is therefore much in use for floors, furniture, and carpentry.

Between these two qualities of oak, range a great number of others, differing in their condition.

When trees are found to be decayed at the trunk, it must be attributed to an interruption of the functions of the root. It will occur that one or several of the roots die, by which putrefaction is imparted to the lower part of the stem, if this rot be white or black it is not very dangerous; it does not generally reach more than one foot above the roots; but when the rot is of a red colour, the wood should not be used in construction or it will soon lead to decay.

Trees arrive at an age when their wood becomes ripe, and then is the proper time to fell them. This may be seen when the top of the tree brings forth no leaves in spring. Such trees are superannuated; that is to say they grow no longer; and then they become subject to a serious evil called the dial. This is explained by the following process:—We know that with a vigorous tree in full growth the heart-wood contains the smallest portion of water, and that its density decreases from the centre towards the circumference; when it is felled and dried, it will split from the outer side towards the centre. This is not the case with a superannuated tree, in which the oldest wood begins to perish first; and consequently the greatest density lies between the heart-wood and the bark. Now, in such a tree the central wood contracts while drying, which causes the splits. Sometimes splits are found in trees which bear a glossy blackish aspect, and they must be distinguished from those just mentioned. They extend from the circumference towards the heart, and were created whilst the tree was growing. It is asserted that they are effected by frost. They look at first straight or capillary and enlarge with each heavy cold. They show themselves mostly longitudinally, on a swelling of the stem, and make the tree useless.

The splits in the heart of a tree must not be confounded with holes caused in felling. There is no danger with the latter beyond that they diminish the length of the timber.

Often in the trunk of a stem a particular irregularity is found in the non-juxtaposition of two successive annual rings.

This fault is caused by the strong winds, which affect it in the point where the flexion of the stem has its maximum.

It will also arise when the tree has not sufficient nourishment, by which two layers are prevented from growing well together. It shows itself in incomplete dark rings. If these are only in the sap-wood, they may be looked upon as unimportant ; but when they are, on the contrary, in the heart-wood, and accompanied with the dial, they betray a serious defect in the tree.

In some cross sections of an oak we often notice circular bands of a different colour from the remainder of the section, sometimes white, yellow, red, or brown. The texture of these bands appears loose, even spongy, and betrays signs of decomposition. It is found in the best qualities of wood, and it cannot be cured. The reason for this decay is not definitely known. Some persons suppose it to arise when the sap wood is prevented by severe cold from developing itself into good wood. When this evil is in the heart, it looks like a whitish circle, and is called the moon. Wood from such trees ought not to be used, because it will soon decay. When the faulty bands are straight, and the shades of colour are less observed, the vice is not so dangerous.

Druxy knots are caused by woodpeckers, by lopping, and by dead and broken branches, which make holes in the tree : into these the water runs, decomposes, and directs the evil towards the inner stem. If we find on a tree a swelling or depression, we may conclude that the condition of the tree is bad. Such trees are often found with the sap running out of their armpits. Among the various rots engendered by the knots, we have the following :—

Wet rot is composed of porous fibre running from the knot into the trunk of a tree. This rot is of brown colour and has an offensive smell. This evil is often found with white spots, the latter of watery substance. When it has yellow flames it is very dangerous. Black coloured knots are easily cured, and unimportant.

We find wounds on trees which have been effected by the fall of a neighbouring tree ; from the friction of a cartwheel by which the bark was torn. If this wound does not reach beyond the bark, it has no bad effect upon the wood ; but should it have damaged the ligneous portion of the stem, the wood soon assumes a green-like colour, and begins to decompose.

It occurs that a new bark grows over such wound, and in such instances the evil is not detected until the stem is cut into timber. Similar defects are also caused by lightning.

As a very elaborate work upon the various kinds of oak, I may mention Kotschy's Eichen Europa's, "Durability and Preservation of Wood."

Well seasoned timber will last for an indefinite period if kept in dry air or under water; but when alternately exposed to atmosphere, water, and light, it begins to decompose. The ordinary causes by which this is effected are chiefly the fermentation of the azotic substances contained in the cellular tissue. This is developed under the influence of the oxygen in the atmosphere, and by the moisture contained in the wood. We have therefore the problem to find means to prevent this fermentation, either by obviating all such circumstances as air and water, or to extract from the wood its vegeto-albumen, or to act upon the latter in a manner that it will resist fermentation, and the attacks of insects. No process has yet been invented which answers all these conditions, and with all its trials we must have the assistance of chemistry and entomology.

I refer to our museums as the place where, among other rude-made articles, will be found here and there a remnant of wood which bears the age of decenniums, and other specimens of petrified wood which must have been in existence in its natural state centuries ago.

That wood in sandy soil will last for centuries may be seen in the specimens which were dug up whilst making the new docks at Birkenhead, from depths varying from 8 to 32 feet below the surface, and they are reckoned to have been there for centuries.

Among the many inventions to preserve wood, those of England have proved the most successful. Already in 1737 a patent was granted to Mr. Emerson, for preparing timber with hot oil, and soon after the method of Oxford and Kyan came into use.

In 1837 a patent was taken out by Margary, to impregnate wood with sulphate of copper; and since 1838, Sir William Burnett's process, chloride of zinc, has been in use.

Mr. Payne obtained a patent in 1841 for preparing wood with two solutions, such as carbonate of soda and sulphate of iron. Some very good results are obtained with this system, but it must be done with the greatest care.

Still better is the invention patented by Mr. J. Bethell, which consists in the injection of oil of tar after the air has been extracted. This process is effective to a great extent, and for a full description I refer to Mr. Burnell's paper, read before the Society of Arts in London, 1860. (See Vol. 8 of "Transactions," p. 554.)

The disadvantage of the creosoting system is the offensive smell and the increased danger by fire; but it is recommendable for railways and hydraulic works.

In France, the price of creosote is too high to admit its general use;

and solutions of metallic salts are employed instead. Among these M. Boucherie's method has obtained the best results. He acts with a pressure of 5 or 7 feet of water upon wood not later than two or three months after it is felled, and injects a solution of sulphate of copper by a transversal section, while the sap runs out in the opposite direction. Railway sleepers prepared in this manner were laid down in 1846; and in 1853 they were found in so good a condition that ever since, M. Boucherie's system has been much employed in France. Another economical process of Mr. Fontenay is worth mentioning. He acts upon wood with what he calls metallic soap, which he obtains from the residue in the greasing-boxes of carriages; also from the acid remains of oil, suet, iron and brass dust, which are all melted together.

A piece of wood was put in such a hot fluid for forty eight hours after the water had previously been partly extracted under the ordinary pressure of the atmosphere. When taken out, the metallic solution which it had taken up stood at 3 per cent. to its first weight. This piece of wood was used as a railway sleeper on the Orleans Railroad, and after eight months it was in perfect condition, whilst other wood not treated in a similar manner was in a state of decomposition.

Another process is recommended by Mr. Dondeine, and much applied in France and Germany. It is a paint consisting of the following:—

Linseed oil	15	kilogrammes.
Rosin	15	"
Tar	5	"
Zinc or white lead	12	"
Vermillion, red or yellow	10	"
Colour (clay colours must be avoided as they thicken too much)	4	"
Cement	6	"
Oxide of iron	8	"
Gutta percha, glue, or gum	2	"
Hydrate of chalk	6	"
Lard	15	"
Litharge	2	"

(One kilogramme = 2,205lb. English.)

All these are well mixed, and reduced by boiling to one-tenth. When applied warm, it can be applied with a brush; but not too hot. It may also be used cold; in which case the paste must be mixed with a little varnish or turpentine oil. The results obtained with this process are reported as yet very satisfactory. It prevents decay, and admits no humidity.

Mr. Dondeine further reports that it prevents oxydation of iron; and wherever walls have had a coat of this mixture it has kept away all wet, and unpleasant insects, ants, bugs, &c. Roofs of pasteboard or of wood which have been painted with the mixture keep dry, and withstand the effects of rain and snow.

Wood impregnated with sulphate of copper will not last longer in sea-water than other wood. It is quite as much attacked by the sea worm as when in its natural state. On the other hand it has been proved that wood impregnated with sulphate of copper will have longer durability in the soil than when either tarred or charred.

The following statement of M. Brouzet to the French Academy may also be of interest. He has a seat in the Cavennes Mountain, where he cultivates silk-worms. The shelves upon which they breed are of pine. During the period from 1853 to 1858 all his crops perished through illness. In 1860 he was induced to make new shelves of pine impregnated with sulphate of copper, and ever since the silk-worms have been in the finest and healthiest condition.*

At Saint Sebastian, in Spain, the piles of a wooden bridge standing in the sea have been guarded against the attacks of sea-worms in the following manner. Each pile is surrounded by a wooden box, and the space between filled up with cement. After six years it was proved that the piles were in perfect condition, whilst the outer boxes were completely riddled by the worms.

SODA ASH.†

BY MURRAY THOMSON, M.D., F.R.S.E.

Soda Ash, or, as it is sometimes called in commerce, "Alkali," is a preparation of soda largely used by the paper maker, and his use of it has greatly increased since the scarcity of rags has compelled the introduction of new sources of fibre. The process by which an almost unlimited supply of soda ash can be produced we owe to the ingenuity of a Frenchman, M. Leblanc, who published his process about the end of last century. It was first practically applied at St. Denis in 1804. It was proved then to be an eminently successful process, and though it early commanded the esteem of our English manufacturers, yet it was not till the repeal of the salt duty that it was adopted in this country, and one of the first manufacturers to employ it was Muspratt of Liverpool.

Previous to the introduction of Leblanc's process, our only source of alkali was from the ash of seaweed, known under the name of *Barilla*, when it came from Spain, and *Kelp*, when it was made in the

* See 'Comptes Rendus de l'Academie Française,' vol. 54.

† From 'The Paper Trade Review.'

western islands of Scotland and in Ireland. Barilla or kelp, was at the best but a limited source, and Leblanc's process was, therefore, a great improvement, when it enabled us to obtain soda from such a plentiful substance as common or sea salt.

We deem it sufficient to indicate in outline only the different stages of Leblanc's process, as a full description of them would hardly prove interesting to our readers.

The first stage consists in converting the chloride of sodium, or common salt, into sulphate of soda, by heating it in a reverberating furnace along with oil of vitrol. Hydrochloric acid is given off during the process. This gas is not allowed to escape into the atmosphere as it once was, but is condensed in an arrangement known as the Coke Tower. The sulphate of soda, which is left in the furnace, is called *salt cake.*

The second stage consists in roasting the salt cake of the last operation along with a mixture of chalk and ground coal in a reverberating furnace until it is completely fused. Carbonic oxide gas is given off abundantly during the process. The fused mass on being withdrawn from the furnace, is now called *ball soda* or *black ash.*

The third stage consists in dissolving out of this black ash the valuable soda salts. This is done by a most ingenious application of tepid water, by means of which a large amount of black ash is thoroughly exhausted of its soda salt by a comparatively small amount of water. What the water does not dissolve is known as soda waste. It consists mainly of oxysulphide of calcium.

The soda liquor or lye, which is thus obtained, is then evaporated to dryness, and once more calcined along with some sawdust or coal dust, the effect of which is to decompose any sulphide of sodium, and convert it into carbonate of soda. It undergoes another purification by being once more dissolved, evaporated, and calcined. The product of this last operation, on being ground under mill-stones, constitutes the soda ash of commerce. It may be regarded as a mixture composed in chief part of carbonate of soda, and in smaller quantity of caustic soda ; but, besides these, it may contain such impurities as sulphide of sodium, hyposulphite, and sulphate of soda, particles of sawdust, &c.

If the relative quantities of carbonate of soda and caustic soda remained always the same, in every sample of soda ash, there would be no use for processes for valuing the article ; but, as these frequently vary, there has long been in use a method of estimating the exact value of any sample of soda ash. These methods are applicable to pearl ash as well, and are known under the general name of alkalimetry.

An alkalimetrical method is based on the well established fact, that a certain known quantity of an acid, such as sulphuric acid, will always neutralise or combine with a fixed definite quantity of alkali, such as soda or potass ; and it is easy to tell, by the use of a little colouring matter, such as litmus, when this neutralising has been effected. The following details of the most approved method of ascertaining the amount of available alkali in any sample of soda ash, will best illustrate the subject of alkalimetry.

Some ordinary commercial oil of vitriol, which has usually the specific gravity of 1845, water being 1000, is diluted with eight times its bulk of distilled water—if distilled water be difficult to procure, clean rain water will answer. This diluted acid is now tested as to its strength, in the following way. A graduated glass measure, is filled to a point between the division 23 and 24. It is understood of course, that these numbers count from the zero or 0°. the measure is now filled to zero with pure water, covered with the hand, and inverted several times, so as to cause thorough mixture. The diluted acid in every division of the measure ought to neutralise or saturate one grain of pure or uncombined soda. To determine if this is really the case, 100 grains of carbonate of soda, is obtained by heating red hot for some time the common bicarbonate of soda, the heating converts it into carbonate of soda, and 100 grains of this is now dissolved in 3 or 4 fluid ounces of water in a Florence flask, and when the solution has been effected it is filtered if necessary. The filtered solution is now coloured with some infusion of litmus and heated to near boiling. The acid contents of the measure are now added little by little, each addition is followed by brisk effervescence and a partial reddening of the litmus colour, but on again applying heat, so as to boil the solution, this reddening is changed back again to blue, and so with each addition of the acid, until 58·5 measures have been added, when a reddening is produced which boiling fails to restore to blue. This indicates that the soda of the 100 grains of heated bicarbonate is neutralised or saturated. If the 58·5 measures of acid has exactly neutralised the 100 grains of pure carbonate of soda, then the remainder of the diluted oil of vitriol may be put in a stoppered bottle, and kept as a store of standard acid, to be used for testing in the above way any sample of soda ash. If, however, the diluted acid should be so strong that 50 measures of it effected saturation of the above amount of carbonate of soda, then it is clear that these 50 measures should have occupied the bulk of 58·5. A change in accordance with that can easily be effected by adding to every 50 measures of the acid in the measure, 8·5 of pure water, or to every 100 of the acid 17 measures of water. If, on the other hand, more than 58·5 measures of diluted acid be required, this indicates that the standard acid is too weak to bring up its strength, there is no more convenient method than to add of vitriol drop by drop, to the quantity of acid first diluted, and subsequently trying it with fresh carbonate of soda.

With ordinary discrimination, one or two such trials is usually sufficient to restore the acid to its proper strength. When this has been done, the whole of the diluted acid should now be put aside as before, with a label attached, to the effect that the alkalimeter, or graduated measure, when filled to 23·5 with this acid, and then to 0° with water, every division of the alkalimeter is equal to one grain of caustic or pure soda. Enough of this standard acid should now be made to serve for a great number of valuations.

The actual process of valuing any sample of soda ash is now proceeded with in the same way as the 100 grains of carbonate of soda was treated in the foregoing description. The only difference being, that the inference to be drawn in this case is not the strength of the acid from the saturation of the pure carbonate of soda, but the converse ; the strength of the sample of soda ash, or real amount of soda it contains, is to be inferred from the amount of acid used to neutralise it, each measure being equal to one grain of pure soda.

ON THE PAPER MANUFACTURE.

BY BENJAMIN LAMBERT.

II.

Among the almost infinite variety of objects which arrest the attention of the diligent Technologist, paper must always hold a foremost place, not only as being a beautiful product of practical science, with uses so various as almost to defy enumeration, but mainly on account of the numerous members of the vegetable kingdom, which are fitted to enter into its constituent parts. The paper manufacture of this country, both by the amount of its invested capital and relative producing power, is entitled to rank as a national industry ; and although its proportions may be dwarfed when brought into comparison with the gigantic wealth-producing interests, cotton and coal, must still claim a conspicuous place in the long list of British manufactures. Such being the case, its welfare becomes matter of public concern, and its scientific necessities the subject of careful and special consideration.

The welfare of the great bulk of the paper manufacture is based on a plentiful supply of cotton and linen rags, and the complaint of the trade is that the available supply is not equal to the demand. It is stated with truth that the production of rags cannot be increased by any effort of private enterprise, but the further allegation that rags are essential to the production of the finer sorts of paper, must be taken *cum grano salis* by all parties who have seriously investigated the question. For centuries rags have been considered a waste product, destitute of value, other than for the manufacture of paper. We have always bought largely in the different continental markets ; whilst our own has been subject to periodical visitation from our cousins in the United States of America. Under the old fiscal regulations, the established system of trade worked smoothly enough, and paper-makers in this country did not care to look seriously beyond existing circumstances for any prospective disturbing cause. Rags were abundant, the paper-maker could literally revel in the variety of material which his capital could at any time command. Foreign competition in the markets of the world, in finished paper, was a state of things to which they were well accustomed, and knew how to be victorious when they chose; but foreign competition at home, within the very shadows of our British mills, was a possibility never seriously contemplated. So, when the inevitable abolition of all fiscal imports on paper came, and with it, an army of Teutons, invading the counting-houses of their customers, offering good-looking papers, in startling quantities, at prices fabulously low, and on terms temptingly inviting, our makers incontinently lose heart of grace, instead of girding their loins for the coming struggle, with a stern determination to vindicate our manufacturing supremacy.

How far the present state of things is exceptional and temporary, rather than consequent and fixed, is worthy of calm consideration. Our paper-makers state that while the price of rags has advanced, the value of finished paper has rapidly declined, and that whilst the rise in rags and decline in paper must be treated in the relation of cause and effect, the former is simply the effect of increased consumption in countries which either entirely prohibit, or place a high duty on the export of the raw material, the increased consumption again being the effect of the foreign makers being admitted to free competition with the English makers in their own market. This mode of stating the case may seem rather involved, but the inquiry is surrounded with peculiarities—for example, it would be fair to expect that the prices of our home collection of rags would have closely assimilated to the enhanced price of rags abroad. Yet London " fines" and "seconds" are very much the same in price as they have been for many years past. Again, it is well known that immediately on the repeal of the duty on paper, several makers increased their prices for fine sorts, and not the least puzzling circumstance is, that mills which, prior to the abolition of the excise on paper, had been shut up for years, were started again, quite twelve months after the duty had ceased, and that by one of the largest makers of printings in the trade, an anomaly for which we have never been able satisfactorily to account. For all the purposes of argument it may be stated, that in the matter of quality, no foreign paper has yet been brought into the English market which our own makers are not prepared to equal, at prices which shall properly remunerate the foreign makers, be they made from rags, or the veriest rubbish that ever defiled an engine, did the question of character not intervene. Almost every mill in this country has a reputation, laboriously acquired, for excellence in the make of some description of paper, and consequently to lower their standard of quality is a question of very serious import. A buyer of English paper almost invariably looks for the mill number on the wrapper, confident in his knowledge of the quality of paper made at that particular mill, but this is not true of the continental mills, either in sense or extent. The word *foreign* covers a multitude of sins, and the consequence is that our market has been flooded with large quantities of stuff in the semblance of paper, which for a time has successfully ministered to the necessities of the low-priced newspapers, but possessing neither the substance, finish, or durability of a really good article.

Belgium and Prussia are the two countries from which the bulk of recent imports have come, and the sorts have been mainly low printings, and worse than low browns and other wrapping descriptions. Of the latter we have seen such samples as were simply a disgrace to any maker, utterly unfit for use in any trade with which we are acquainted. What, either in the heavens above or the earth beneath could have produced such stuff, with the exception of the chopped straw with which the surface was plentifully plastered, passes our comprehension. As regards the printing sorts, they, of course, look very much better and handle surprisingly well when the very low prices at which they are offered are considered. Yet they do not suit our market; they neither wet well nor work free, and the chronic tendency which makers of "printing sorts" on the Continent have to load their paper heavily with various mineral substances, seriously detracts from the permanent value of the manufactured article. All things considered, we incline to the opinion that the Continental makers cannot manufacture a sound paper such as would command the approval of British consumers, and put it into damaging competion with our own makers, at a price which shall be properly remunerative to the producer. Already the Customs' Returns exhibit a marked diminution in the weight of paper imported from abroad; so marked indeed as to bring the figures representing the imports for the five months of the present year below those for the corresponding period in 1862, and this is rendered more significant when coupled with the fact that the German paper-makers are combining for the purpose of rescuing the trade from imminent peril, brought on by the unremunerative prices at which sales have been forced for some time back, an immediate advance of 10 per cent. was resolved upon at a meeting of the trade held at Carlesruhe in April last, and the Belgian makers will, in all probability, find it necessary to follow the example.

When speaking of the adulteration of paper by the admixture of mineral ingredients it has been very much the habit to attribute it almost entirely to foreign makers. And the practice has been most heartily denounced by both printers and publishers,—the former very naturally at finding his forms filled up with fluffy clay, and the latter in the want of firmness in the printed quire; to pay 6d. per pound for paper in which there was 30 per cent. of China clay, was considered very much too bad even for this advanced period of the century. Some of our own makers, however, as would appear from a letter published in the 'Paper Trade Review' for the month of June, have become no mean adepts in the science of adulteration. Mr. James Eckworth, of Newcastle, states that he has just finished the examination of "eleven samples of first-class papers," all British made, "and of the eleven only two were free from adulteration;" and he goes on to say: "It may appear almost incredible, but I can vouch for its being correct, that some of these papers were so heavily charged with mineral ingredients, that the proportion reached the astounding rate of 50 per cent. The lowest proportion of adulteration was 20 per cent., and the ingredients employed were various, and included gypsum, China clay, silica and starch." Mr. Eckworth may well remark that such a state of things may appear almost incredible. Had he found low-class papers very largely adulterated it would not have excited surprise, but that from 20 to 50 per cent. of mineral ingredients should have been found in first-class British-made papers, is a circumstance demanding critical attention. In the matter of low printings the paper manufacture seems to be gradually drifting into a dilemma difficult of explication. The shout "Cotton is King" went forth from the Confederate States of America as the key-note of a national programme. Whether the assertion properly belongs to the region of fact or to that of fiction remains to be proved. From the reading masses in this empire there has also gone forth a shout "Penny is King," and as with Cotton, it remains to be proved whether the prophecy shall be recorded among the things that were, or be graven in the annals of our periodical literature as indisputable truth. Of course the great Penny feature of the day is the cheap daily newspaper; and the problem is not yet by any means satisfactorily solved whether a newspaper with any just pretension to literary excellence, can give a sheet of decent paper measuring $46\frac{1}{2} \times 35\frac{1}{2}$, and weighing say 60 lbs. to the ream for one penny. The quantity of paper consumed weekly by the cheap newspaper press is something enormous, and the quality of the paper ranges from execrable to very common, with a fluctuating medium which may be described as bad. Of straw paper, ordinarily so-called, there is no lack, and of low rag paper with a mixture of raw fibre there is an abundance; but there is at the same time an enormous quantity of nondescript stuff which it would puzzle any paper-maker in the three kingdoms to describe. The raw material, whatever its kind, may be tolerably decent, but the make is usually of the most discreditable character, and the finish destitute of the mark which experience never fails to leave even on the lowest manufactured product. We are not without knowledge that within the last few years, and especially since the repeal of the duty, the number of paper-makers in this country has slightly increased, it would be illiberal to deny that in some instances the trade if it has not and gained, has, at all events, suffered no loss of reputation from the accession; but we cannot close our eyes to the fact that there are others, and the number is not a few, who have signally mistaken their calling, and who have been furnishing the markets, as the fruits of their incompetence, with much of the paper which we feel called upon so unhesitatingly to condemn. An amateur paper-maker is, generally speaking, a dangerous specimen of the *genus homo*, and it cannot be sufficiently impressed upon such that, although the science of paper-making may be rapidly mastered by those whose natural taste and ancillary knowledge qualifies them for the pursuit, there are others, the standard of whose ultimate excellence must be mediocrity, resulting, in many cases, in disappointment and disaster.

The principal materials employed in the manufacture of paper in this country are rags, cotton waste, and bagging of various descriptions, but rags are the staple article, ever since the establishment of the manufacture paper-makers have regarded rags as the only material from which a respectable quality of paper could be produced. And it is therefore to be expected that when, from any cause whatever, a rise occurs in their market value, the trade becomes uneasy and alarmed. At the International Exhibition of 1862, the British makers were very inadequately represented. Scarcely 11 per cent. of the total number of exhibitors hailing from Great Britain and Ireland, but although the exhibitors were few, it is fair to assume that all those makers who were possessed of any speciality in raw material, exhibited their produce; and the following tabulated statement printed in the Jurors' Report is interesting as showing the materials from which the various samples of paper exhibited were manufactured :—

1862.—CLASSIFICATION OF PAPER FROM THE DIFFERENT COUNTRIES.

COUNTRIES.	Total number of Exhibitors.	Number of Medals.	Honourable Mention.	Makers of cardbd. and pasteboard.	Of paper from rags alone.		Total Makers of papers from rags.	Paper and mill-board from ropes.	Paper from straw, wood, and other raw materials.	Description of raw materials employed, other than rags or ropes.
					First class paper	All other sorts				
Great Britain and Ireland . . .	11	6	2	2	2	—	2	3	4	2 of straw. 1 of esparto. 1 of hop-bine
New Brunswick .	1	—	—	—	—	1	1	—	—	
India	3	—	—	—	—	3	3	—	—	
Belgium . . .	6	—	3	1	1	2	3	1	1	Unknown.
Denmark . . .	1	—	1	—	1	—	1	—	—	
France	17	10	6	—	12	5	17	—	—	
Austria	4	3	1	—	4	—	4	—	—	Maize.
Baden	1	—	1	—	—	1	1	—	—	
Hanover . . .	1	—	1	—	—	1	1	—	—	
Gd. Duchy of Hesse	2	—	1	—	—	1	1	—	1	Straw.
Prussia	20	10	5	2	12	3	15	—	3	Straw.
Saxony and Reuss	2	1	1	—	1	1	2	—	—	
Würtemburg . .	2	2	—	—	1	—	1	—	1	Wood.
Italy	10	2	7	—	6	3	9	—	1	Straw.
Netherlands . .	3	1	—	—	1	2	3	—	—	
Norway	1	—	—	1	—	—	—	—	—	
Portugal . . .	4	—	2	—	—	4	4	—	—	
Japan	1	—	—	—	—	1	1	—	—	Bark.
China and Formosa	2	—	—	—	—	2	2	—	—	
Russia	3	—	3	—	3	—	3	—	—	
Spain	8	—	4	—	—	8	8	—	—	
Sweden	3	—	3	—	3	—	3	—	—	Wood.
Total . .	106	35	41	6	47	38	85	4	11	

NOTE.—The column "first-class paper from rags alone" is intended to include such papers as are manufactured of the best materials, and at great expense for sizing and finishing, such as high-class writing, and plate, and drawing papers.

Among the thirty-eight "other sorts," there are many papers which have been made of very superior materials, but they are for the greater part for printing purposes, and in the case of Spain they consist almost wholly of paper for cigarettes.

From the foregoing it will be seen that out of 100 sorts of paper shown by the same number of exhibitors, 85 per cent. was made from rags, 7 per cent. from straw, and only 4 per cent from raw fibres ; such a statement as this is conclusive evidence as to the almost universal use of rags all the world over.

The paper manufacture of Great Britain and Ireland requires of raw material about 150,000 tons every year ; and of this large quantity, the greater proportion is rags ; about 8 per cent. of the gross weight having to be imported, we stand in the peculiar position of requiring a larger supply of paper than we can furnish raw material for. The continent of Europe has at present a surplus of this raw material, whilst America is very much in the same position as ourselves. The following extracted statement, although we do not vouch for its accuracy in detail, will give a sufficiently fair view of the relation existing between rags and paper both in this country and on the Continent : " The Continent consumes only 4 lbs. of paper per head of its population, requiring 6 lbs. of paper material for its production ; England consumes 8 lbs. of paper per head, requiring 12 lbs. of paper material ; and America consumes 10 lbs. of paper per head, requiring 15 lbs. of paper material for its production : these simple figures 4, 8, and 10, represent with sufficient accuracy the relative position of England both towards the Continent and towards America as regards paper production and rag supply. It requires $1\frac{1}{2}$ lbs. of paper material, to make 1 lb. of paper. The paper material therefore, consumed on the Continent is 6 lbs. per head of its population. In England it is 12 lbs. per head, and in America it is 15 lbs. per head ; now the Continent, using 6 lbs. per head, does not consume all the paper material it produces, it has a surplus for export. England, consuming 12 lbs. per head, consumes a great deal more than it produces. The average, therefore, of paper material (or rags) that is made per head of these populations is somewhere between 6 lbs. and 12 lbs. It would be a long affair to show how the figures are reckoned out, and it is rather an uncertain calculation, with all the care that can be taken, but it is not far from true to compute that the Continent makes 8 lbs. per head of raw material (or rags,) and England 10 lbs. This would show that the former, requiring for its own use but 6 lbs., has 2 lbs. per head to spare for export ; and that England, requiring for its use 12 lbs., needs 2 lbs. per head to be imported to keep its mills going. The Continent, would therefore (from the population of 80,000,000) have about 36,000 tons of rags to spare for the wants of England and America, the only two countries that have to import rags because their home supply is deficient, and England would require in ordinary years about 13,000 or 14,000 tons to make up her quantity. In 1862, owing to the dearth of cotton waste, she imported more than this quantity by 6,000 or 7,000 tons. The account corrected by deducting the English export of rags gives between 19,000 and 20,000 tons as the actual foreign supply of rags for that year."

The importance of a good supply of rags to the paper-making interest is from the foregoing perfectly obvious, but no notice whatever seems to have been taken by the writer of the large quantities procurable from Egypt, India, and Japan ; paper-makers almost without exception say that Eastern rags are worthless on account of their softness, and the excess of wear which the woven fabric receives before it is condemned ; there is much more force in the first objection than there is in the latter. In order to convert a good strong rag into paper, there is not so much skill and care required at the hands of the experienced manufacturer, as is necessary in the working of a comparatively soft material ; as a rule, the lowness of the rag must be in an inverse ratio to the state of the machinery ; with strong stuff after being couched, the paper-maker may let his dry felts waddle on the stretching rolls, if precision be not with him a cardinal virtue, and generally to allow the paper to run as slack as it may until it either falls on the cutting board or is wound on the reel, but it is otherwise with a low material, which requires making in the strictest sense of the term ; then precision is absolutely indispensable, and the machinery from the engine roll downwards, must be in the most perfect order. Many inexperienced paper-makers imagine that anything will do for a common material, the contrary being the case as we have already stated. The principal difficulty with which the paper-maker has to contend in working soft rags, is their inability to carry engine size, rendering machine sizing necessary ; and as very few machines in this country are adapted for sizing, it follows that stuff needing this particular treatment is necessarily condemned. Nearly all modern machines are made with a double set of drying cylinders so as to admit the use of animal size, but the great bulk of the machines in use have been running for a great number of years, are small in size, and not worth the additions which it would be necessary to make in order to fit them for sizing purposes. The paper-makers of this country must set about the substitution of modern for comparatively ancient machinery, before long, if they would keep their proper place in the van of the manufacture. Cotton spinners, so long as they could obtain a plentiful supply of long staple cotton from the Gulf of Florida, classed every other sort coming from the East under the name of Surats, and condemned their use, but now that the supply of Sea Island and other favourite marks is cut off, they are gladly putting their machinery in order for the working of the shorter stapled, but still valuable, Surats, we do not say that to such a pass the paper-makers of this country must come, but the lesson may have its uses. From Japan alone a large and increasing exportation of rags is going on ; Sir Rutherford Alcock states the cost of collection, freight, and incidental expenses to be about 14*l.* per ton laid down in this country, and the wisdom of allowing a mass of such material to lie neglected in our warehouses, and finally to be reshipped to another market, is, to say the very least, exceedingly questionable.

The mode in which rags are collected for the use of the paper maker is one of the most roundabout conceivable, generally speaking they are considered as most decidedly contraband by thrifty housewives, who declare that dirt is inseparable from their stowage—first come the itinerant vendors of hearth stones, glass ornaments, crockery *et hoc genus omnes*, who in exchange for their wares are anxious to receive rags and bones, soleless boots, and crownless hats, the value of which no one but a Bohemian could satisfactorily appraise; they in turn convey their purchased stock to the rag shop, which is the market for their miscellaneous gleanings. There, from a mass of indiscriminate rubbish perfect order is evoked. Rags are sorted into cottons and linens, new and old, white and coloured, the latter being again subdivided into blooms and other varieties. Here also rags are first accumulated, as the rag-man does not, as a rule, sell his stock, until a parcel of respectable size has been obtained, when they are all cleared out and sold to the merchant, by whom they are supplied to the paper maker—and so exclusive is the trade that a stranger would have the greatest possible difficulty in purchasing a small parcel of rags from a merchant unless he were well introduced, the owner of a rag shop usually refusing to sell to any but the merchant with whom he is accustomed to deal. The collection of rags is, as we have endeavoured to show, indirect in its character, and the conclusion is inevitable that a large per-centage is annually withdrawn from the market, by burning and other means of destruction. A *quasi* charitable movement has been recently set on foot in London, for the direct collection of rags, under the name of the Rag Brigade, and we understand that it has so far been a financial success, but if the quantity of rags collected for paper-making purposes is to be materially increased, some more extensive organisation must be established. In the Jurors' Report on Class 28, Section A, in the International Exhibition of 1862, already referred to, the following curious calculation is given of the approximate quantity of rags made, collected, and wasted in this country. In the year 1860 the quantity of linen and cotton fabrics retained for home consumption, (which is found by deducting the quantity exported from what was imported) amounted to 210,000 tons, thus :—

	Tons.
Imported of Linen, Flax, &c. . . .	145,000
Cotton all kinds . . .	170,000
	315,000
Deduct exported . . .	105,000
	210,000

And the report goes on to state that "by taking the returns from the Excise Books for a similar period, it appears that in the year 1860 there were charged with duty 99,840 tons of paper of all sorts, being the largest aggregate ever reached, indicating that there ought to be of rags, making a large allowance for waste, not less than 50,000 tons of raw material produced by the wear and tear of our habiliments, which do not as yet find their way to the paper mill." The calculation is ingenious, but it would be much nearer the truth to estimate the quantity of rags uncollected at 100,000 instead of 50,000 tons, on the basis of 210,000 tons of material being available. Hitherto it has been assumed by the paper makers that they are as certain of a monopoly of the rag collection in the future as they have been in the past, an assumption which we are inclined seriously to doubt. It was stated recently in the public prints that a French engineer had invented a machine by which cotton and linen rags could be made available for re-spinning, and it was stated at the time that it would be impossible to estimate the extent to which such an invention might revolutionise particular staple industries. Such an announcement in the ordinary course of things might fairly be considered a remote contingency, were it not for the startling fact that the process which has been in embryo in this country for the last two or three years is now being developed so steadily as to leave no doubt of the position it is destined to assume, as an important branch of the cotton manufacture. So far the demand for rags has been scarcely felt by the paper makers, because manufacturers have not yet had sufficient time to get a large plant in order, but that done, every thousand spindles will tell upon the supply of rags with unmistakeable distinctness; against such an industry as this the paper maker will be powerless, as the prices the spinner could afford to offer would be such as to make rags unattainable for the purposes of the paper manufacturer. To meet such a contingency as this we do not believe the paper makers of this country are prepared. Its realisation even in a partial sense will herald the downfall of many. The hard cotton waste, which in the days of plenty the spinner cast to the paper maker, as a waste product, is now found, in the days of scarcity, to possess a high textile value, and that is consequently going slowly but surely from his grasp. It cannot reasonably be expected that a waste product, such as rags, which has been proved to possess a length of staple when broken up, sufficient for the spinning of low numbers, will be much longer permitted to find its way exclusively to the paper mill, and the paper makers of this country as prudent men of business, ought at once to bestir themselves in anticipation of the event. How far they are in a position to avail themselves of raw material other than rags, from whence it must come, and the multifarious and momentous considerations which such a change would entail, may possibly be noticed by us at another time.

ON THE *VERONICA QUINQUEFOLIA* AS A REMEDY FOR SCROFULA.

BY WILLIAM R. PRINCE.

I am not aware whether diseases derived from parentage can be eradicated ; but I am fully satisfied that there is no impurity of the blood, derived from whatever source, that is within the limit of possible cure by remedials ever yet applied, that will not be eradicated by the proper use of the root of the species of plant which I now shall proceed to name. In regard to the plant remedial for small-pox I speak with less force, because the discovery of its efficiency is more recent, but I find the fact attested by great numbers, and no denials of its potent relief.

Until my recent tour through Mexico, I had no realising conception of the extent, and of the apparent abiding existence of scrofula, among whole tribes of the inhabitants of earth. It has been with me an enigma difficult to solve in connection with Divine power, wisdom, and love, that children are afflicted through the errors of preceding generations. I find its solution alone in the mighty truth, that all moral and physical influences and results are based on the all-pervading principle of an eternal retributive justice. In a large district of Mexico bordering on the Pacific and extending 150 miles inland, the entire population consists of the Pinta or painted race, their faces and their skin on every part presenting the appearance of various coloured calico. The cause of this peculiar characteristic is declared to have resulted from the perpetuity of scrofula by a lack of adequate cures, and the intermarriage of such persons throughout that region of country. I was told that the men possess less strength than other tribes. The only hope for the repurification of this unfortunate race, and for others who have inherited similar maladies, consists in the constant exercise by nature of all her recuperative energies toward the resumption of her primitive prerogative of health and purity, and in effecting this she will avail herself of every means which may influence such a result. I have made these initiatory remarks, which some may deem superfluous, by way of explaining why my mind, which has always been devoted to the culture of trees and plants, has been attracted to a consideration of the maladies which so sorely afflict humanity.

There are 150 species of the Veronica described in botanical works, of which 22 species are natives of the United States, and it is matter of surprise that Eaton, in his general "Manual of Botany for North America," fails to include and describe all of our native species. Our botanical umpires, Torrey and Gray, we trust, will, in the concluding part of their great work, amply fulfil the task which they have so nobly begun. The present species has been found in several localities in greater or less quantities, and with flowers of different shades, varying from white to purple. The plant possesses such inestimable properties as a remedial for all diseases arising from impurity of the blood, that I deem it a duty to give to the world a cursory history of it, the earliest details being copied from the Memoirs of William Prince, my father, who was born in 1766, and died in 1843, and who took extreme pains in the distribution of this plant, gratuitiously, among his invalid friends and to different hospitals, the great desire being that they all should fully test its applicability to various diseases ; his whole life seeming to overflow with purposes of benevolence.

At the beginning of the eighteenth century there still existed a remnant of the Indian race in the vicinity of this town, and they were noted for their success in curing various diseases, and the town was visited by very many persons for the purpose of obtaining what was then termed the "Indian Physic." The knowledge of the cures then effected by the root of this plant furnished by the Indians became so wide spread, that William Prince, my grandfather, who had established his nurseries here, received applications for it from all parts of the Union, and having, after a long period of Indian secrecy, obtained some fresh root, he by immediately planting it, succeeded in ascertaining its name. He forthwith inserted it in his Catalogue as a specific for leprosy, &c., and the consequent demand became so great that every locality where it had grown spontaneously was nearly exhausted, and latterly as high as 12 dols. has been paid for ten ounces of the fresh root, this being the quantity prescribed for a patient labouring under any scrofulous disease. Dr. Ogden, a very eminent physician, who resided and died here, has stated in his Memoirs 'that twelve ounces of the root of this plant, taken in moderate doses, will restore the blood of an adult to the purity of that of an infant.' Dr. W. Beach has recorded in his medical works a very remarkable cure of a poor man, named Noah Coombes, who was a leper, covered with this disease over his entire body down to his toes, and was deemed in a dying condition, to whom on hearing of his direful case, my father sent this root, and who about ten weeks after came fifteen miles to thank him, he driving his own waggon, and being perfectly cured. This root has cured the severest cases of mercurialised human systems that have ever been witnessed. Even dropsy, as well as erysipelas, and all other scrofulous diseases, have been eradicated by it. In fact it may be justly deemed the most potent of all remedials for the whole chain of maladies arising from impurity of the blood. I have recommended it wherever such diseases have been spoken of, and have never endeavoured to make it a source of pecuniary benefit, deeming always that what nature bestows on us spontaneously, man should impart freely to his brother man, and that our only just claim to compensation is for our actual toil. This plant, which was formerly quite plentiful in the marshy portions of our island, became nearly eradicated about twenty years since, and this is probably the cause why its great merits have been in a measure lost sight of. I have recently ascertained some new localities where it is attainable, and I have urged one of my sons to undertake its culture. I have some plants growing in my garden borders, where any one can have the privilege of examining them. In regard to the Red-flowered Sarracenia, a remedial which arrests the small-pox in twelve hours, it is also a native of our island, and is found in moist localities, on the borders of ponds, and in white cedar swamps. It is now becoming very generally applied, and, I understand, always with successful results.

Flushing, Long Island, N. Y., May, 1863.

ON PETROLEUM AND PHOTOGEN.

BY W. PROCTER, M.D., F.C.S.

The discovery, in 1825, by Dr. Faraday, of benzole in the products of the distillation of oil, and the numerous applications which were made of it, may be said to be the origin of those investigations into the substances produced by the distillation of coal which have led to results of the utmost importance, viewed either in a scientific, economic, or commercial aspect. The two most valuable are the discovery of aniline with its wonderful dyes, and the coal and other illuminating and lubricating oils. It is to the latter of these two subjects that the present paper is devoted..

The ancient inhabitants of different parts of the world, both civilised and barbarian, were acquainted with natural oils which flow from the earth, such as mineral oil, or petroleum, naphtha, bitumen, &c., and used them for illuminating and other purposes. In Egypt, a substance derived from petroleum was employed for embalming bodies, and in some neighbouring countries asphalt is used to cover the roofs of houses and coat boats. Mixed with grease, the Trinidad asphalt is applied to the sides of vessels to prevent the borings of the teredo, and with lime is used as a disinfectant. The Persians, Burmese, and other nations, still continue to employ these substances, in their crude state, to give light, and for medicinal purposes.

In addition to these natural sources, similar compounds have long been obtained by the distillation of coal and other allied minerals. As early as 1694, Erle, Hancock, and Portlock "made pitch, oyl, and tar out of a kind of stone, and obtained patents, therefore." In a work in 1791, by Lewis, on Materia Medica, it is stated that oils were distilled from black bituminous shale. The early papers, also, of the Royal Society, give accounts of the distillation of oils from coals and other bituminous substances. In 1781, Lord Dundonald obtained a patent for "a method of extracting or making tar, pitch, and other substances from pit-coal," and in this manner is said to have turned the mines of coal on his own and other estates, to considerable profit. Later, the attention of some French chemists, especially M. Selliguier, was turned to the purification of these products, and their exertions were attended with some success, and the purified oils acquired an extensive sale in Europe for illumination and lubrication. But the first real practical success was made in this country by Mr. Young. Previous to his investigations, the thickness, coarseness, and unpleasant odour of the oils then manufactured, were such that they had fallen into disuse in Europe, when the attention of Mr. Young, a manufacturing chemist of Glasgow, was called to some petroleum which had been obtained from Riddings, in Derbyshire. The spring was an old coal-mine, from the sandstone roof of which a dirty rock-oil exuded. This source soon became exhausted, and Mr. Young then investigated the somewhat similar oils which Reichenbach and Selliguier had previously shown might be obtained by the distillation of coal, lignite, peat, &c. Since that period, enormous impulse has been given to the manufacture, especially by the recent discoveries in America.

We now, without any lengthened or scientific details, proceed to consider generally the substances capable of affording oils by distillation. The materials which are employed at the present time are coals, bituminous shales, asphalt, bitumen, bituminous sands and clays, petroleum, lignite, and peat.

I. Coal.—When coal, as in the ordinary process of gas manufacture, is submitted to distillation in closed iron retorts, three substances may be said to be the result of that process. 1. Illuminating gas of complex composition, consisting chiefly of gaseous vapour of hydro-carbons. 2. Tar. 3. Coke which is left in the retorts. The quantity and composition of these several products are dependent on several causes, but principally on temperature and the nature of the coal. These circumstances will guide the manufacturer in the selection of the conditions under which he distils the coal, according to the products which he wishes to obtain. The higher the temperature employed, the greater is the quantity of volatile matter or gas which is produced. Therefore, in gas-works, when it is the object to procure as much volatile matter as possible, the coals are distilled at a high temperature, sufficient to decompose the oils. These the manufacturer of photogen desires to preserve, and accordingly distils his materials at a heat which does not destroy the liquid hydro-carbons. The following is a general outline of the process usually adopted for the preparation of illuminating oils and other substances of economic value from coal :—

The coal is distilled at a temperature of 700°, and the tar collected. The latter substance is put into a large iron retort (which is of different fashion in several manufactories), connected with a coil of iron pipes surrounded with cold water, called the *condenser*. The retort is heated, and a light oil or naphtha (sp. gr. 0.830) comes over, and is succeeded by a series of heavier oils, which constitute the lamp-oil. Steam is now forced into the retort, and a heavy, lubricating oil passes over, and, as a residue, there is left a black, tarry matter used to grease heavy machinery, and a black coke employed as fuel. When the oils first come over, they are in a very impure condition ; the amount of foreign matter which they contain renders their purification a matter of difficulty, as well as of expense, and although much has been effected in this direction, much remains to be done before they are rendered free from all offensive odour, and free from colour. The process of purification consists in the treatment with concentrated oil of vitriol to remove the coloured and odorous constituents of the crude distillate, and washing with an alkali to remove carbolic acid and its congeners, as well as that portion of sulphuric acid which remains suspended in the naphtha, and the sulphurous acid produced by the decomposition of a portion of the sulphuric acid by the carbon of some of the organic compounds. The alkalies also serve to remove some sulphuretted hydrogen and other fetid sulphur compounds and their resulting products. By a careful purification, coal-oil is now obtained perfectly free from colour. It often exhibits the phenomena of dichroism. This is diminished by perfect purification with acids and the removal of the less volatile portion of the distillate.

But few common bituminous coals can be successfully employed for the production of oils, their distillates abounding in creosote, carbolic acid, &c., and their purification is both troublesome and expensive. Few coals produce over 100 gallons per ton ; some cannels will not yield over 50, others 30 gallons per ton. The quality of the crude oils also differ ; some afford a large quantity of paraffin, or heavy oil, and but a small percentage of light oil, and others yield the opposite. The lighter qualities yield the largest proportion of burning oil.

II. Boghead Coal occurs at Torbane hill, in the county of Linlithgow, in the carboniferous limestone of the Frith of Forth. It is used largely by Mr. Young for obtaining his paraffin and paraffin oil, his manufactory being situated in the immediate vicinity of the mines. At one time this mineral was largely exported to America, and in 1859 the Kerosene Light Company imported upwards of 20,000 tons at 18 dollars per ton ; but the discovery of strata of cannel coal, and of petroleum, has done away with the necessity of that importation.

The nature of Boghead coal is at the present time an undecided question, even after an action at law. At that trial a great array of scientific witnesses were examined on this matter; they consisted of chemists, geologists, botanists, mineralogists, microscopists, as well as practical coal engineers and owners. The evidence was conflicting, one party maintaining that it was coal, whilst the other declared it to be an undescribed mineral or bituminous schist. But the evidence is in favour of its right to be ranked as a true coal ; it rests on a bed of fireclay full of Stigmaria, and is surmounted by shale and ironstone, with plants and shells (Anthracosia). It has the microscopical structure of coal, burns with a flame, and yields 70 per cent. of volatile matter.

Whatever may be the precise nature of the Boghead coal, it is a most valuable producer of oils. One ton yields 120 gallons of crude oil, of which 65 gallons are lamp-oil, 7 paraffin oil, and 12 lbs. of pure paraffin can be extracted.

III. Bitumens.—Deposits of this substance exist in various parts of the world, and have been lately employed largely in that branch of manufacture which we are now considering. The largest deposit known is the celebrated Pitch-lake of Trinidad, three miles in circumference. The bitumen is solid, and cold near the shores, but gradually increases in temperature and softness towards the centre, where it is boiling. The solidified bitumen appears as if it had cooled in large bubbles as the surface boiled. The ascent to the lake from the sea, a distance of three-quarters of a mile, is covered with hardened pitch, on which trees and vegetables flourish, and contains small pools of water, clear and transparent. The lake is underlaid by a bed of coal. Mr. S. P. Wall shows that the asphalt of Trinidad and Venezuela belongs to strata of tertiary formation (the upper miocene or lower pliocene age), which consists of limestones, sandstones, and shales, associated with beds of lignite. The bitumen is found not only in the pitch-lake, but *in situ*, where it is confined to particular strata, which were originally shales containing vegetable remains. These have, he says, undergone "a special mineralisation, producing a bituminous matter instead of coal or lignite. This operation is not attributable to heat, nor of the nature of a distillation, but is due to chemical reactions at the ordinary temperature and under the normal conditions of climate."—(Proc. Geol. Soc. of London, May, 1860.)

One ton of the Trinidad bitumen yields 42 gallons of oil fit for lamps, and 11 for the purpose of lubrication. The bitumen contains sulphur. Sulphuretted hydrogen issues from the pit where the mineral is discharged from the earth. The first distillate is full of impurity, such as pyroxylic spirit and other products of the distillation of wood, which give evidence of the vegetable origin of this pitch; it is also accompanied by a peculiar volatile oil, which imparts to it a most unpleasant odour and renders it difficult to purify.

From time immemorial the burning and naphtha springs of Persia and other parts of the East have been known. But these substances were not utilised in England, until an agent of Price's Candle Company, in his search after new sources of palm oil, discovered a material fitted for his purpose in the so-called *mineral tar of Rangoon*, in the Birman Empire. Iron tanks were constructed, and were filled with the crude tar at the wells. This, when refined at the Sherwood works, yielded solid paraffin, heavy lubricating oil, Belmontine oil, &c. The tar is obtained by sinking wells in the soil of blue clay, about 60 feet deep; the fluid oozes in from the soil, and is removed; it is of the consistence of goose-grease, of a green-brown colour, and of a peculiar but not disagreeable odour, and contains only 4 per cent. of solid matter. It is said that there are now 520 wells, which yield 400,000 hogsheads annually. The tar affords about 70 per cent. of oil and 11 of paraffin. None of the cannel or bituminous coals or shales, or other substances used for yielding burning fluid by distillation, give distillates of such purity and freedom from odour as Rangoon tar. The more volatile portion of the latter is known as Sherwoodole, and is used instead of benzole for the removal of grease, &c. The paraffin obtained from Rangoon tar has a greater value for commercial purposes than that from Boghead coal, inasmuch as it has a higher melting-point which renders it better adapted for the manufacture of candles.

There are several mines of bitumen in the Island of Cuba which yield from 100 to 140 gallons of crude oil per ton. This, when purified, is well adapted for lamps; but the objectionable odour is an obstacle to its use. Large deposits also exist in Central and South America, and on the shores of the Dead Sea. In the vicinity of the Caspian Sea there are springs yielding large quantities of naphtha, which is used throughout the region for lamps. In Europe there are a few similar deposits. On one of the Ionian Isles an oil formation exists, and the oracular fires of ancient Greece have been attributed to similar sources. Oil-springs also occur in Bavaria and in the Grand Duchy of Modena, in France, and one near Amiano, in Italy, which was formerly used for lighting the city of Genoa.

IV. Peat has been employed for the manufacture of oils, but up to the present time with no marked success. An able and elaborate paper on this subject by Dr. Paul, will be found in the sixth volume of the 'Chemical News.' Peat, on distillation yields all the products which are obtained from coal, but the main question is whether the operations can be carried on, to be remunerative.

V. American Petroleum has led to a wonderful trade in that country; in 1862 there was exported, 10,625,568 gallons. The existence of Petroleum in America has long been known, having been collected by the Seneca Indians, and used by them chiefly for medicinal purposes. The first discovery of a large supply was in 1859, when a vein was opened whilst boring in search of a salt spring. One well alone is stated to have yielded 7,000 gallons per day and another 100 gallons per minute. Large quantities ran to waste from the difficulty of getting vessels to receive it, so that eventually the whole district became odorous from oil and the very ground sticky with it.

The petroleum region embraces a vast extent of the Continent. It is known to extend from the Southern extremity of the Ohio Valley North to Georgian Bay, and from the Alleghanies East, in Pennsylvania, to the Western limits of the bituminous coal-fields. It has been found in Virginia, Maryland, Pennsylvania, New York, Ohio, Michigan, Kentucky, Tennessee, Kansas, Illinois, Texas, and California.

The petroleum is obtained by boring holes in the rock three or four inches in diameter. When the oil is struck it flows for some time from the pressure below, without the aid of a pump. An iron pipe is then inserted, and to the top of this a pump is attached and worked by hand or steam power. The average depth at which oil is procured, does not far exceed 250 feet, the strata penetrated being chiefly limestone, sandstone, and shale. Some wells yield 200 barrels per day, one in Pennsylvania at the depth of 170 feet yields 300 barrels per day. At the present time upwards of 550 wells are in operation yielding about 30,000 gallons of crude oil daily. There are two sources in the West for petroleum springs 1. The oil regions of Pennsylvania and N. E. Ohio, which are on the bituminous coal measures and sandstones of the Portage and Chemung groups. 2. The oil regions of W. Virginia and S. Ohio, including a portion of W. Pennsylvania which are on the coal measures.

The source and formation of Rock oil is difficult of explanation and has given rise to different and various opinions. One hypothesis is that petroleum has its origin in coal beds, that a low heat in the coal seams drives off hydro-carbon vapour, which is condensed in the pores of the rocks and the soil, and is washed by rains into subterraneous recesses situated at various depths in the rocky strata; an evident objection to this explanation is that the coal of the district possesses the natural quantity of hydro-carbon and bitumen.

Another theory is, that the oil was produced at the time of original bituminisation of the vegetable or animal matter. If this was so, wherever there is bituminous coal, we should expect to find corresponding quantities of oil. This is not so, there is no oil except in fissures in the rocks overlying the bituminous strata, and these fissures can be shown to have been made since the coal strata became bitumenised.

Petroleum occurs in rocks of all ages from the lower Silurian to the tertiary; it is, doubtless, of organic origin, and is generally found impregnating limestone, more rarely, sandstones and shales. The presence of it in the lower paloeozoic rocks which contains no traces of land plants is a sufficient proof that petroleum has not in every case been derived from terrestrial vegetation, but *may* have been formed from marine plants or animals, or both; of the latter, the *Poole* and shale which contains abundant remains of fishes and crustacea, and affords in distillation a large quantity of illuminating oil is an example. This is not surprising when it is recollected that considerable portions of the tissue of the lower animals is destitute of nitrogen and similar in composition to the woody fibre of plants. Sir W. E. Logan describes the Canadian oil as being yielded by a limestone formed chiefly of fossil corals in the pores of which the oil is stored, so that the oil may be the result of the decomposition of the soft jellylike animalcules, in the same manner as the decay of plants has in later times given rise to bituminous coal. However this may be, the production of petroleum there is every reason to believe is due to the decomposition of organic matter, but the exact conditions under which it is capable of being produced are unknown, or wherefore it should from decomposition rather assume the form of this substance than that of lignite or coal. But in the fermentation of sugar (to which we may compare the transformation of woody fibre) according to the circumstances under which it occurs various products result, under certain conditions it yields carbonic acid and alcohol, under others butyric and carbonic acids, and in certain modified fermentations the acetic, lactic and propionic acids. The oils of Canada although long known to have existence in that country, did not attract the attention of adventurers until 1853, and were not until 1857 turned to profitable account. The very successful introduction of the new coal oils for lubricating and illuminating purposes by Mr. Young, led to the formation of a company which secured the lands of Enniskillen, in which the superficial deposits of asphalt occur, for the purpose of using it as a substitute for coals in the manufacture of such oils. But on penetrating below the asphalt large quantities of the materials were found in a fluid state, and therefore much nearer the conditions required for the manufacture. There are now about nine wells (from 100 to 230 feet deep) in operation, yielding three to four hundred barrels per day. The soil penetrated is a stiff clay, arising from the decomposition of the underlying rocks which have the characters and contain the fossils peculiar to the Hamilton group of the Devonian system. No rock of a bituminous nature seems yet to have been struck, although detached masses of bituminous shale are met with. The oil is diffused through the clay, penetrating numerous cracks or fissures, and rises up in such quantities that the wells have the appearance of boiling cauldrons of pitch. Although the oil-bearing rocks are nearer the surface in Canada than in the United States, the oil of the latter loses less per cent. by purification, and has a less unpleasant odour, the thick tarry consistence of the Canadian causes difficulty in its rectification on account of the frothing.

The American rock-oil is composed of a series of hydro-carbons, with different degrees of inflammability, and different boiling-points. Its specific gravity is from 0·830 to 0·890. MM. Pelaire and Cahours have separated from it twelve hydro-carbons of the marsh gas series. They could discover in it no benzine, nor any of its homologues, which they consider seems to indicate that the petroleum could not have been derived from coal, unless it had undergone a decomposition different to that of ordinary distillation. The products more nearly resemble those which are formed when various fatty acids, their corresponding alcohols, and a great number of organic bodies containing carbon and hydrogen in the proportion of equivalent to equivalent, are submitted to high temperatures.

These oils are, as is well known at the present time extensively used for the production of artificial light. The term petroleum or rock oil being properly applied to those which are produced naturally, whilst the product of the distillation of coal, shales, &c., are called Photogen, Paraffin, or Coal Oil ; many manufacturers have given to their products peculiar and unmeaning names, such as Caselline, Belmontine, &c. They are burnt in properly constructed lamps, with flat or round wicks, in the former case the greatest amount of light is procured by cutting the wick flat, so that the top is made as even as possible.

These hydro-carbon oils are the best means of light for domestic purposes, inasmuch as they give the largest amount of light with the least development of heat. The following tables are by Dr. Frankland; the first gives the illuminating equivalents of various materials, showing the quantity of other substances which would be required to give the same amount of light as would be obtained from one gallon of Young's Paraffin oil.

Young's Paraffin oil	1·00 gallons.
American Rock oil	1·26 "
Paraffin candles	18·6 pounds
Sperm "	22·9 "
Wax "	26·4 "
Stearine "	27·6 "
Composite "	29·5 "
Tallow "	39·0 "

The following table shows the comparative cost of the light of 20 sperm candles, each burning 10 hours at the rate of 120 grains per hour, and of the heat evolved per hour:—

	s.	d.	Unit of heat.
Tallow	2	8	100
Wax	7	2½	82 (Wax and Sperm)
Sperm	6	8	
Paraffin candles	3	10	66
Rock oil		7	29 (Rock oil and Paraffin oil)
Paraffin oil		6	
Coal gas		4¼	47
Cannel gas		3	32

The objections which have operated chiefly against these oils as agents for the production of artificial light have arisen from the fear of explosion, and the unpleasant odour produced during their combustion. It is unquestionable that accidents have occasionally arisen from explosion of the oil in lamps by the ignition of the explosive mixture which their vapours form with air. When the accident occurs it arises from imperfect purification of the liquid, by the imperfect removal of the benzine or more volatile constituents, so that the safety of a given sample depends upon the temperature at which vapour is given off. The purification is now more efficiently performed than when the materials were first manufactured, and as the cistern of a lamp, especially if made of glass or other nonconducting substance, is never likely to rise higher in temperature than 100 deg., all oils which do not give off vapour at that heat may be considered safe. A simple test is the application of a light to a small quantity, if it takes fire, and burns like alcohol it is unsafe. The other objection is, the odour which they produce during combustion, various oils differ in this respect, which in some measure depends upon their constitution and their purity; but it may be greatly lessened or entirely overcome by attention to certain precautions. The chief causes are imperfect combustion with consequent production of offensive empyreumatic substances, and the volatilisation of a portion of the fluid unconsumed. The lamp should therefore be burnt with a good flame, and the wick well turned up, the cistern of the lamp not filled too full, and all the metal of the burning parts kept scrupulously clean.

The length of this notice of petroleum precludes the consideration of the uses of a large number of other substances which are obtained with the oil by the distillation of coal, and which admit of most valuable and extensive employment such as Benzole, Paraffin, &c., as well as the application of Rock oil to the manufacture of illuminating gas which has been carried out successfully in New York.

ON THE OWALA OR OPOCHALA.

BY JOHN R. JACKSON.

In the 3rd volume of the TECHNOLOGIST, at p. 155, is an account of the "Owala," or "Opochala" of Western Africa, and of the oil which is yielded by its seeds. At the time that article was written, little was known of the habits of the plant, and consequently the native name was all the clue that could be had, with the exception that from the form of the pods, seeds, &c., it was clearly seen to belong to the Leguminous order. Since then, however, Mr. Gustave Mann, the zealous botanical collector to the Royal Gardens, Kew, who has spent three years in West Tropical Africa, has identified it with the *Pentaclethra macrophylla*, Benth, belonging to Leguminosæ, sub order Mimoseæ. It is a large and handsome forest tree, with bipinnate leaves 2-3 feet in length, made up of many trapeziform leaflets, each about an inch long, and the small flowers arranged in a spicate manner on the branches of a terminal panicle. The pods in the Museum of the Royal Gardens, Kew, which are those sent home by the late Mr. Barter, are not only, as stated in the paper before alluded to, 1 foot long, but quite 2 feet, and this, I understand, is about the ordinary length, the widest part three inches, and the thickness of the entire pod about 1 inch. The seeds lie in an oblique direction. One of the most peculiar things connected with the pod is the extraordinary strength of the fibrous tissue of which it is composed. The valves are each a quarter of an inch thick, made up entirely of this strong fibrous substance, the fibres running longitudinally. When ripe, the two valves burst open with a loud report, scattering the seeds, and, at the same time, each valve contracting and curling round in opposite directions. So great is this power of contraction, that if the pods be bound round with strong wire at the distance even of two or three inches apart, it frequently bursts between its bands as if overloaded inside, but in all cases the membranous lining of the pod always remains uninjured. This peculiar habit of contraction was first brought to my notice as the pods were lying amongst other specimens of fruits, seeds, &c., which had been recently brought from a cold room into a warm one, by a motion at intervals amongst the whole collection. Upon examination, I found that the apparent vitality was in the pods of the *Pentaclethra*, the valves of which were gradually rolling themselves into a much smaller compass, of course upsetting the other things by their movements.

The seeds, besides yielding the oil alluded to, are collected at the seasons of their falling, and eaten as food by the natives of Fernando Po.

Kew, July 11, 1863.

ON THE TALLOW TREE (*STILLINGIA SEBIFERA*) AND THE PELA, OR INSECT WAX OF CHINA.

BY D. J. MACGOWAN, M.D.

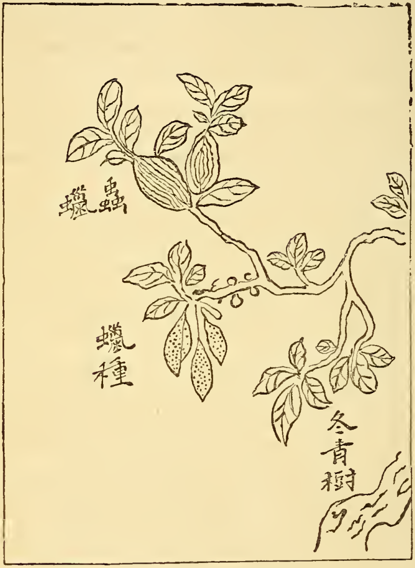
The botanical characters of this member of the Euphorbiaceæ are too well known to require description, but hitherto no accurate account has been published of its various uses; and although it has become a common tree in some parts of India and America, its value is appreciated only in China, where alone its products are properly elaborated.

In the 'American Encyclopædia,' it is stated that this tree is almost naturalised in the maritime parts of South America, and that its capsules and seeds are crushed together and boiled, the fatty matter being skimmed as it rises, hardening when cool.

Dr. Roxburgh in his excellent 'Flora Indica,' says:—"It is now very common about Calcutta, where in the course of a few years it has become one of the most common trees. It is in flower and fruit most part of the year. In Bengal it is only considered an ornamental tree. The sebaceous produce of its seeds is not in sufficient quantity, nor its quality so valuable as to render it an object worthy of cultivation. It is only in very cold weather that this substance becomes firm; at all other times it is in a thick, brownish fluid state, and soon becomes rancid. Such is my opinion of the famous vegetable tallow of China."

Dr. Roxburgh was evidently misled in his experiments by pursuing a course similar to that which is described in the 'Encyclopædia Americana,' and in many other works, or he would have formed a very different opinion of this curious material. Analytical chemistry shows animal tallow to consist of two proximate principles—stearine and claine. Now what renders the fruit of this tree peculiarly interesting, is the fact that both these principles exist in it separately in nearly a pure state. By the above-named process, stearine and claine are obtained in a mixed state, and consequently present the appearance described by Roxburgh. Nor is the tree prized merely for the stearine and claine it yields, though these products constitute its chief value; its leaves are employed as a black dye; its wood, being hard and durable, may be easily used for printing blocks, and various other articles, and finally, the refuse of the nut is employed as fuel and manure.

The *Stillingia sebifera* is chiefly cultivated in the provinces of Kiangsi, Kongnain, and Chihkiang. In some districts near Hangchan, the inhabitants defray all their taxes with its produce. It grows alike on low alluvial plains and on granite hills, on the rich mould at the margins of lakes, and on the sandy sea-beach; the sandy estuary of Hangchan, yields little else. Some of the trees at this place are known to be several hundred years old, and though prostrated, still send forth branches and bear fruit. Some are made to fall over rivulets, forming convenient bridges. They are seldom planted where anything else can be conveniently cultivated—in detached places, in corners about houses, roads, canals, and fields. Grafting is performed at the close of March, or early in April, when the trees are about three inches in diameter, and also when they attain their growth.



WAX-TREE AND INSECT.

Fac-simile of a drawing made from the Pun-tsaou-kang-muh. The upper characters on the left are *Chung-lă* (insect-wax); beneath them, *Lă-chung* (wax-seed; in the right-hand corner at bottom *Tung-tsing-shoo* (winter-green-tree).

The 'Fragrant Herbal' recommends for trial the practice of an old gardener, who, instead of grafting, preferred breaking the small branches and twigs, taking care not to tear or wound the bark. In mid-winter, when the nuts are ripe, they are cut off with their twigs by a sharp crescentic knife, attached to the extremity of a long pole, which is held in the hand and pushed upwards against the twigs, moving at the same time such as are fruitless. The capsules are gently pounded in a mortar to loosen the seeds from their shells, from which they are separated by sifting. To facilitate the separation of the white sebaceous matter enveloping the seeds, they are strained in tubs, having convex open wicker bottoms, placed over cauldrons of boiling water. When thoroughly heated, they are reduced to a mash in the mortar, and thence transferred to bamboo sieves, kept at a uniform temperature over hot ashes. A single operation does not suffice to deprive them of their tallow; the steaming and sifting are, therefore repeated. The article thus procured becomes a solid mass on falling through the sieve; and to purify it, it is melted and formed into cakes for the press. These receive their form in bamboo hoops, a foot in diameter, and three inches deep, which are laid on the ground over a little straw.

On being filled with the hot liquid, the ends of the straw beneath are drawn up and spread over the top, and when of a sufficient consistence, are placed with their rings in the press. This apparatus, which is of the rudest description, is constructed of two large beams placed horizontally so as to form a trough capable of containing about fifty of the rings with their sebaceous cakes; at one end it is closed, and at the other it is adapted for receiving wedges, which are successively driven into it by ponderous sledge hammers wielded by athletic men. The tallow oozes in a melted state into a receptacle below, where it cools. It is again melted and poured into tubs smeared with mud to prevent its adhering. It is now marketable, in masses of about 80 lbs. each, hard, brittle, white, opaque, tasteless, and without the odour of animal tallow.

Under high pressure it scarcely stains bibulous paper; melts at 104 deg. Fahr. It may be regarded as almost pure stearine; the slight difference is doubtless owing to the admixture of oil expressed from the seed in the process just described. The seeds yield about 8 per cent. of tallow, which sells at 2½d. per pound.

The process for pressing the oil which is carried on at the same time remains to be noticed; it is contained in the kernel of the nut, the sebaceous matter, which lies between the shell and the husk, having been removed in the manner described. The kernel and the husk covering it is ground between two stones, which are heated, to prevent clogging from the sebaceous matter still adhering. The mass is then placed in a winnowing machine, precisely like those in use in western countries. The chaff being separated, exposes the white oleaginous kernels, which after being steamed are placed in a mill to be washed. This machine is formed of a circular stone groove, twelve feet in diameter, three inches deep, and about as many wide, into which a thick solid stone, 8 feet in diameter, tapering at the edge, is made to revolve perpendicularly by an ox harnessed to the outer end of its axle, the inner turning on a pivot in the centre of the machine. Under this ponderous weight the seeds are reduced to a mealy state, steamed in the tubs, formed into cakes, and pressed by wedges in the manner above described; the process of washing, steaming, and pressing, being repeated with the kernels likewise.

The kernels yield above 30 per cent. of oil. It is called tsing-yu, sells for about 3 cents. (1½d.) per lb., answers well for lamps, though inferior for this purpose to some other vegetable oils in use. It is also employed for various purposes in the arts, and has a place in the Chinese 'Pharmacopœia,' because of its quality of changing grey hair black, and other imaginary virtues.

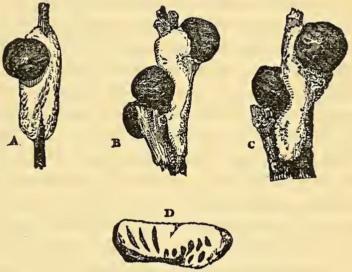
The husk which envelopes the kernel, and the shell which encloses them and their sebaceous covering are used to feed the furnaces, scarcely any other part being needed for this purpose. The residuary tallow cakes are also employed for fuel, as a small quantity of it remains ignited a whole day. It is in great demand for chafing dishes during the cold season, and finally, the cakes which remain after the oil has been pressed out, are much valued as a manure, particularly for tobacco fields, the soil of which is rapidly impoverished by the Virginia weed.

Artificial illumination in China is generally procured by vegetable oils, but candles are also employed by those who can afford them, and for lanterns. In religious ceremonies no other material is used. As no one ventures out after dark without a lantern, and as the gods cannot be acceptably worshipped without candles, the quantity consumed is very great. With an unimportant exception the candles are always made of what I beg to designate as vegetable stearine.

When the candles, which are made by dipping, are of the required diameter, they receive a final dip into a mixture of the same material and insect-wax, by which their consistency is preserved in the hottest weather. They are generally coloured red, which is done by throwing a minute quantity of alkanet root (*Anchusa tinctoria,*) brought from Shantung, into the mixture. Verdigris is sometimes employed to dye them green. The wicks are made of rush, coiled round a stem of coarse grass, the lower part of which is slit to receive the pin of the candlestick, which is more economical than if put into a socket. Tested in the mode recommended by Count Rumford, these candles compare favourably with those made from spermaceti, but not when the clumsy wick of the Chinese is employed. Stearine candles cost about 8 cents, (4d.) the pound.

Prior to the thirteenth century bees-wax was employed as a coating for candles ; but about that period the white-wax insect was discovered, since which bees wax has been wholly superseded by the more costly but incomparably superior product of this insect. It has been described by Abbé Grosier, Sir George Staunton, and others, but those accounts differ so widely among themselves, as well as from that given by native authors, as to render further inquiry desirable. From the description given by Grosier, entomologists have supposed the insect which yields the *pe-la*, or white wax, to be a species of Coccus. Staunton, on the contrary, describes it as a species of *Cicada (Flata limbata.)* As described by Chinese writers, however, it is evidently an apterous insect; hence the inference, either that there are two distinct species which produce white wax, or that the insect Staunton saw was falsely represented as the elaborator of this beautiful material.

A few particulars regarding the Himalaya wax insect (*Flata limbata,*) by Captain Hutton, are published in the 'Journal of the Asiatic Society of Bengal,' vol. xii. p. 898. After alluding to Sir George Staunton's and the Abbé Grosier's account of the wax-yielding insect of China and to various authorities, Captain Hutton observes: "From all these statements, therefore, we arrive at the positive conclusion, that as this deposit, (that of *F. limbata,*) will neither melt on the fire, *per se,* nor combine with oil, it cannot be the substance from which the famous white wax in China is found; and we are led to perceive from the difference in the habits of the larva of *Flata limbata,* and that of the insect mentioned by the Abbé Grosier, that the wax is rather the produce of a species of *Coccus* than of the larva of *F. limbata,* or even of the allied *F. nigricornis.*"



COCCUS SINENSIS, WESTWOOD.

A B C. Mature female insects adhering to pieces of stick partially encrusted with the wax (*natural size*).

D. Vertical section of a piece of the crude wax, showing the position of the young insects (*magnified*).

The subjoined account has been principally derived from the Puntsau and the Kiangfangpu, two native herbals of high authority. The insect feeds on an evergreen shrub or tree, (*Ligustrum lucidum**) which is found throughout Central China from the Pacific to Thibet, but the insect chiefly abounds in the province of Szetchuen. It is met with also in Yunan, Hunan, and Hupeh. A small quantity is produced in Kiuhwa, Chekiang province, of a superior description. Much attention is paid to the cultivation of this tree; extensive districts of country are covered with it: and it forms an important branch of agricultural industry. In planting they are arranged with the mulberry, in rows about 12 feet apart; both seeds and cuttings are employed. If the

* The Himalaya insect is not confined to a Ligustrum.

former they are soaked in water in which unhusked rice has been washed and their shells pounded off. When propagated by cuttings, branches an inch in diameter are recommended as the most suitable size.

The ground is ploughed semi-annually, and kept perfectly free from weeds. In the third or fourth year they are stocked with the insects. After the wax, or insect, has been gathered from the young trees, they are cut down just below the lower branches, about four feet from the ground, and well manured. The branches which sprout the following season are thinned, and made to grow in nearly a perpendicular direction. The process of cutting the trunk within a short distance of the ground is repeated every four or five years, and, as a general rule, they are not stocked until the second year after this operation.

Sometimes the husbandman finds a tree which the insects themselves have attained ; but the usual practice is to stock them, which is effected in spring, with the nests of the insect. These are about the size of a "fowl's head ?" and are removed by cutting off a portion of the branch to which they are attached, leaving an inch each side of the nest. The sticks, with the adhering nests, are soaked in unhusked rice-water for a quarter of an hour, when they may be separated. When the weather is damp or cool they may be preserved in jars for a week ; but if warm, they are to be tied to the branches of the trees to be stocked, without delay, being first folded between leaves. By some the nests are probed out of their seat in the bark of the tree, without removing the branches. At this period they are particularly exposed to the attacks of birds, and require watching.

In a few days after being tied to the tree, the nests swell, and innumerable white insects, the size of "nits," emerge, and spread themselves on the branches of the tree ; but soon, with one accord, descend towards the ground, when, if they find any grass, they take up their quarters. To prevent this, the ground is kept quite bare ; care being taken also that their implacable enemies, the ants, have no access to the tree. Finding no congenial resting-place below, they re-ascend, and fix themselves to the lower surface of the leaves, where they remain several days, when they repair to the branches, perforating the bark to feed on the fluid within.

From "nits" they attain the size of "Pediculus homi." Having compared them to this, the most familiar to them of all insects, our author deems further description superfluous. Early in June the insects give to the trees the appearance of being covered with hoar-frost, being "changed into wax;" soon after this they are scraped off, being previously sprinkled with water. If gathering be deferred till August, they adhere too firmly to be easily removed. Those which are suffered to remain to stock trees the ensuing season, secrete a purplish envelope about the end of August, which at first is no larger than a grain of rice ; but as incubation proceeds, it expands and becomes as large as a fowl's head, which is in spring, when the nests are transferred to other trees, one or more to each, according to their size and vigor, in the manner already described.

On being scraped from the trees, the crude material is freed from its impurities, probably the skeleton of the insect by spreading it on a strainer, covering a cylindrical vessel, which is placed in a caldron of boiling water. The wax is received into the former vessel, and on congealing is ready for market.

The pe-la or white wax, in its chemical properties is analogous to purified beeswax, and also spermaceti, but differing from both ; being, in my opinion, an article perfectly *sui generis.* It is perfectly white, translucent, shining, not unctuous to the touch, inodorous, insipid, crumbles into a dry inadhesive powder between the teeth, with a fibrous texture resembling fibrous feldspar ; insoluble in water ; dissolves in essential oil ; and is scarcely affected by boiling alcohol, the acids, or alkalies.

The aid of analytical chemistry is needed for the proper elucidation of this most beautiful material. There can be no doubt that it would prove altogether superior in the arts to purified beeswax. On extraordinary occasions, the Chinese employ it for caudles and tapers. It has been supposed to be identical with the white wax of Madras ; but as the Indian article has been found useless in the manufacture of candles (Dr. Pearson, Philosophical Transactions, vol 21), it cannot be the same. It far excels also the vegetable wax of the United States, (*Myrica cerifera.*)

Some interesting particulars on this subject are contained in a memoir in the Philosophical Transactions for 1848, by Mr. B. C. Brodie, entitled "On the Chemical Nature of a wax for China." Mr. Brodie states that although in appearance the substance resembles stearine or spermaceti more than beeswax, it comes nearest to purified cerin. The Comptes Rendu for 1840, tome x. p. 618, contains a communication by M. Stanislas Julien on the China wax, and the insect which yields it. The wax insects are there stated to be raised upon four species of plants, these are Niu-tching (*Rhus succedanea*) Tung-tsing (*Ligustrum glabrum* and *lucidum*) Chouikin, supposed to be *Hibiscus syriacus*, and Tcha-la (botanical name unknown). *Rhus succedanea*, or a nearly allied species occurs in the Himalayahs.

Is this substance a secretion ? There are Chinese who regard it as such ; some representing it to be the saliva, and others the excrement of the insect. European writers take nearly the same view ; but the best authorities expressly say that this opinion is incorrect, and that the animal is changed into wax. I am inclined to believe the insect undergoes what may be styled a ceraceous degeneration ; its whole body being permeated by the peculiar product in the same manner as the *Coccus cacti* is by carmine.

The wax costs at Ningpo from 22 to 35 cents. (1s. to 1s. 6d.) per pound. The annual product of this humble creature in China cannot be far from 400,000 pounds, worth more than 100,000 Spanish dollars.

Mr. Daniel Hanbury, with that exhaustive research and thorough investigation which he bestows on all commercial subjects he examines and treats of, has furnished one of the most complete accounts of the insect white wax of China in a paper in the xii. vol. of the 'Pharmaceutical Journal,' and to the Council of that Society we are indebted for the use of the wood-cuts which illustrate this article. Mr. Hanbury states the only considerable importations of Chinese wax into England were in 1846 and 1847, when nearly three tons were imported into London. Some of this wax sold in April 1847 fetched 1s. 3d. per pound, a price too low to be remunerative, and no further importation we believe has taken place.

The insect wax occurs in commerce in circular cakes of various dimensions; some of those imported into London had a diameter of about 13 inches, a thickness of 3½ inches, and were perforated near the centre with a hole five-eighths of an inch across.

The broken surface generally exhibits the wax as a beautifully sparkling, highly crystalline substance somewhat resembling spermaceti, but much harder; some cakes are internally much less crystalline and sparkling than others. The wax is colourless and inodorous, or nearly so, tasteless, brittle, and readily pulverizable at the temperature of 60 Fahr. The melting point of the commercial wax is 181.4, that of the perfectly pure wax, 179.6.

The mean of Mr. Brodie's analyses of the purified wax gave its composition thus:—

Carbon	82.235
Hydrogen . . .	13.575
Oxygen	4.190
	100.000

In the 'Quarterly Journal of the Chemical Society,' vol. v., p. 24, will be found an interesting paper by Mr. A. S. Maskelyne, "on the Oxidation of Chinese Wax." The late Professor Quekett states:—

When a small portion of the wax is examined under the microscope, it is found to consist of a series of short filaments or cylinders, some of which are straight, but others more or less curved; within each cylinder is a tubular cavity extending throughout its whole length. In fig. 1 is a representation of the cylinders as seen under a power of 500 diameters. If the wax be heated on glass, it readily melts when the temperature rises to 184 Fahr., and if examined in this state, the fluid mass is perfectly transparent and structureless. On cooling, however, it crystallises precisely like spermaceti, as shown in fig. 2. One of the most perfect insects taken out of the wax is represented in fig. 4. This is its dorsal surface. Fig. 5 is a representation of the abdominal surface of the same insect.

FIG. 1.

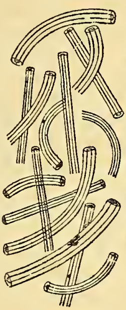


FIG. 2.

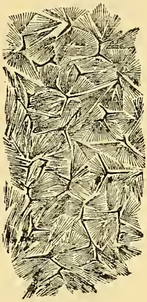
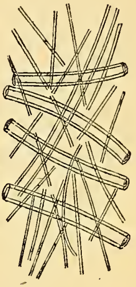


FIG. 3.



It will be seen that it has six legs, and the body is full of wax. The white filaments and minute oval bodies with which the cochineal insect is surrounded present nearly the same structure as the insect wax. They are represented in fig. 3.

FIG. 4.

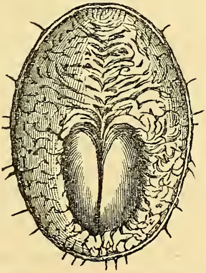
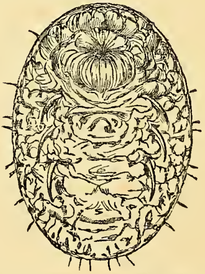


FIG. 5.



Dr. Martius, commenting on the same subject, says—In Mr. Hanbury's paper it is mentioned that *Flata limbata* has been assumed to be the insect producing pe-la; but, according to Burmeiston ('Handbuch der Entomologie,' II., p. 466), this insect only inhabits Western Africa. Besides *Cicada limbata*, Donovan (*Flata nigricornis*, Fabr.) is a native of China, and its caterpillar is stated to live on *Stillingia sebifera*, to be entirely covered with a white down, which remains on the leaves, and which, when melted, forms the pe-la. In the late edition of Pereira's

'Materia Medica' (Vol. II., p. 2220), there is a wood engraving giving a good idea of this insect.

The statements of Westwood and Quekett, however ('Pharmaceutical Journal,' Vol. XII., p. 482), that *Coccus sinensis* produces pe-la, render the above assertions very doubtful. Besides, it is stated that the white substance above referred to is washed away by the dew and rain, whereas pe-la is well known to be insoluble in water. I suspect that *Flata limbata* exudes a sugary substance—a kind of manna. Helbig ('Miscellaneorum Ephemerides,' 1693, p. 459, No. 18) mentioned, a kind of Ceylon manna which, perhaps, owes its origin to this insect. At any rate, it would be highly interesting if those who can give information upon this subject would do so.

ON THE TRADE IN CORK BARK.

BY THE EDITOR.

The trade in the bark of the *Quercus Suber* is one respecting which there is not much recent detail accessible, and yet it is an important article of commerce, our imports reaching in value nearly a quarter of a million sterling. The demand for and consumption of cork in England has increased, since the year 1848, three hundred per cent., and is still far beyond the actual means of supply. The average imports of cork-bark are about 5,000 tons annually, nearly all of which is used here. Its price varies, according to quality, from 32*l.* to 35*l.* per ton, the Spanish cork fetching the highest price. Of ready-made corks the imports have been steadily on the increase, and two-thirds of those imported are used here, the remainder being re-exported. The average price is a little over 1s. of foreign per lb.

Uses.—Cork is light and porous, readily compressible, and wonderfully elastic. These qualities make it superior to all other substances for stoppers for bottles, in the manufacture of which it is principally made use of. It is also employed as buoys to float nets, the construction of life-boats, cork jackets, cork belts, and other life-preservers, cork mattrasses, the making of waterproof shoes, the lining of hats, models, false limbs, and for various other purposes. When burned, it forms a light-black substance known as Spanish black.

The cork mattrasses, although intended originally for the army and navy, are valuable, especially for emigrants, and in other ways. The mattrass consists exclusively of minute "clippings" of cork—a material utterly useless for any other purpose, and, until so applied, regarded as worse than "waste;" for when accumulated, it became absolutely necessary to destroy it. The inventor of this admirable adjunct to health and comfort has, therefore, turned to valuable and profitable account that which was heretofore a nuisance in the cork factory. These minute bits of cork are placed between two layers of oiled linen, or caoutchouc cloth, thus preserving the sleeper entirely from all hazard of damp, the nature of cork being to resist it. On sea-board, besides excluding all the "disagreeables" that generally haunt a vessel during a long voyage, it serves as a life-buoy in case of shipwreck—either to the individual or to the boat; its value, therefore, to the emigrant is incalculable.

Cork should be chosen in fine layers or boards, not broken nor knotty, smooth when cut, and of moderate thickness.

The cork-oak is abundant in Portugal, Spain, especially Catalonia and Valencia, Italy, the South of France, and parts of Northern Africa. In France it is found in great abundance in Languedoc, Provence, the environs of Bordeaux, and the department of Var.

M. Casimir De Candolle has recently published a dissertation upon the manner in which cork is formed in the cork-tree.

The bark of all trees consists of a parenchymatous or soft cellular tissue, and of a harder ligneous tubular tissue. In most cases the latter is most abundant; in the cork the former constitutes the mass of the bark, and hence its elasticity and the facility with which it is cut in all directions. When, however, it is first generated, the bark of the cork-tree is far less elastic than it becomes subsequently, which is owing to its consisting, in the first instance, of a large proportion of woody matter. When the latter is once formed, which takes place in the first year of its growth, it never increases, however long the bark may remain in a living state; but the parenchymatous substance will go on growing as long as the bark is alive, a provision of nature connected with the annual increase in diameter of wood, and the necessity of the bark giving way to the pressure from within.

If the growth of the parenchyma is prolonged and rapid, a corky substance is the necessary consequence, as in certain kinds of elms, the common oak itself, and many other trees; but it does not occur in any European tree in such excess as in the cork. As soon as the bark dies, it of course ceases to grow, and then, not distending as it is pressed upon from within, it falls off in flakes which correspond to the layers that are formed annually.

The careful removal of this outer or dead bark from the cork-tree does not in any way injure it; on the contrary, it is stated that the tree grows more vigorously and lives longer in consequence of being thus stripped. After a tree has attained to the age of 26 to 30 years, it may be barked, and the operation can be subsequently repeated every eight or ten years, the quality of the cork improving with the increasing age of the tree. The bark is taken off in July and August, and trees that are regularly stripped are said to live for 150 years or more. The bark is stripped from the tree in pieces two inches in thickness, of considerable length.

The bark-peeler or cutter makes a slit in the bark with a knife, perpendicularly from the top of the trunk to the bottom ; he makes another incision parallel to it and at some distance from the former, and two shorter horizontal cuts at the top and bottom. For stripping off the piece thus isolated, he uses a kind of knife with two handles and a curved blade. Sometimes, after the cuts have been made, he leaves the tree to throw off the bark by the spontaneous action of the vegetation within the trunk. The detached pieces are soaked in water, and are placed over a fire when nearly dry ; they are, in fact, scorched a little on both sides, and acquire a somewhat more compact texture by this scorching. In order to get rid of the curvature, and bring them flat, they are pressed down with weights while yet hot.

The charring occasions that peculiar and disagreeable empyreumatic flavour which is so frequently imparted to liquors which have been stopped by cork thus treated. Some years ago an attempt was made to avoid this evil by using younger cork-bark, the texture of which is not so close as to need the aid of fire ; but this bark is too thin for ordinary purposes, and could only be used by cementing two or more layers of it together. The risk of bad flavour was by this means altogether avoided, but for some reason or other the plan was not persevered in.

Although the outer bark may be removed without any injury to the tree, the inner bark, which is employed in tanning, cannot be removed without producing the death of the tree. It is not commonly separated for commercial purposes except in Corsica, Spain, and a few other countries, where the tree is indigenous and very abundant. It contains about twice as much tannin as oak bark of average quality. The tannin of cork tree bark appears to bear more resemblance in its properties to that of catechu than to the tannin of most other vegetable matters. Like catechu, cork tree bark scarcely affords any of the light fawn-coloured deposit called bloom, and it is doubtful whether this variety of tannin is susceptible of conversion into gallic acid. The dark colour which cork tree bark always communicates to leather, produced by its means, is the greatest objection to the use of this material. This bark was extensively used for tanning in Ireland some years ago, as much as 8,000 or 10,000 tons having been imported annually for this purpose, cargoes are occasionally received from Rabat and Laroche, ports of Fez, in Barbary, and from Sardinia. That from Leghorn is not considered so good, being less astringent than oak bark. It has long been used by the tanners of Marseilles, being imported from Corsica and other parts of the Mediterranean. In Italy, it is almost exclusively used in tanning sole leather. In the forests belonging to the state lands of Tuscany, nearly 1,000 tons are annually collected.

The landowners in Tuscany, neglecting to bark their trees every six or eight years and carry it away, it becomes too large and mouldy from remaining so long. If due care were taken in this respect, the cultivation of the tree would be improved, and Italy might be able to send corks to France and other countries, instead of being under the necessity of importing them.

The American Government a few years ago imported a large quantity of acorns of the cork oak from the south of Europe, and distributed them over the middle and southern States for experiment, to test the adaptation of the tree to the climate. The Government was desirous of being independent of importation by naturalising the tree.

The cork trade in Portugal is reported to be on the increase. The annual exportation now amounts in value to upwards of 10,000,000 francs. It takes place principally from Sines, the only port of the province of Alentejo where the largest quantity of cork trees grow. The greatest amount is sent to London, where, on the average, the consumption amounts to 10,000lb. per day of Portuguese corks. A considerable quantity is also sent to France, America, and the Baltic. The Portuguese cork is inferior to the French, but superior to that of Italy.

The trade now is chiefly carried on locally through the instrumentality of the Algarveros: persons who, travelling from forest to forest, purchase on the ground parcels of cork, which, at great labour and expense, they carry to Lisbon and other places, where it is prepared for export. The money for these purchases is usually borrowed by them at high rates of interest, frequently at 20 to 30 per cent., thereby increasing the cost of the cork by this item of expense. The waste attending the preparation of the cork for the market is about one-half.

A company was lately formed in London with a capital of 100,000*l.* to carry on the cork trade on a large scale. In their prospectus it is stated that the cork trade in this country has been for years confined to a few firms, who have had the power, by this union of capital, to regulate the prices of all cork imported, as also the prices at which the cork is sold to the cork-cutters, thereby preventing the cork grower from receiving the full value of his cork, as compared with the prices at which it is sold to the trade.

The directors have secured a large monopoly in supply for terms of years, on leases extending over the largest and most renowned cork producing districts. These leases grant the sole right to take cork in 142 forests, some containing as many as 15,000 to 30,000 cork trees, in the districts of Montemor, Evora, Arraiollos, Estremoz, Portel, Vianna, and Fronteira, in the Province of Alentejo.

Statistics.—Between 1815 and 1823, the quantity of cork bark imported annually ranged from 25,000 to 60,000 cwts., the duty being 8s. 9d. per cwt. In the succeeding ten years, the range was from 32,000 to 55,000 cwt., the duty being still 8s. per cwt. From 1846 to 1853, the average import was 3,500 to 4,000 tons per annum.

On the 19th March, 1845, the duty on manufactured corks was abolished. The imports and value for a series of years have been as follows :—

	Tons.	Value. £.
1846	3,400	56,110
1847	2,806	46,623
1848	3,028	50,310
1849	2,529	41,555
1850	6,358	...
1851	3,707	...
1852	3,483	...
1853	4,131	...
1854	3,849	114,508
1855	3,744	128,726
1856	4,033	130,058
1857	4,729	152,144
1858	6,579	212,322
1859	5,747	185,413
1860	4,855	157,707
1861	5,351	172,963

In the ten years ending with 1840, the largest annual import of cork from Spain, was 5,730 cwts.; but on the average of years there have been only a few hundred tons received from thence.

In 1861, our imports were drawn as follows : from Portugal, 4,634 tons ; from Spain, 577 tons; and from other countries, 140 tons.

The duty on ready-made corks was formerly 8½d. per lb. On the 4th June, 1853, it was reduced to 6d. per lb., and on squared corks for rounding, 16s. per cwt. On the 6th March, 1860, the duty on manufactured corks was further lowered to 3d. per lb., at which it still stands. Corks are cut with the pores laterally; bungs have them downwards ; hence, they do not keep in the liquid as well. There has been a large and steady increase in the import of foreign made corks, and a corresponding reduction in the price, as the following official figures will show :—

Imports of Manufactured Corks.

	Weight. lbs.	Value. £.
1848	98,747	9,891
1849	125,812	12,586
1850	159,757	15,989
1851	184,809	18,509
1853	373,217	—
1854	479,939	47,994
1855	347,688	30,423
1856	390,192	34,141
1857	472,237	41,329
1858	452,365	33,935
1859	537,682	33,605
1860	702,602	38,507
1861	859,884	46,577

Scientific Notes.

Disease in Silk Worms.—A premium of 40,000 francs (1,600*l.*) is offered by the Department of l'Isere, France, for an efficacious remedy against the silk worm disease. To entitle a competitor to the prize, he must prove that by a consecutive experience of three years he has discovered an efficacious means of curing or preventing the "gatine" and "pebrine" maladies by which the silk worm is attacked. These experiments must have bèen conducted in Grenoble or within a radius of 8 kilometres or more of that town. It must be the result of the education of 25 or 30 grammes of eggs per month. All who desire to compete are to notify to the administration the locality where their experiments have been carried on.

Tobacco-Seed Oil.—Mr. Tredinnick stated a few years ago that he had found the seed of the tobacco plant to contain about 15 per cent. of oil possessing peculiar drying properties, calculated to render it a superior medium, especially for paints and varnishes. The process employed for extracting the oil was to reduce the seed to powder, knead it into a stiff paste with hot water, and then submit it to the action of a strong press. The oil thus obtained was submitted to a moderate heat, which by coagulating the vegetable albumen of the seed, caused all impurities contained in the oil to form a cake at the bottom of the vessel employed, leaving the oil perfectly limpid and clear. It possesses the drying quality to a much higher degree than any other oil, a circumstance which would render it of great value to painters and varnish makers, if it could be obtained in quantity.

A New Use of Glycerine.—It is not many years ago that glycerine was a waste product, which the manufacturer of oils and fats was glad to get rid of in any way. Now it has attained a high commercial value, and every day new and enlarged economic uses are found for it. From its emollient and beneficial action on the skin, it is an excellent component for toilet soaps, but it has hitherto been generally excluded from soap in saponification, and can only be introduced mechanically. The difficulty has hitherto been to incorporate more than ten per cent. of glycerine, as it was found to make the soap too soft. Mr. E. Rimmel has, however, discovered and patented a method of combining glycerine with soap by fusion, so as to introduce 30 per cent. into the mass, while the soap is perfectly hard. Persons whose skin suffers from the use of ordinary soaps, may now employ this pellucid glycerine soap with confidence, as it does not irritate, but rather corrects acridity and softens the skin, an evident advantage for ladies and children. The transparent aspect conveyed by the glycerine contained in it, and the delicious aroma produced by the perfume of flowers which enter into its composition, are calculated to render this soap as agreeable as it is useful.

MACCARONI.—The best maccaroni is made between Naples and Salerno, and is known there by the name of "Maccaroni della Spiagga." It is made from wheat of the finest quality, and the grain, after being thrashed out (generally in the fields), is carefully spread out upon the flat roofs of houses during the hot weather, and then left exposed to the sun during the day, and to the dews of the evening and early morning, for a fortnight or three weeks, until by these means it has become quite hard and dry. It is also known by the name of "Maccaroni della Zitta."

EXTRACTION OF COPPER FROM ROASTED PYRITES.—In the year 1850 Mr. Gossage showed that the copper amounting to about one per cent. in Irish pyrites, could be extracted, and this is still more practicable in the case of Spanish Pyrites, which contain about 3 per cent., and, after roasting, from 5 to 6 per cent. The extraction of copper is, however, rarely carried out by the sulphuric acid manufacturer. In England the copper is obtained in the dry way by successive meltings. In France the roasted mineral is exposed to the action of the air, the copper sulphate thus produced is extracted by water, and the metal precipitated by iron. More recently the copper has been extracted as chloride, by melting the roasted mineral with sodium chloride. The method patented by Mr. Henderson, is worked at Mostyn with the pyrites residues from Messrs. Muspratt's works, and works are being erected near Glasgow for treating the residues from Messrs. Tennant's works.

PUBLICATIONS RECEIVED.

A Treatise on Colouring Matters Derived from Coal-Tar, &c. By Professor Dussauce. (Trubner & Co.)—Holmes's Magnetic-Electric Light, as Applicable to Lighthouses.

THE TECHNOLOGIST.

THE HARD WOODS OF COMMERCE.*

BY P. L. SIMMONDS.

Few but those who have looked into the subject would suppose that foreign woods were imported to the value of nearly twelve millions sterling annually, besides our own supplies of British oak and home-grown woods, which are utilized for various purposes. Notwithstanding the extensive adoption of iron for constructive purposes in ships and buildings, there has been no diminution in our consumption of foreign building woods. Indeed, the imports in the past two years show an increased value of one million and a quarter over the imports of six or seven years ago. The second great class of woods—dye woods—has remained somewhat stationary, and this may arise from the extensive use of mineral dyes within the last few years. The class of foreign hard woods and furniture woods has, however, increased considerably in consumption within the past ten years, an indication of the greater demand for the purposes of Art and luxury, and possibly from the stimulus given by Exhibitions, since that of 1851, for these have served to bring into many new and beautiful woods previously unknown or disregarded. Since 1856 the value of the hard woods and ornamental woods imported into this country has doubled. It would be impossible in the compass of a brief article to pass under notice all the principal furniture woods used by the cabinet maker, and we shall confine ourselves, therefore, to a glance at the hard woods used by the turner and engraver. Several of these woods are also employed for other purposes, but we shall speak chiefly of their application in turnery.

The principal woods used by the turner are—African Black-wood,

* From the 'Art Journal.'

Angica, Barwood or Camwood, Bully tree, Botany Bay oak, Boxwood, Brazil-wood, Braziletto, Canary-wood, Cocus-wood, Coromandel, Ebony, Fustic, Iron-wood, Jack-wood, King-wood, Letter-wood, *Lignum vitæ,* Madagascar Red-wood, Nutmeg-wood, various Palms, Partridge, Prince's and Purple woods, Queen-wood, red Sanders, Rosewood, Satin, Tulip, Yew, and Zebra-wood. Of these we shall now proceed to speak *seriatim.*

Of the sources of the African black-wood nothing certain is known. It is referred by some to the *Cocobolo prieto*, from Madagascar and Eastern Africa, a tree which we cannot trace. Possibly it may be from *Afzelia Africanus*, but more probably it is the black iron wood, or South African ebony, *Olina carnifolis,* a most valuable hard-wood, brownish, close, and heavy ; excellent for turning and carving, and much used in the Cape colony by cabinet-makers. Angica is a Brazilian wood, which is used also by cabinet-makers. The tree producing it has not been correctly determined, but it is believed to be a species of *Ailanthus.* The barwood and camwood of commerce, although imported under distinct names and from different parts of Western Africa, are the product of the same tree, *Baphia nitida.* The wood yields a brilliant red colour, which is used for giving the red hue to English bandanna handkerchiefs. It is not a permanent colour, however, and is rendered deeper by sulphate of iron. We imported in 1861, 1,154 tons of camwood, valued at 20,457*l.*, and 2,075 tons of barwood, valued at 6,171. These woods may be distinguished by their rich purplish tinge. The bully tree or beef-wood is said to be a South American wood, obtained from British Guiana, and has been referred, but erroneously, to *Robinia panacoco.* The wood passing under the name of "panacoco" is *Ormosia coccinea.* Botany bay oak, sometimes called beefwood, is the trade name for the wood of *Casuarina stricta* and other species of *Casuarina,* of New South Wales. Among those which were sent to the recent Exhibition by the colony, were the forest or shingle oak, or beefwood (*C. suberosa*), a wood of great beauty, but only fit for veneers ; the spreading oak, swamp oak, and white oak, all woods of little value in an ornamental point of view. Some of the wood imported under the name of Botany Bay oak is well adapted for inlaying and marquetry. It is of a light yellowish brown colour, often marked with short red veins. One variety is extremely beautiful, and nearly as hard as tulipwood. It is finely dappled with rich intwining streaks, on a high flesh-coloured ground.

Boxwood is one of the most important hard woods which we receive for the special uses to which it is applied. The mediæval collections testify to the exquisite skill of some of the old wood carvers on this material. Boxwood is also of great use to the turner, the mathematical and musical instrument makers, and the wood engraver. The largely extended use of woodcuts for the illustrated literature of the day has led to an universally increased demand for this, the best material known for the purpose. Whether all the boxwood imported is furnished by *Buxus sempervirens*, is not known. It is, however, not improbable that *B. balearica*, a larger species, may furnish some of that which comes from the Mediterranean. The wood of this species is coarse, and of a brighter yellow than the common species. Rondelet, in a table of the mean heights of trees, gives that of the trunk of the box at 16 feet, and the mean diameter at 10½ inches. In 1820 the imports of foreign boxwood were 363 tons, the duty being as high as 7*l.* 18s. 6d. per ton, and on that from British possessions 1*l.* 13s. 4d. In 1831 the imports had risen to 484 tons, the duty having been reduced in 1826 to 5*l.* on foreign grown, and 1*l.* on British grown. The duty is now only 1s. per ton levied for statistical purposes. The average imports of the last three years have been about 3,500 tons, showing the great increase of the trade in this important wood. The value in 1860 was about 11*l.* per ton, and in 1861, 10*l.* From the Russian port of Soukoum Kali, in the Black Sea, 1,450 tons of boxwood, valued at 10,384*l.* were shipped in 1861 to Constantinople ; the greater part of this was sent on to England. The market price of the wood at Soukoum Kali was 4s. 2d. the pood of 36lbs. But little boxwood of any size is to be obtained now in the United Kingdom, and we draw our chief supplies from Turkey; while France depends a good deal on Spain.

The importance of finding some wood calculated to come into the aid of boxwood, the most generally useful of all the European hard woods, has long been felt. Attention was drawn to the subject at the Madras local exhibitions a few years ago, and it has occupied attention in several of our colonies. Among the large and varied collections of woods from different countries, shown at the recent Exhibition, we did not notice any which, upon trial, appeared adapted for the purpose. We may, however, incidentally mention those which have been pointed out as suited for wood engraving. The essential properties requisite for this purpose are uniformity of structure, and considerable toughness, hardness, and retention of any sharp angles to which it may be cut, whether on the end or on the side—colour, except for certain purposes, is of little consequence. Dr. Hunter, of Madras, has furnished the following results of experiments on woods for engraving, made under his superintendence at the School of Arts, Madras :—The guava-wood (*Psidium pyriferum*), though close grained and moderately hard, with a pretty uniform texture, was found to be too soft for fine engraving, and did not stand the pressure of printing. It answered well for bold engraving and blocks for large letters, and for this purpose has been used for several years. The small wood from hilly districts was found to be harder and finer in the grain than that from large trees. Satin-wood proved to be hard, but uneven in the grain, coarse in the pores, and, like many other large woods, harder and denser in the centre than near the bark. As it was found to splinter under the graver it was condemned. The small dark coloured kinds of sandal wood of 5 inches in diameter, grown on a rocky soil, proved to be the nearest approach to boxwood in working quality, hardness, and durability under pressure. It cuts smoothly, the chips curl well under the graver, and the oily nature of the wood seems to preserve it from splitting when cut. Many hundred engravings have been executed upon this wood, and some blocks have yielded upwards of 20,000 impressions without being worn out. The question of price has, however, to be taken into consideration in order to see if it can compete with boxwood in England. Two species of *Wrightia* were experimentalised on without success. The palay (*Wrightia tinctoria*) has a pale, nearly white wood, close and uniform in the grain, but too soft to stand printing. It cuts smoothly, but does not bear delicate cross-hatching. Although unfit for wood-engraving, it is well suited for turnery, carving, and inlaying with darker woods. Veppalay-wood (*W. antidysenterica*), on inspection under the microscope, appeared to be suitable for the purpose, from the closeness of texture and the polish left by the chisel in cutting it across the grain ; but the uneven quality and the softness of the outer parts showed that it was not fit for engraving. The wood of the wild orange bears a strong resemblance in appearance to box in working qualities, and is often as hard. The wood of the wild Ber tree (*Zizyphus jujuba*), common almost everywhere in India, gave good promise under the microscope, but proved to be a soft, spongy, light wood, that did not stand cross-hatching or pressure. A small garden tree, the China box (*Murraya exotica*), proved on trial to be like the wood of many of the orange family—hard and close in the grain near the centre, but softer near the bark. The cross section was, however, very irregular. The wood of the coffee tree was found to be soft, uneven in the grain, and not fit for engraving, though well adapted for ornamental carving or inlaying. This wood works beautifully in the turner's lathe, and cuts very sharply under the chisel, gouge, or graver ; it is deserving of more attention for ornamental carving and inlaying. It harmonises well in colour with the wood of orange and that of the Manila tamarind (*Inga dulcis*).

There are a few other woods which may be incidentally noticed. The white beech (*Fagus sylvestris*) is much used for carved mouldings, for picture frames, and large wood letters for printing. It is easily worked and may be brought to a very smooth surface. The extremely hard wood of the white thorn (*Cratægus punctata*) is used by wood engravers, and for mallets, &c. The dogwood (*Cornus florida*) is well adapted for the same purposes as boxwood. It is so remarkably free from silex, that splinters of the wood are used by watchmakers for cleaning the pivot holes of watches, and by the optician for removing the dust from small lenses. The wood of the olive has occasionally been used for engraving on. A very compact, fine and uniform wood (*Dodonæa viscosa*) sent from the Neilgherries, under the name of iron wood, used for turnery and making walking-sticks, worked well under the graver and on the turning lathe ; but the piece sent was too small to print from. The close-grained wood of *Podocarpus neriifolius* a Burmese tree, has been suggested as a substitute for boxwood, but I have not heard that it has been tried. Another close-grained but undefined wood, locally called Baman, much used by the Karens for bows, has been also pointed out as probably adapted to take the place of box. The white close-grained wood of *Gardenia lucida* is apparently well adapted for turning. This wood like that of several other species of *Gardenia* and *Randia*, is used by the Burmese for making combs. A kind of plum wood, rather coarse in the grain, is used in China for cutting blocks for books. As a good deal of wood-block printing is carried on in Japan, it would be interesting to ascertain what wood is used by this intelligent and ingenious people for the purpose. Both the stone-wood (*Callistemon salignus*), a remarkable hard wood found sparingly distributed in Gipps Land, and the *Pittosporum bicolor*, have been used in Victoria for wood engraving. The wood of *Pittisporum undulatum*, from New South Wales, was brought forward here by the commissioners of that colony last year as calculated to be serviceable for wood engraving. Although favourably reported upon by the late Mr. P. Delamotte, it is not likely to be of much use to the wood engraver here. Mr. Delamotte stated that although the samples of wood he received were probably inferior ones, having been felled at the wrong season of the year, yet it was well adapted for certain kinds of wood engraving, being superior to the pear and other woods, generally used for posters. It is the produce of a small tree, with very close-grained, hard, white wood. When seasoned carefully, it would be well suited for turning. Sound transverse sections of more than 10 to 16 inches are, however, rare. Another of the *Pittosporums*, the boxwood of Tasmania (*Bursaria spinosa*), which is very close and even-grained, of a yellowish colour, unmarked, has the appearance of being well adapted for wood engraving. The *Celastrus rhombifolius*, a dense, hard, and heavy yellow box-like wood of the Cape colony, where it is called Pendoom, might be useful to turners and musical instrument makers, especially for flutes, clarionets, &c. It is much used in turnery, but does not grow to any size, never exceeding 4 to 5 inches in diameter. The lightwood of New South Wales (*Duboisia myoporoides*) is almost as light as the wood of the lime, very close-grained and firm ; but easily cut, and hence especially adapted for wood carving.

Leaving the engraving woods, we now pass on to the commercial woods of the turner. Brazil-wood and Braziletto are the produce of leguminous trees, at one time much in demand as dye-woods. The former is the produce of *Cæsalpinia echinata*, and grows abundantly in South America, being imported chiefly from Pernambuco and Costa Rica : hence it is sometimes called Pernambuco wood. When first cut it is of a light colour, but becomes a dark red on exposure to the air. The peach-wood, Nicaragua-wood, and Lima-wood of commerce, are supposed to be produced by the same tree. The imports of Brazil-wood in 1861 were 5,101 tons, valued at 102,262*l.* Braziletto wood is furnished by *C. Brasiliensis,* which grows in Jamaica and other parts of the West Indies to the height of about 20 feet. This wood is much used for ornamental cabinet work, and both kinds are employed in turnery and for making violin bows. Canary-wood is obtained from the *Laurus indica* and *L. canariensis,* trees natives of Madeira and the Canaries. Cocus-wood or Kokra is obtained from Cuba and other West Indian islands, but has been referred by some to *Lepidostachys Roxburghii* of Eastern India. Cocus is much used in turnery, and for making flutes and other musical instruments. It is a wood of small size, being usually imported in logs of about 6 or 8 inches diameter. The alburnum is of a light colour, while the heart-wood is of a rich deep brown, and extremely hard. Calamander, or Coromandel wood, is obtained in Ceylon, from *Diospyros hirsuta.* It is a scarce and beautiful wood, exceedingly hard, fine, closed-grained and heavy. It consists of pale reddish-brown fibres, crossed by large medullary plates, or isolated elongated patches of a deep rich brown colour, passing into black. These latter are chiefly conspicuous in well-defined veins and broad spots, admirably contrasting with the lighter parts. The lustre is silky where the medullary plates are small, but higher and more varying where the plates are larger and the grain coarser. Calamander-wood is considered by many persons the handsomest of all the brown woods : the root has the more beautiful appearance. This wood is now getting scarce. Another species (*D. Ebenaster*) furnishes in Ceylon a very fine wood, bearing a close resemblance to Calamander. The planks of Calamander shown at Paris in 1855 and at London last year were magnificent.

Belonging to the same genus as the Calamander is the Ebony of commerce, which, from its colour and deneseness is so much used by turners, and for inlaying work by cabinet makers. Of 1,500 tons, valued at about 15,000*l,* imported in 1861, the bulk came from India and Africa, and a small quantity, 260 tons, of inferior, worth only about 5*l,* a ton (instead of 11*l.* 10s.), from Cuba. The carved ebony furniture from Ceylon was much admired. There are several woods which pass under the general name of ebony. The green ebony, obtained from Jamaica and other parts of the West Indies, is supposed to be furnished by *Brya Ebenus,* a small tree. The duramen of the wood is a dark green, the alburnum, or outer wood, of a light yellow. The wood is hard and susceptible of a very high polish. It is much used for rulers and other small work, also in marquetry. Another green ebony is said to be obtained from *Jacaranda mimosifolia,* in Brazil. The name green ebony is also applied to the wood of *Excœcaria glandulosa,* of Jamaica. Red ebony is an undefined wood of Natal. Several species of *Diospyros* are known to yield in great abundance the black ebony of commerce. Those of the East Indies are *D. Ebenus, cordifolia, Ebenaster, Mabola, melanoxylon, Roylei,* and *tomentosa.* The ebony from the west coast of Africa is usually the most perfect black, that from the Mauritius and Ceylon being variegated more or lesss with cream brown. *D. cordifolia* is a dark brown and difficult to work. Ebony is much affected by the weather, and, to prevent splitting it should be covered. Ebony of very superior quality is procurable in the western districts of the Madras presidency, as well as the Northern Circars. We have seen sixteen-inch planks of a fine uniform black, chiefly obtained from Coorg and Canara. Smaller pieces are procured from Cuddapa, Salem, Nuggur, &c., ; but there is no steady demand, though it is a peculiarly fine timber for cabinet work, and some of it is well veined for ornament. Ebony may be obtained in Siam, but the quality is not very good ; a little is exported thence every year to China by the junks. The species of *Diospyros* have this peculiarity, that the black heart-wood is surrounded by white sap-wood. The task of determining the species which yield the best wood, and verifying the specific names, is important, and merits careful elucidation. Fustic is a hard, strong, yellow wood, obtained from *Maclura tinctoria*, a West Indian tree. It used to be employed in cabinet work, but was found to darken and change colour on exposure to the air and heat. It is chiefly used now as a dye-wood. The imports in 1861 were 8,458 tons, valued at 50,444*l.* The principal imports come from Venezuela, the West Indies, Mexico, and New Granada, and through the northern Atlantic ports. Iron-wood is a common name for many trees producing hard, ponderous, close-grained woods. In America it is applied to the *Ostrya virginiaca*, a tree which only grows to a small size ; but the white wood is compact, finely grained, and heavy. There is an iron-wood in Brazil, but the tree yielding it is not defined. One of the iron-woods entering into commerce is the *Metrosideros verus*, an East Indian tree, whilst some species of *Sideroxylon* furnish other iron woods. The iron-wood of Norfolk Island is the *Olea apetala*. Another close, hardwood, which sinks in water, is the *Argania sideroxylon* of Morocco. Jack-wood, or Cos, as it is locally called in Ceylon, is an excellent furniture and fancy wood, obtained from the *Artocarpus integrifolia*, a tree allied to the bread-fruit. It is a coarse and open-grained, though heavy wood, of a beautiful saffron colour, and emits a peculiar, but by no means unpleasant, odour. King-wood, one of the most beautiful of the hard woods imported, reaches us from Brazil, in trimmed billets, from 2 to 7 inches diameter. It is probably from *Spartium arbor*, or some undefined species of *Triptolomœa*. It is also called violet-wood, being streaked in violet tints of different intensities, is finer in the grain than rosewood. The smaller pieces are frequently striped, and occur sometimes full of elongated zone eyes. Letter-wood, or snake-wood, is a scarce and costly wood of British Guiana, obtained from *Piratinera guianensis*. It is very hard, of a beautiful brown colour, with black spots, which have been compared to hieroglyphics. The spotted part is only the heart-wood, which is seldom more than 12 or 15 inches in circumference. Its application to cabinet-work and to small turnery articles was shown in the British Guiana collection. *Lignum vitæ* is a common, well-known, hard, ponderous wood, the produce of two species of *Guaiacum* obtained in the West Indies, which is used for a great variety of purposes requiring hardness and strength. The Madagascar red wood is as yet undescribed. Nutmeg-wood is another name for the wood of the Palmyra palm (*Borassus flabelliformis*), which is used in turnery, for cabinet-work, and, from its mottled character, for umbrella and parasol handles, walking canes, rulers, fancy boxes, &c.

The stems or trunks of several palms obtained in the East and West Indies are imported, to a small extent, for fancy use. They furnish a great variety of mottled, ornamental wood, black, red brown, and speckled, and are used for cabinet and marquetry work, and for billiard cues. Amongst those so used are the cocoa-nut, the betel-nut, Palmyra, &c. The nuts of two South American palms, the vegetable ivory nut (*Phytelephas macrocarpa*), and the dark coquilla nuts from *Attalea funifera*, are largely used by turners for small fancy articles. Partridge-wood is a name for the wood of several trees coming from South America, which has usually, but erroneously, been ascribed to *Heisteria coccinea*, but is more likely to be from *Andira inermis.* It is used for walking-sticks umbrella and parasol handles, and in cabinet work and turnery. The colours are variously mingled, and most frequently disposed in fine hair streaks of two or three shades, which in some of the curly specimens resemble the feathers of the bird. Another variety is called pheasant-wood. Prince's wood is a light-veined brown wood, the produce of *Cordia Gerascanthus*, obtained in Jamaica, almost exclusively used for turning. Purple-wood is the produce of *Copaifera pubiflora* and *bracteata*, trees of British Guiana, which furnish trunks of great size, strength, durability, and elasticity. The colour varies much in different specimens, some being of a deep red brown, but the most beautiful is of a clear reddish purple, exceedingly handsome when polished. It is used for buhl work, marquetry, and in turning. Varieties of King-wood are sometimes called purple and violet woods, but they are variegated, while the true purple-wood is plain. Queen-wood is a name applied occasionally to woods of the Cocus and Greenheart character, imported from the Brazils. The wood of *Laurus chloroxylon*, of the West Indies, furnishes some. Red Sanders wood is a hard heavy, East Indian wood, obtained from the *Pterocarpus santalinus*, imported from Madras and Calcutta, chiefly as a dye-wood. It takes a beautiful polish, and somewhat resembles Brazil-wood. Rosewood is a term as generally applied as iron-wood, and to as great a variety of trees, in different countries ; sometimes from the colour, and sometimes from the smell of the wood. The rosewood imported in such large quantities from Brazil is obtained from the *Jacaranda Brasiliana*, and some other species. The *Physocalymnna floribunda* of Goyaz, in Brazil, is said to furnish one of the rosewoods of commerce. It is the "Pao do rosa" of the Portuguese. The fragrant rosewood, or "Bois de Palisandre," of the French cabinet-makers, has been ascertained to belong to two or three species of Brazilian *Triptolomeas.* The imports of rosewood in 1861 were 2,441 tons, of the computed value of 46,884*l.* In 1820, when the duty was as high as 20*l.* the ton, the imports of rosewood were only 271 tons. In 1826 the duty was reduced by one half, and in 1830 the imports had risen to 1,515 tons. The shipments of Brazilian rosewood are chiefly made from Bahia. In 1857, 16,870 logs were sent from there, and in 1858, 17,834 logs, of a total value of about 28,000*l.* The great bulk of the shipments go to France and Germany. A rosewood is obtained in Central America and Honduras, from a species of *Amyris.* East Indian rosewood, a valuable mottled black timber, is obtained from *Dalbergia latifolia* and *sissoides*; these furnish the well-known Malabar black-wood which is heavy and close-grained, admitting of a fine polish. The principal articles of carved furniture in the East Indian collection were made from this wood. A similar kind of rosewood is obtained on the west coast of the Gulf of Siam, but the grain is not so close as the South American wood. A large quantity is exported yearly from Bangkok to Shanghai, and other Chinese ports.

The East Indian Satin wood is the produce of *Chloroxylon Swietenia.* It is close-grained, hard, and durable in its character, of a light orange colour, and when polished, has a beautiful satiny appearance; unless protected by a coat of fine varnish, it loses its beauty by age. This tree occurs abundantly in the northern parts of Ceylon. That variety called, on account of the pattern, "flowered satin," is scarce. The tree also grows in the mountainous districts of the Madras presidency. The West Indian satin-wood is obtained from *Maba guineensis*, in the Bahamas, and from an unnamed tree in Dominica. The wood of the European Yew (*Taxus baccata*), being hard, compact, and of a very fine, close grain, is occasionally used for fine cabinet work, or inlaying, and by turners for making snuff-boxes, musical instruments, &c.; parts near the root are often extremely beautiful. For the combination of colour with figure, it ranks at the head of the eyed or spotted woods. Brazil furnishes tulip-wood, and zebra-wood; the latter, which is scarce, is from the *Omphalobium Lamberti*, a large tree of Demerara. It resembles king-wood, except the colours, which are generally dispersed in irregular but angular veins and stripes. Zebra-wood is a beautiful wood for cross banding. Some very good specimens of Colonial turning in goblets and ornaments, from the native ash, red gum, cherry tree, and black-wood of South Australia, were shown at the International Exhibition of 1862. One or two new woods have recently been introduced, but not to any large extent; of these we may mention the following Australian woods. The scented Myall (*Acacia homolophylla*) is a very hard and heavy wood, of an agreeable odour, resembling that of violets. It is especially adapted, from its pleasant odour, for glove and trinket boxes, and any interior applications where not being varnished, it would retain its pleasant scent. Myall has a dark and beautiful duramen, which makes it applicable to numerous purposes of the cabinet-maker and the wood-turner. It rarely exceeds a foot in diameter, but has been used for veneers. Musk-wood (*Eurybia argophylla*) is a timber of a pleasant fragrance, and a beautiful colour, well adapted for turning and cabinet work. The *Pomaderris apetala* furnishes us with a soft useful wood of a pale colour, well adapted for carver's and turner's work. One of the most complete, extensive, and tastefully designed applications of the hard or fancy woods of commerce was the model of the Royal Exchange, shown at the International Exhibition by Messrs. Robert Fauntleroy and & Co., in which there were specimens of more than five hundred ornamental woods from different parts of the world.

We may close with a word or two on a few other woods occasionally used. The mountain ash (*Pyrus aucuparia*), the "rowen tree" of Scottish song, yields a beautiful light wood, quite equal to satin-wood in appearance, and, like holly, box, horse chestnut, and apple, very serviceable in inlaying. The root and burr of *Quercus pedunculata*, and *Q. sessiliflora*, also rival many foreign woods. The close texture of the maple-wood, with the beauty of its grain and its susceptibility of a high polish, doubtless contributed to its continued use for the manufacture of the pledge cup and wassail bowl. Hence its Scandinavian name of *mazer* came to be applied to the cup made from the wood of the tree; and when, at a later period, other woods and even the costliest metals, were substituted, the old designation of the mazer cup was still retained. The late Mr. T. H. Turner, in a series of papers in the *Archæological Journal*, on "The Usages of Domestic Life in the Middle Ages," remarks :—"Our ancestors seem to have been greatly attached to their mazers, and to have incurred much cost in enriching them. Quaint legends in English or Latin, monitory of peace and good fellowship, were often embossed on their metal rim and on the cover; or the popular but mystic Saint Christophus, engraved on the bottom of the interior, rose in all his giant proportions before the eyes of the wassailers, giving comfortable assurance that on that festive day, at least, no mortal harm could befall them." Most of our earlier poets illustrate the familiar use of the maple bowl in ancient times; it figures at the latest in Scott's "Lord of the Isles." Spenser furnishes a beautiful description of a highly wrought emblematical mazer cup, in his Shepherd's Calendar," evidently suggested by the bowl for which the shepherds contend in Virgil's Third Pastoral :—

"Lo Perigot, the pledge which I plight,
A mazer ywrought of the maple ware,
Whereon is enchased many a fayre sight,
Of bears and tigers that make fiers war;
And over them spread a goodly wild vine,
Entrailed with a wonton ivy twine.

"Thereby is a lamb in the wolf's jaws;
But see how fast runneth the shepherd swain
To save the innocent from the beaste's paws,
And here with his sheep hook hath him slain.
Tell me such a cup hast thou ever seen?
Well might it become any harvest Queen."

ON THE APPLICATION OF ALFA OR ESPARTO TO THE MANUFACTURE OF PAPER.

BY JULES BARSE.

Under the name of alfa in Northern Africa, and esparto in Spain and other parts of Europe, we meet very commonly with a coarse strong grass growing in tufts, resembling in the cylindrical form of the stalk, rushes. It is known under the several scientific names of *Macrochloa tenacissima*, *Lygeum spartum*, and *Stipa tenacissima*.

Alfa grows without culture, in great abundance, on soils the least fitted for any agricultural operations, over a large extent of country in Algeria.

By systematic gathering, the quality and the quantity of the leaves are improved ; left to itself, the plant does not die being perennial. The stem on which there are matured leaves, will no less produce fresh leaves ; and it is not unusual to find on the same stem, the shoots of three successive years.

Cultivated or wild, this plant, from its hardy constitution, ought to be classed in the first rank of the vegetable products, from which industry demands a regular supply of useful raw material.

Industry and science had long foreseen the future that awaited alfa, whenever it should become possible to extract economically the special fibre which it contains. In spite of the efforts of a great number of laborious, instructed, and persevering men, alfa is not yet a commercial commodity, in the large sense, regularly enquired for and accepted in any industry except that of 'sparterie' or cordage. Yet the paper-trade is eagerly seeking after everything that can secure it against the scarcity or enhancement in price of the raw material.

Why is not alfa more used in the mills? Because inventors and manufacturers have often thought that they were able to use alfa before the question of practical processes was matured ; many hopes have been dispelled by the cost of the manufacture, according to systems, not one of which, taken separately, I dare affirm, was sufficiently perfect to realize a success. But if, without pretending to create a monopoly, previous labours are examined, with sufficient discrimination to retain what is good and to reject what is bad ; if, to the sum of these collected elements, the results of recent experiments are added ; if above all, the powerful patronage of the local administration lends its aid, an appeal may be made to the judgment so often previously awarded, and bring back conviction to the minds of men, who know that industry progresses continuously. Such has been the object, on which I have concentrated all my efforts, and towards which I now contribute the appended information.

Gathering, Management, Transport, &c., of the Fibre.—In Algiers, and particularly in the province of Oran, alfa alternates with the dwarf-palm, lentisk, asphodel, and squill, on all untilled land. On soils, of which the basis is chalk, the dwarf-palm and asphodel predominate ; on stony soils, in which silica and iron replace alumina and lime, alfa, in close tufts, grows abundant in the plains up to the mountain ridges, excluding, however, the culminating heights of mountain chains. The districts of Mers-el-Kébir, Aïn-el-Turk, Bouzefer, to the west of Oran ; of Saint Cloud, Fleurus, Kristel (mountain of the lions), Saint Louis, Arzew, to the East ; the forest of Muley-Ismael, the Macta, in the direction of Mostaganem ; the slopes north of the mountains which border on the south the plains of the Zig and of the Hobra, are localities exceedingly favourable to the industry, and amply supplied to meet the wants of the French trade. By concentrating the means and capital on the littoral of this province, they are placed in the neighbourhood of existing roads, and of those which will shortly be opened. The ports of Arzew, Oran, Mers-el-Kébir ; the places of embarkation for feluccas, of Aïn-el-Turk, Bouzefer, the mouth of the Macta, are so many places where depots for the collected alfa can be established ; each of these localities corresponds to a centre of population, farm, village, or town, under the regular and efficacious protection of civil and military administrations. The Arab tribes are in daily communication with the French : this element, together with the Spaniards, Moors, and others, who make up, more or less, the floating population of the country, will supply labourers for the gathering of alfa, as soon as a respectable establishment, worthy of confidence, shall have been at work for more than a year.

At what time of the year and under what conditions of maturity ought the gathering to take place ? In its wild state, a tuft of alfa consists of withered leaves, leaves that have attained maturity and are still full of sap, and lastly, of young tender shoots not yet expanded. Taking the plant in this view, it might be said that the gathering can be done at any time, provided that at any period of the year, the tuft yields fibrous matter suitable for making paper. But if alfa is subjected to a systematic and regular process, all is changed : if care is taken, as in Spain, to pluck off all the dry dead shoots from the stem ; if all the shoots that come to maturity are gathered, if the young shoots only are left, then the plant is in complete cultivation and the gathering becomes annual ; it should be done at a fixed time. Is it necessary, as in Spain, where alfa is used for making rope, cord, carpets, to wait until the seed is quite ripe and the leaves begin to fade. Ought, on the contrary, the moment to be seized when the leaves, wholly *curled up*, do not re-open under the alternate influence of light and moisture, without taking account of the state of the seed, ripe or not ?

As regards paper-making, the chemical analysis of the plant settles the question : the matured leaf has in its constituent elements, silica and iron, upon which chemical agents act with difficulty : the boiling, the bleaching, the conversion into fibre can only be obtained to the detriment of the quantity and quality of the pulp. The leaf, still green, although its full growth is attained, is easier to boil, its fibres separate under the influence of less energetic agents ; silica and iron, which hold the yellow and red colouring matters in the fibre, are eliminated, so to speak, at the same time as the gum-resin which binds the fibres ; the knots, analogous to those of straw, are still sufficiently tender so as not to require that the boiling, to be effective in reducing them, shall have been too prolonged and compromising in regard to the leaves.

It may hence be concluded that the leaf ought to be gathered when green, but also as near maturity as possible. I say *as near maturity as possible*, because a leaf too green gives translucid fibres, and consequently a paper analogous to *vegetable* paper ; on the other hand, the waste is so much the greater as the leaf is less matured. There is also, in respect to alfa, the same proceeding to be followed, as with hemp and flax which are gathered with reference to the fibre, leaving out of account the seed. Flax and hemp, cultivated for seed, will have lost their properties for yielding fibre precisely because they have attained complete maturity.

The gathering of alfa should be done by hand : cutting ought to be strictly forbidden, as it obstructs the reproduction of the plant. The labourer holds in his left hand a stick 2 or 3 centimetres thick and about 40 centimetres long ; he seizes a bunch of alfa leaves with the right hand and twists it round the stick ; at the same moment he pulls at the stick with the left hand and at the bunch of leaves which the right hand still grasps ; the whole of the leaves separate from the stem at the articulation. The right hand places the bunch under the left arm ; the hands remain free ; the labourer gathers three or four bunches, according to his capability, and these, collected under the arm, make a *manada*, which is then tied together by the labourer or by children engaged for that purpose. The bundles are ranged on the spot to dry, which is effected in a week. It is said an expert labourer can gather 200 kilogrammes of green alfa in a day. I have never met with such.

The operations which, conjointly with M. Cruzel, we carried out in Algeria, were undertaken with full authority over our labourers, and with full compensation for their work ; on the one hand, we have had Spaniards and Moors, who are considered the most expert at this business ; on the other, the General commanding the province had granted us thirty Zouaves, under the control of sub-officers, with orders to make an official return of how much each man, determined to exert himself, could gather, both on first coming to the work and in the following weeks. We had, therefore, good will, emulation, and inspection with us ; the daily gathering of green alfa per man was, in summer, an average of 100 kilog. In drying alfa loses 40 per cent. The labour of a man is consequently equal to 60 kilog. of dry alfa per day. Such is the basis upon which commercial estimates must be founded.

The bundles dried in the fields are collected in bales and brought to the port of embarcation.

The alfa, in its natural state, is bulky and forms an unwieldy package for ships, although its real density is great, for a kilog. of alfa immersed in water, displaces 1165 grammes of liquid only, which gives 0.858 for the alfa ; the water being 1000. But, in ordinary bundles, a cubic metre contains only 212 kilog. of alfa, and the maritime ton of 1m. 44 cube contains 305 kilog. ; in this state it therefore requires three maritime tons of space for 1000 kilog.

In Algeria we obtained permission to pack the alfa with Poncets's presses, which are used by the military administration. The press-cases measuring 1m. 40 cubic, were uniformly filled with 297 to 300 kilog. of alfa packed with care ; the press turned out a bale of 870 to 880 cubic decimetres. In this state, a ship would receive scarcely 500 kilog. of alfa per ton of space.

Before my departure for Algeria, M. Cruzel, who was to take part in my proceedings, had made at Paris, and placed at my disposal, an hydraulic press of great power, and arranged in a special manner, for the compression and binding of the alfa. This press could not be forwarded to me in time at Oran, but at Paris it served to make some very precise and practical experiments. The bales turned out by this machine are of a cylindrical form, having a diameter of 60 centimetres, and a length of 85 ; they measure 320 cubic decimetres, and weigh 180 kilog. Consequently, 800 kilog. of alfa go to the maritime ton. Each press of this kind will turn out two compressed bales per hour. Reduced to this volume, alfa is no longer an unwieldy package ; it can be stowed easily, and preserves the normal centre of gravity to the ship without increasing the ballast. The cylindrical form of the bales facilitates the transfer they undergo on the route.

Until now alfa, considered as cumbrous waste in bundles, has been charged at a high rate of carriage by the railways, and commerce would not resort to this mode of transport, which cost eight centimes per kilometre ; and per ton, even when baled, this price is only reduced to six centimes. But this rate will not be enforced for bales compressed on the system adopted by M. Cruzel, and myself. These bales are hooped with iron, are not exposed to any damage, do not in any extraordinary manner affect the responsibility of railway companies ; and their stowage, cubical weight, and form, make them similar to goods in bulk, and most convenient for transport.

I may now give a summary of expenses arising from the various manipulations of alfa, from its first collection or separation from the parent stem to its arrival in France, within reach of the mills :

	fr.	ct.
1. Gathering in April, May, and June, at the rate of 60 kilog. of dry alfa, per day and per labourer, at 2 francs, for 100 kilog. .	3	33

	fr.	ct.
2. Drying on the field, and carriage from the field to the road	0	75
3. Carriage from the road to the port	1	0
4. Compression and packing in hooped bales, at 4,000 kilog. per day and per press, employing four men and two boys	0	50
5. Hoops of sheet iron, 3 kilog., and rivets	1	85
6. Carriage of the bales to the ship	0	35
7. Wages, rent, maintenance of material, fire insurance	0	50
8. Freight to Havre	4	50
9. Marine insurance	0	30
10. Merchant's profit and interest on capital at 10 per cent on the above sums	1	30
Cost of 100 kilog. of alfa, delivered at Havre	14	38

Technical Operations; Conversion of Alfa into Paper.—Chemically examined for paper making purposes, alfa consists of cellulose, mixed with gum, resinous matter, silica, lime, and iron. The incrustated materials are intercombined in such a manner that there is no hope of isolating the textile fibres by prolonged ebullition in mere water. The silicates and the resin which form the epidermis of the leaves, even resist the dissolving action of alcohol and ether. Recourse must be had to caustic agents—lime, soda, potash, ammonia—combined with boiling water, or the pressure of steam, to disintegrate the plant.

The internode which binds the leaf to the stem, similar to the joints of straw, resists much longer than the stalk the action of boiling and the ley. Hence the necessity of dividing the plant into one portion containing the knots or joints, which will undergo a special boiling, and another portion containing the stalks, which will require less boiling. Operating on these divided portions saves time, and gives, moreover, weight to the paper. Those who have operated on the entire plant have reduced a large quantity of tender fibres into useless particles by the action of the ley, in their endeavour to expose the tough fibres to a prolonged boiling.

The alfa, suitably boiled and lixiviated, preserves sufficient tenacity to be drawn off into long fibres, supple and easy to disintegrate. By washing, it yields a yellow colouring matter, soluble in alkaline agents. This yellow matter is not that which offers the chief obstacle to the bleaching. There remains in the fibre another colouring matter, which, under the combined action of chlorine and caustic ley, will also become soluble, and be eliminated by washing in water, which assumes the colour of blood.

Every attention must be given to the indications of this interesting reaction, for so long as the alfa has not given off this red tinge, it will not bleach. Chlorides cause it to take the colour of walnut wood, and acid baths, after the chlorides, leave the fibre in the form of greenish grey matter, only fit for the manufacture of papier bûlle. I do not speak of processes which will produce white pulp at great cost, by means of reagents and time ; they are, or at least have been, commercially impracticable. Those who have not commenced by the elimination of the yellow and red dyes, have treated alfa with corrosive leys or chlorides equally destructive; they have been able to get white pulp, but the waste or the cost has been represented by startling figures ; it is quite otherwise, in following the rational method of bleaching, by the successive elimination of the two colouring matters.

According to my experiments, the normal waste is made up as follows :—

Yellow colouring matter	12	26·5
Red colouring matter	6	
Gum resins	7	
Salts constituting the ashes of alfa .	1·5	
Fibre suitable for paper		73·5
		100

The theoretic loss of 26·5, it is true, can only be estimated, according to the care and discernment exercised in the use of the chemical agents and in the washing manipulations. It is as well, however, to know the exact limit to which perfection may attain.

The analysis of the ashes determines the quantities of the caustic agents necessary for the washing of the plant.

I obtained from 100 kilog. of alfa an ash weighing 1·41. From this ash I extracted :—

1. By boiling in water	Soda	0·110
	Sulphuric acid . .	0·090
	Hydrochloric acid .	0.030
2. By washing in aqua regia the residue left by the water.	Lime	0·200
	Sulphuric acid . .	0.285
	Oxide of iron Fe^2O^3	0·045
3. By treating with soda the residue left by the aqua regia.	Oxide of iron . .	0·324
	Silica	0·326
		1·410

There are also in 100 kilog. of alfa 1·510 of incorporated silicious and ferruginous salts, plus 7 kilog. of gum ; in all 8·510 of matter to be got rid of, in order to free the fibre. Admitting that the silicates require a quantity of alkali, thrice their weight, to make them soluble ; that the resin, to become soap, requires weight for weight of caustic soda, 100 kilog, of the plant must, in theory, be treated with 2·250 of alkali, and 7 kilog. of caustic earth.

In practice, the degree of temperature, and of pressure at which the boilings are made, must be considered, in order to increase or diminish the theoretical proportions. Thus, at the mills of Gueures and of Valernier, in operating in open boilers, at a temperature of 100 deg., a ley of double the theoretic quantity left the plant badly disintegrated, after twenty-four hours boiling. At Mont Saint Guibert, where rotary boilers are used, at a temperature of 140 and under a hand-pressure of four atmospheres, the plant was burnt and all its cohesion destroyed, in leys containing merely the theoretic quantity and even less, and after twenty, twelve, six hours of boiling. It therefore requires a very careful study, according to the apparatus, to retain in the alfa all its value as regards condition and solidity. Is the plant more or less green? Is the pressure more or less high? Here are two considerations which will necessarily vary the quantity of caustic and the time of boiling. Again, are the operations carried on without pressure in coppers where the ley is unagitated? Or are they carried on with apparatus where the ley alternately rises and falls through the mass? Further, there are modifications in the quantities of chemicals to be used which practice alone can teach, but which are essential to be known.

We have hitherto supposed that the alfa simply cut into four or five parts is operated upon: this gives a good result; but I ought to mention a very ingenious machine, which its inventor, M. Edmund Bertin, set at work for our experiments. In M. Bertin's machine, the alfa is placed lengthwise under a roller, which in rotating, draws it systematically between cylinders, where the stalk is crushed, firstly from end to end, without being torn.

From these cylinders, the alfa passes between hinged tables, in which are combined two movements—the first movement causes the plant to advance lengthwise under the cylinders; the second movement, perpendicular to the other, twists the alfa leaf as it advances, and deposits it in grooved receptacles, still without tearing it. The alfa thus bruised lengthwise and crosswise, is a mass of loose filament, admirably prepared for boiling and washing, without requiring pressure and large quantities of caustic agents.

I believe that M. Bertin's machine will be generally used in establishments for the preparation of textile plants. It economises the cost of re-agents, the time of boiling, and dispenses with the washing cylinders for crushing. For the manufacture of unbleached papers the method of crushing by vertical mill-stones, organised at Valvernier, gives results which no other perhaps, can attain; dispatch, homogeneity of pulp, simplicity of operation and of working, no waste; such are the advantages of this method. For white pulp, the question varies; the mill at Valvernier does not produce fibre, it produces pulp which is taken direct to be finished, and which cannot be treated with steam or chlorine gas, for this will only pass through spongy and easily permeable masses. Without this condition, it either does not operate, or but partially. Consequently, for white pulp, recourse must be had to sharp-tackle in the rag engine to *laminate* the alfa rather than to bruise it : well-formed fibre, a good reaction with chlorine gas, a perfect elimination of the red colouring matter, then a final chlorided and acidulated washing ; such are the practical means for the transformation of new fibrous plants into paper pulp.

Are these means sufficiently economical, so that paper, similar in quality, may not cost more, when made from alfa than from rags, taken at the average prices for the last five years ? Before giving in figures a reply on this point, I must be allowed to record my opinion on certain ideas that prevail with regard to textile plants. It is said, that alfa, diss, &c., instead of being sent to the manufacturer in the raw state, should be dealt with where collected, and made into pulp or half-stuff. The waste it is asserted, is thus got rid of, and the useful material alone forwarded, therefore we should turn our attention to the organisation of such works. Certain individuals, even hope to be able to reduce the price of paper, by making pulp in France from plants brought from Algeria or Spain, and supplying the paper-makers with this pulp.

My experiments have convinced me that alfa is more bulky in pulp than in the fibrous state. We can compress, as is done by M. Cruzel, 800 kilog. of the alfa plant into a cubic spare of 1m. 44, the maritime ton. We can compress 500 to 600 kilog. of pulp into the same volume, when in a humid state, until the mass is like a sheet of cardboard. But, if the pulp is humid, the water which it retains, will augment its weight at least in equal quantity, perhaps more, to the loss that the raw plant gives ; if the pulp is dry, it is unacceptable to the paper-maker, because it cannot be reconverted from the condition of cardboard to that of pulp, without special machinery and expensive manipulation.

Allow this first objection to be ill founded, although it is seriously felt by certain eminent paper-makers, who have been willing to use pulp, prepared elsewhere than in their mills ; I may yet dare to affirm, and herein in perfect accord with many master manufacturers, that if on the one hand white pulp is used, such as is got from the washing engine, and allowed to flow direct into the beating engine, then into the vats, then on to the machine, and lastly in the state of dry paper ; the operation will be better and more economical than if, on the other hand, this same pulp as it comes from the washing engine, is allowed to flow into draining pans, then dried, either by pressure or otherwise, then suitably packed to protect it from damage, and lastly remade at a new mill. In the first case, the paper is finished, it is delivered into the warehouse ; in the second case, the pulp has got to the rag-store, nothing more. It must again be torn to pieces, and washed and, perhaps one-third or a quarter bleached, before it can be given over to the beaters. I therefore consider it a faulty proceeding, in principle, to separate a paper mill in two ; the general expenses and packing charges, interest on capital, transport and cartage cost are doubled, and we merely offer to the manufacturer an article that may possibly be good, but which the paper-maker did not see prepared; which he cannot conscientiously warrant, and which, costing more than the raw material, does not economise machinery or labour. Alfa is too high in price, at present, to allow of superfluous or faulty methods in its use.

But if the idea of pulp mills is impracticable, it is not so as regards an establishment for cleansing the alfa, before compressing it. The alfa when yet green would by fermentation, yield its resin and a great part of its colouring matters. Its fibres softened, then dried, could be compressed with more ease, and the paper maker would find it more economical to substitute cleansed alfa for the raw plant. But, in practice, in Algeria as in Spain, the scarcity of water in the vicinity of the alfa regions makes this a difficult proceeding.

I will now examine, comparatively, the prices of alfa-paper, and of rag-paper; in the first part of this essay, the plant delivered at the port of Havre, is shown to cost 14.38 frs. per 100 kilog. In another paragraph, the estimated loss, theoretically, from the raw plant to paper is 26.5 per cent.; according to this calculation, 100 kilog. of alfa would yield 73½ of paper, and 136 kilog. of the plant 100 kilog. of paper. 136 kilog. of alfa at 14.38 frs. gives 19.55 frs. as the cost of the raw material at Havre.

Now, rags at the price of 19.55 frs. are not of a superior quality; old cordage, more or less tarred, is worth 24 to 28 frs. (at present 34 to 35 francs). Rags at 19 frs., linen, wool, cotton of all colours, and mixed (whereas the waste on alfa has been considered in our calculation and does not exist) give a loss of 30 to 45 per cent., according to the degree of whiteness desired; being on the average 37 per cent. Consequently 100 kilog. of rag-paper will cost, in respect to raw material (136 kilog. at 19.55 frs.), the sum of 26.78 frs. If we consider the actual conditions of manufacture for certain papers, we shall find that for news-paper the raw material is represented by the sum of 32 frs. as the minimum, up to 54 frs. for certain sorts. Proceeding from theory to practice, and without being indiscreet as to the working of the mills where I have made important experiments jointly with a skilful maker, we have seen that alfa, from the first, without modification of machinery, of re-agents, and of labour, advantageously contends with the raw materials habitually employed in these mills, and even with straw for common wrapping-papers. But, in the cost of manufacture, alfa was taken in its raw state, waste not included, at the price of 14 frs. the 100 kilog. Consequently, practice has verified two things: the practical waste corresponds exactly with the theoretic waste, and the various manipulations of the alfa are not more costly than those of its rivals.

In conclusion, the results have been in favour of alfa as regards the entire manufacture, and have led to a demand for extensive supplies.

In the establishment of the price of 140 frs. per 1000 kilog. of alfa, delivered at the port of Havre, I have endeavoured to eliminate all erroneous expenses arising at the outset of a commercial operation. Until now, in fact, the cost of 14 frs. has not been positively realized by a merchant, although he made the undertaking with his own money, and managed all himself.

M. Cruzel, who remained in Algiers after the completion of my researches, in which he participated, supported and assisted with the greatest activity by the civil and military administrations, for furthering our common work, has made and continues to make under his own inspection, and without intermediate agents, the first shipments intended to encourage the French paper-makers to adopt the use of alfa. The various estimates of management have been verified by each department. And not to tempt the trade with the show of illusory profits, the price of 140 frs. must be taken as the extreme limit in a regular and economical undertaking: moreover the freight of 45 frs. per 1000 kilog. must be retained. In conclusion, it is established that Algeria can supply to the French paper-trade a raw material which the international customs modifications, necessitated by progress, has made necessary. It is a fact that the use of alfa enables the paper-trade to keep pace with the progressive decline in the price of any object of urgent necessity, without compromising the economy of its constitution.

Moreover the organised collection of alfa in Algeria offers employment to a large number of natives.

The alfa-trade can, on the one hand, be made such that the welfare of the districts and of the inhabitants of the alfa provinces can be promoted, and on the other hand, the wants of a trade which fears for its supplies met, while lastly, commercial operations in the Algerian ports, will ere long be largly benefitted.

[We append to the foregoing article some extracts from a paper on "Esparto Grass," which we contributed to the "Paper Trade Review," for July, which furnish some additional practical information.]—Editor.

Mr. T. Routledge has been manufacturing paper from esparto exclusively, at his mills near Oxford, for upwards of five years. On the 28th November, 1856, a number of the weekly Journal of the "Society of Arts, Manufactures, and Commerce" of London, which contained a lecture by Dr. Forbes Royle "on Indian Fibres fit for Paper-making, &c." was printed on esparto paper made by Mr. Routledge at Eynsham. That gentleman has now other mills at Ford, near Sunderland, where he is making newspapers and also half stuff, both from esparto, for sale to the trade.

In the Jury Report on Paper, &c., shown at the last Exhibition, we find the following remarks on esparto paper :—

"Mr. Routledge represents that the cost of production, either in the condition of half stuff or paper, is below that of rags to produce a similar quality of paper, and the power required for reduction much less. Judging from the specimens of paper exhibited by Mr. Routledge, manufactured by him at his mills at Eynsham in Oxford, exclusively from esparto as well as from the other specimens of paper manufactured at various other mills employing his process, in which esparto is used as a blend with the ordinary rag material, the results are very satisfactory, demonstrating that a new material has at length been brought into use, meeting this long-desired requirement both as regards quality and economy.

"One satisfactory feature in Mr. Routledge's process is the fact that no material alterations in existing machinery or appliances are required; no higher pressure boiling in expensive vessels is necessitated; the silica, always more or less combined with a coating of raw fibres, is got rid of and the gummo-resinous matter neutralised, permitting the fibres to be eliminated and drawn out by the ordinary pulping engine as now practised with rags. The assurance of a successful result appears to be dependent on the proper adjustments of the proportions of the chemicals employed: this secured, and the process is extremely simple; the issue appears to be reliable, and, what is of no little importance, invariable and constant. The fibres produced from esparto are specifically lighter than those from any other paper-making material in use; their mechanical structure, moreover, admits of minute sub-division without destroying the feathery or mossy arrangement which facilitates the intimate feeding or blending of the ultimate fibres on the endless wire of the Fourdrinier machine; then esparto paper, in consequence of this peculiarity, feels thicker in the hand, and takes a finer surface than that made from cotton rags, and in proportion to the blend or admixture with other rag or paper-making material, imparts these advantageous characteristics. It is to be remarked, however, that its introduction generally into the trade, being only, comparatively speaking, of recent date, it has not yet arrived at full development, its employment being hitherto limited to common and ordinary printing papers and cartridges, and in the unbleached state, to brown and cap papers."

Looking at the scarcity of paper-making material from the cessation of cotton imports, it is fortunate esparto came to the assistance of the trade, in which it has now taken a permanent position, although, like all innovations, both it and the introducer were much sneered at, at the outset. It may safely be said that the most of the common printing and newspapers in this country, not excepting the 'Times,' have a blend of esparto introduced into their manufacture.

At the commencement of last year esparto fibre was selling at 5*l.* the ton, but the price fell, owing to the reduction in the price of rags, and to the general stagnation of trade caused by the American war. Recently, however, a fresh impetus has been given to the market, and it is now selling at Newcastle-on-Tyne at 6*l.* the ton, and the imports last year were about 18,000 tons. This importation is equal to the manufacture of about 9,000 tons of printing or white papers, but as much esparto is used for brown and other unbleached papers, where the loss in the chemical treatment is not so great, 11,000 tons will be nearer the mark.

ON THE DIFFERENT SPECIES OF ILEX EMPLOYED IN THE PREPARATION OF THE 'YERBA DE MATE,' OR PARAGUAY TEA.*

BY JOHN MIERS, F.R.S., F.L.S. &c.

Notwithstanding the seemingly authoritative evidence we have on record concerning it, I have entertained a doubt for many years past in regard to the plant which produces the celebrated Paraguay Tea, the favourite beverage of the Spanish South Americans. I will here detail the results of my investigations into this subject, and will preface the inquiry by a short history of the events which had great influence on the production and trade of this article of commerce ; these events are the more interesting as they are in some degree connected with the biography of the celebrated botanist Bonpland, to whom I am indebted for the knowledge of the true plants which produce the Yerba.

In the settlements of the Indians in Paraguay and along the borders of the River Paraná, under the dominion of the Spanish government, administered as they were at that period by the Jesuits, the preparation of the Yerba constituted the principal branch of industry of the country. The plant from which the Maté is prepared was first mentioned by Azara, as growing wild in many parts of Paraguay. It is found in great abundance in all the moist valleys of the ramifications that branch from the main chain of mountains called Maracajú, which, rising in that part of Paraguay bordering upon Matto Grosso, in lat. 19° S., and tending S. E., divides the northern half of the country into two distinct watersheds—the rivers flowing westward running into the river Paraguay, and those eastward into the Paraná. This chain, after a length of 150 miles, suddenly takes a more easterly course, and is soon cut through by the latter river at a place called Sete Quedas, (seven cataracts or large rapids,) in lat. 24° S. ; it then crosses into the Brazilian province of San Páolo, through which it runs nearly due east for 300 miles, as far as Curitíba, where it becomes blended with the main chain of the Serra do Mar, that skirts the coasts of the southern provinces of Brazil. The Yerba-tree is found more or less abundantly in all the valleys that branch out of this extensive range of mountains, but principally, as before mentioned, in the northern portion of Paraguay. Wilcocke, in his 'History of Buenos Ayres,' mentions three kinds of Yerba known in commerce—"the *Caácuy*, *Caámini*, and *Caáguazú* :" the first is there said to be prepared from the young leaves recently expanded from the buds ; the second is from the full-grown leaves, carefully picked and separated from the twigs ; and the third from the older leaves, carelessly broken up with the young branchlets : all being half-roasted by a crude process. But I have always been of opinion that these several qualities were pre-

* From the 'Annals and Magazine of Natural History.'

pared from different species of *Ilex*. The Guarani general term, *Caá*, signifies a leaf or branch; and in the Missions, the names of *Caá-riri* and *Caá-ûna* or *Caûna* are given to the different kinds of *Ilex*. The prepared leaves have always borne the name of *Yerba* among the Spaniards, its infusion being made in a peculiar kind of cup called a *Maté*. In the Portugese Missions the Yerba is called *Caûna*, and in most of the Brazilian provinces it is known by the name of *Congonha*, pronounced *Congonia*.

Under the Spanish government, the principal harvests of Yerba were made in the valleys bordering upon the river Ypané, a tributary of the Rio Paraguay,—the produce there collected being conveyed to the town of Villareal, at its mouth, in lat. 23° 30′ S., and thence transported down the River Paraguay, in large pontoons, to the metropolitan town Assuncion. Although the largest harvests were obtained in Paraguay, considerable quantities in addition were raised in the various settlements of Indians founded by the Jesuits beyond its limits. These were called Missions, and were thirty in number, twenty-three being situated between the rivers Paraná and Uruguay, and seven on the left bank of the latter river, in the province of Entrerios. These, as well as all the extensive settlements in Paraguay proper, were at their greatest prosperity at the period of the expulsion of the Jesuits in 1768; but, owing to the defective management of the Indians under the subsequent rule of the Spanish authorities. the commerce in Yerba languished considerably. In 1810 the quantity raised was supposed to amount to five millions of pounds; but Mr. Robertson states that in 1812 (two years after Paraguay became independent) the exports of Yerba still amounted to eight millions of pounds, or 3,750 tons, from the port of Assuncion alone, at which period, too, its cultivation in the Missions had become almost annihilated. In all these Missions, during the devastating wars then raging throughout the Argentine provinces, the Indian settlers were robbed of all their cattle and horses, their farms were destroyed, the men forced to become soldiers, and otherwise were so oppressed, that the greater number sought a refuge in Paraguay.

* * * *

At this period, Paraguay was governed by the renowned Dictator, Doctor Francia.

Under the Spanish rule, the Paraguayans had cultivated besides the Yerba, little beyond a fine kind of tobacco (considered equal to that of Havana, and much appreciated in Chile and Peru), and also some sugar and yucca (yams). They were soon induced by Francia to extend their agricultural pursuits, to cultivate rice, maize, and other vegetables, on a large scale, and to raise a sufficient quantity of yucca to satisfy the general consumption. Other vegetable products, hitherto scarcely known in the country, soon covered the plains: cotton, formerly procured from Corrientes, was now cultivated to some extent; more attention was paid to the rearing of cattle and horses, instead of importing them from Entrerios, so that in a few years they were able to export a considerable surplus above their own requirements; and they now made cotton cloths for their garments, in lieu of the woollon ponchos obtained from Cordova. The Dictator for many years was assiduous in his endeavours to establish permanently this system of industry, which necessarily supplanted in great measure the trade in Yerba; he even employed coercive measures in order to carry it into effect; and in 1829 he decreed that the possessor of every house or farm should sow a certain quantity of maize, upon the product of which every one was bound to contribute 4 per cent. to the state, no excuse being allowed; and those who sought to evade this obligation became subject to heavy penalties.

To a policy of restraint, which in a more advanced state of society would not have been tolerated, it was certainly one well calculated, in the actual state of Paraguay, to attain the objects he had so much at heart, and in which he gradually succeeded. The good results of these wise measures are well attested by the prosperous advancement of the country up to the present time. His success naturally raised up against him a host of irreconcileable enemies in all the Argentine Provinces, who strove to blacken his character and vilify his conduct. All these Provinces, suffering under the extinction of the trade in Yerba, were leagued against the policy of Francia; but their attention being too much occupied in their constant internecine wars, they had little time or force to spare in the attempt to revolutionize Paraguay. At length, however, the Governor-in-chief of Entrerios, having made peace with the other provinces, turned his attention to that object, and endeavoured at the same time to establish settlements at the former Jesuit Missions (then almost depopulated), with the view of cultivating the trade in Yerba. And we now come to a knowledge of the state of affairs that existed when the celebrated Bonpland visited the River Plate, and how the subsequent phases of his life became connected with the history of the trade in Yerba.

The fall of the Emperor Napoleon and the re-establishment of the Bourbon dynasty in France were events most galling to Bonpland, and he resolved to seek an abode in one of the republican States of South America. Accordingly he reached Buenos Ayres in 1817, with a nominal appointment of Professor of Natural History in that capital. In 1819, Bonpland established himself near Candelaria, one of the old Jesuit Missions on the left bank of the Parana, contiguous to Paraguay, where he formed a considerable establishment, chiefly, as I understood, with a view to the production of and trade in Yerba, under the special auspices and protection of the Governor-General Artigas, who, as I have before mentioned, intended ultimately to carry out his designs against Paraguay. * * * *

From his long residence in the country, and his great experience in all that relates to the preparation of Yerba, no one had better opportunities than Bonpland to identify the real species from which that article of consumption is manufactured.

The system of the merchants in their agreement with the 'habilitadores' who undertake the quest of Yerba in the distant forests of Paraguay, the manner of hiring the Indian labourers for this work, the preparations for feeding them during their long bivouac, the mode of collecting and drying the branches, roasting and separating the leaves, pounding them, and packing the Yerba, thus prepared, in hide bags, are well described in Mr. Lambert's memoir on the *Ilex Paraguayensis*, and in Mr. Robertson's 'Letters from Paraguay,' and Francia's 'Reign of Terror.' The same rude methods were employed in all the Spanish Missions, and also in the Brazilian settlements, up to a very recent period ; but of late years more improved processes, upon a much larger scale, have been brought into use about Curitiba ; but in the province of Rio Grande the old system is still continued. At Curitiba, I am told, the leaves are now roasted more equally, in cast-iron pans set in brickwork, much after the manner in which tea is prepared in China, except that the pans are much larger. When the leaves are sufficiently dried, they are pounded in stamping-mills worked by water-power or steam-engines, and packed in bags by means of presses. The quality of the Yerba has thus been much improved.

We owe to St.-Hilaire the first outline of the botanical features of the tree, growing about Curitiba, that yields the Yerba ; it was only a short diagnosis, published in 1822, when he ascertained it to be a species of *Ilex*, which he considered identical with the Paraguay plant, and which was named inaccurately, through a typographical error, *Ilex Paraguariensis*, a name he afterwards abandoned in 1824 for that of *Ilex Mate*, he, however, resumed the former name in 1833. In the meanwhile, Mr. Lambert, in 1824, gave a much fuller description of the plant, accompanied by a good drawing made from specimens sent from Buenos Ayres, and probably obtained from one of the Spanish Missions : he called it *Ilex Paraguensis*.

I had always been impressed with the conviction that the different qualities of Yerba brought to market were prepared from different species of *Ilex* ; and hence the doubt occurred to me whether the plant described by St. Hilaire from Curitiba be really identical with the true Paraguayan type. The grounds for this surmise were founded upon the dissimilar colour of the two Yerbas, the difference in their flavour, and the higher price always obtained for the Yerba de Paraguay compared with the Yerba de Paranaguá. The short diagnosis of St.-Hilaire answered equally to several species that I had seen. Sir William Hooker, in 1842 (Lond. Journ. Bot. i. 30), gave a very interesting account of the Yerba, describing also the *maté* or cup, formed out of a small calabash (*cuy*), in which the infusion is prepared, and out of which it is drawn into the mouth through a *bombilla* ; he added the characters of the different varieties, which he considered identical with the *Ilex Paraguayensis*, and of these he gave two excellent figures with analyses. This memoir, instead of solving my doubts, only rendered the question still more enigmatical ; for in it is classed, as a mere variety, a plant which

I brought from Rio de Janeiro, which I found growing in the Botanic Gardens there, and which I was assured by the Rev. Frey Leandro, at that time Director of those Gardens, was the "Arbol do Maté," or "Paraguay Tea-tree." This plant, which is well figured in Sir William Hooker's memoir appeared to me quite a distinct species, marked by very peculiar characters.

Anxious to remove this doubt, I applied to my friend Senr. Conselheiro Candido Baptista d'Oliveira, soon after I learned of his appointment as Director of the Botanic Garden, and begged of him to ascertain whether that plant was really identical with the tree which yields the true Yerba de Paraguay, as I had been assured twenty years before, or a different species, and to send me, if possible, authentic specimens of both. He most obligingly forwarded me a fresh specimen of the tree still growing in Rio de Janeiro, and at the same time transmitted my application to M. Bonpland, as the most competent authority on the subject, who, however, did not quite comprehend the object of my inquiry. This renowned botanist most kindly responded, and sent six different species with their varieties, all collected in the Missions, and all alike used in the preparation of Yerba. This at once confirmed my suspicion that more than one species of *Ilex* is employed for that purpose; and as this fact is of some importance in the history of the subject, I will copy here *verbatim* the note of M. Bonpland which accompanied his specimens.

"No. 596. Herbe du Paraguay—Maté—*Ilex theæzans*, Bonpland—*Ilex Paraguayensis*, St.-Hilaire. Se trouve dans le Paraguay, le Brésil, et Entre Rios.

"No. 2425. *Caüna* des Brésiliens—*Ilex ovalifolia*, Bonpl., nouv. espèce. Se trouve dans le Faxinal, au sortir de la Picada de Sa Cruz, à 4 lieues du Rio Pardo.

"No. 2333. *Cauna* des Brésiliens—*Caachiriri* ou *Caachiri* des Guaranis—*Ilex amara*, Bonpl., n. esp. Se trouve dans les montagnes de Sa Cruz et dans les forêts du Paraná.

"No. 2332. *Cauna* des Brésiliens—*Caachiriri* des Guaranis—*Ilex crepitans*, Bonpl., n. esp. Se trouve dans les bois de Guayaraça dans le cœur de Sa Cruz et sur les bords du Paraná.

"No. 2330. *Cauna de folha larga* des Brésiliens.

"No. 2374. *Cauna amarga* des Brésiliens.

"No. 2479. *Cauna* des Guaranis—*Ilex gigantea*, Bonpl., n. esp. Se e trouve dans les bois de Sa Cruz et sur les bords du Paraná.

"No. 2471. *Caunina* des Brésiliens—*Ilex Humboldtiana*, Bonpl., n. esp. Se trouve dans le Picada de Sa Cruz qui conduit à Rio Pardo, Prov. Rio Grande, Brésil.

"Toutes ces espèces d'Ilex sont employées à faire l'herbe Maté. Les nos. d'ordre correspondent à mon journal botanique.

"Corrientes, 17 Juin, 1857." "AIME BONPLAND."

When in Paris a few years ago, I endeavoured to ascertain whether any of these specimens agreed with St.-Hilaire's typical plant; but the latter, unfortunately, had been mislaid or lost in the removal of the collections exhibited in the great "Exposition" of 1855. St.-Hilaire states that he had compared his plant from Curitiba with specimens from Paraguay, and found them specifically identical; this conclusion does not correspond with the specimens before me.

I have since obtained from Curitiba a specimen of the plant there used in the preparation of the Herva de Paranguá. On comparing it with the true *Ilex Paraguayensis* sent by Bonpland, I find the two sufficiently distinct: this fact is of interest, as it accounts at once for the difference in the quality of the tea respectively prepared from these two plants.

Hitherto, I have spoken only of the Yerba produced from these two species. Bonpland, however, states positively that the other species, of which he sent specimens, are also employed in the preparation of the Yerba of commerce. This fact has lately been confirmed by the assurance I have received from a Brazilian gentleman from Porto Alegre, who trades extensively in this commodity: his information is very interesting, both as regards the difference in the quality of these products, and the districts in which the trees are found; and from his knowledge of this matter and his long experience, his account may be fully depended on. The other species grow principally in the districts that stretch far to the eastward and southward of the long mountain range which extends from the "Serra Géral" of Curitiba, in lat. 26° S., to lat. 32° S., where it is shown in the maps as the "Serra do Herval," so called from the abundance of its Maté trees. The summits of this wide-spread mountain range are very broad, forming numerous table-lands which afford excellent pasturage for cattle. The Maté trees are never found on these table-lands, nor in the broad plains that skirt the river beds; they grow invariably on the inclined hill-sides in the numerous gorges intersecting the country, which in most cases are densely wooded; and it is in these woods that the different species of *Ilex* abound. In some places the Maté trees attain a considerable size, often exceeding 100 feet in height. These larger trees grow especially on the declivities of the western side of the same mountain-range, where all the streams flow into the river Uruguay. The Yerba here produced is of an excellent quality, that called by the Brazilians "Herva de Palmeira" is renowned as being equal to the best Paraguay tea.

It is in this region that seven of the far-famed Missions established by the Jesuits are situated, where the Maté is extensively collected. Upon the eastern declivities, along the tributaries of the rivers Pardo and Jacuhy, are the 'Hervales' of Faxinal, Santa Cruz, and Guayaraça, to which Bonpland's specimens refer. Here also is that of Butacarahy, equally renowned, where the *Ilex gigantea* of Bonpland abounds, and where it attains a height of 70 feet: the other four kinds, with smaller and more lanceolate, punctate leaves, rarely here exceed the height of

30 or 40 feet. The latter are more irregularly branched, with a more straggling growth, and they produce the sort called by the Brazilians *Herva brava* (wild Maté), while the larger-leaved species, such as the *Ilex gigantea*, yield a kind of tea called *Herva mansa* (mild Maté) ; such trees have straighter trunks, with more regular and rounded heads. The former sorts have a more bitter and stronger flavour, and want the peculiar and more agreeable aroma of the Paraguay type. When, however, the Herva brava is mixed with the Herva mansa in the proportion of 1 in 3 or 1 in 4, it produces a kind of Maté which is hardly distinguishable from the genuine Paraguay Yerba ; and it thus forms a considerable object of commerce.

Still further to the southward of the Serra do Herval, in the mountain districts of the Taypes or Canguassú, some species of *Ilex* abound which are said to produce a tea as valuable as the best sorts of Herva de Palmeira, or even vying with the Paraguay tea, being equal to them in fragrance, flavour, and strength. This fact is worthy of notice when we take into consideration the great difference in the latitude of these districts. The quality of the tea of all these various kinds depends greatly on the time of year in which the leaves are gathered, the best season for the harvest being well known to the natives.

Dr. Reisseck has lately published, in Martius's 'Flora Brasiliensis,' a Monograph of the Brazilian species of *Ilex*. He evidently had not seen any specimen of the true *Ilex Paraguayensis ;* for his diagnosis under that name refers to some of the smaller, more lanceolate, and punctate-leaved species of the genus, and certainly not to the celebrated true Paraguayan plant.

SUBSTITUTES FOR WAX. *

BY BARNARD S. PROCTOR.

Some months ago, I published a short article drawing attention to the adulteration of white wax : † the present paper follows as a natural sequel to the former, and is designed to indicate the relative merits of various substances which may be considered suitable for replacing wax in one or other of its uses. With regard to the fitness or otherwise of any of these substitutes to take the place of wax for medicinal purposes, I shall say nothing, such a substitution being both unnecessary and illegitimate. It is also unnecessary to say anything with regard to their fitness for making candles, &c., that being unimportant to the chemist

* From the 'Chemist and Druggist.'

† See TECHNOLOGIST, vol. iii. p. 332.

and druggist. But for perfumery purposes, for the polishing of furniture, and the "waxing" of thread, substitutes may with advantage be looked for; and the fitness for any of these purposes will indicate pretty well the fitness of the material in hand for other special purposes, which it would add too much to the length of the present paper to notice in full. I have also indicated the prices (quoted a few months ago, and, of course, subject to variation), and the melting point.

Spermaceti is too well known to call for any remark: stearine and paraffin greatly resemble it when pure, but the former is subject to a greasy, rancid odour, and the latter to the odour of coal tar; they are both more crumbly than spermaceti, the paraffin especially, being readily rubbed to powder, and both are purely white. China and Japan wax greatly resemble good block white wax in their general appearance, but are liable to become coated with a fine white efflorescence resembling the bloom upon many kinds of fruit; they have a toughness somewhat inferior to wax, and when a knife is forced into them, they break with a crackling sound; they are both almost destitute of odour, and what they have is not objectionable: of the two, the Chinese wax most nearly resembles the product of the bee.

Carnauba wax, on the other hand, differs greatly from all the others. It is hard, brittle, and darker coloured than the others; in physical properties it seems to hold a position between white wax and sulphur; it takes a fine polish when rubbed with any soft material; and it is so hard as not to take finger-marks with the heat of the hand: it is suitable for furniture polishes, either alone or mixed with Japan wax or beeswax.

TABLE OF WAX SUBSTITUTES, SHOWING THEIR COMPARATIVE MERITS AND PRICES.

	For thread.	Furniture.	Perfumery.	Melting Pt.	Price.
				deg.	s. d.
Genuine Block White Wax	Good	Good	Good	145	2 10
White Cake Wax (adult.)	Medium	Medium	Good	...	2 4
Jamaica Yellow Wax . .	Good	Good	Good	...	1 10
English ditto	Good	Good	Good	...	2 1
Spermaceti	Bad	Bad	Good	112	1 5
Stearine	Bad	Bad	Good	144	1 4
Tree Wax, Japan	Med. Good	Medium	Good	115	0 10
Insect Wax, China	Med. Good	Medium	Good	118	2 8
Carnauba Wax	Bad	Good	Bad	192	0 10
Paraffin	Med. Bad	Bad	Bad	131	1 5

The quality of some of these materials is subject to considerable variation: thus, paraffin may be obtained quite free from odour; and if so, might possibly be used without disadvantage in the preparation of cold cream or pomades. It is probable that there are other variations besides odour and colour, judging from the melting points. Miller quotes the melting point of paraffin at 110 deg.: I found it melt at 133 deg., and congeal at 103 deg., China wax he states to melt at 182 deg.: I found it melt at 133 deg., and congeal at 103 deg. Japan wax I found melt at 128 deg., and congeal at 102 deg.; the melting point quoted in the table being the mean of the two observations.

The melting point of stearine is liable to vary from very slight causes (see Miller's Chemistry); but so great a discrepancy as indicated above for China wax must surely be the result of a difference in the nature of the sample. The price quoted for Japan wax seems much below what its good properties would seem to justify. The qualities would probably become more uniform, and the prices would find a more reasonable level, if more extensive trial were made of these materials for the various purposes for which wax is at present used.

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ALGERIAN PRODUCTS.

BY PAUL MADINIER.

(Late Editor of the 'Annales d'Agriculture des Colonies.')

In commencing this communication, I have to thank you for the translation of my article on the Plantain, which you published in the TECHNOLOGIST for October last (vol. iii. p. 112).

Since my arrival in Algeria, I have pursued my researches on that plant with the view of making a monograph of it; but the more I look into the matter, the more difficulties I find.

The description of the species of *Musa* by botanical authors is very fallacious—what is defined as a species is often but a variety. Indeed, the whole subject is what we call in French "la bouteille à l'encre," so difficult is it to throw light on it. It is the same, however, with several other cultivated plants of tropical countries, such as the sugar-cane, cotton, rice, sorgho, &c.

With regard to the plantain, I must admit from my own experience that the great number of varieties, and the absence of well-defined characters among them, makes their proper classification a most troublesome labour, to which it would be necessary to devote several years in visits to the different regions of their growth.

I append hereto some remarks on a South African tree, from which I have obtained a colouring gum, and of this I send you a small sample.

While I remain in Algeria I am at your service, should you wish for any detailed information on its productions. You are probably aware that the tonnage duty on foreign ships in Algerian ports is now reduced, and is levied only on the number of tons loaded in the colony. This reform, I hope, will increase the commercial intercourse between Algeria and Great Britain. The latter needs principally raw materials, which are abundant products of Algeria. She can supply you with cereals, wheat, oils, fibres, mineral ores, &c., and will take in exchange cotton cloths, fuel, iron, materials for building, machinery, &c. The relations of the two countries are already advantageous. The English who come to make Algeria their winter quarters are each year more numerous, and it is said that in a short time the Peninsular and Oriental Company's steamers will touch at Algiers.

Looking at the profitable business connections which can be established, I think that it is the office of a journal like yours to acquaint the British trader with the raw materials of Algeria. If you will undertake that duty, I will esteem it a pleasure to furnish you with full particulars, and all necessary documents and information.

I think that some information on the *Lawsonia inermis*, of which the leaves, dried and bruised, constitute the cosmetic dye so universally used by the women from the East, would be acceptable to you. The *henna* is a very interesting product, which will be in great request when better known ; I will send you shortly a communication on this plant, its cultivation and uses. I have seen mentioned in the quarto Indian catalogue for the London Exhibition of 1862, by Mr. Dowleans, p. 45, that an essential oil has been obtained from the petals of *Lawsonia inermis*. Now the flowers of this plant are without smell, and it appears to me that the essential "oil of Mehudee" is rather the produce of some other species, such as *Lawsonia spinosa*, *L. alba*, or others, &c. If you have any information on this point, I should be obliged if you would inform me of it.

Gum from the Schottia latifolia, Jacq.—I have had occasion to examine lately, in the Garden of Acclimatization of Algiers, a small tree from the Cape of Good Hope, the usefulness of which has not yet been pointed out, as far as I know, and to which I think it right to draw the attention of scientific men, who will be better able than I to decide what it may be applied to. I allude to the *Schottia latifolia*, Jacq., of the family of the *Cisalpinæ*. It is a tortuous tree, with thick branches, and the specimen of it in the Garden of Acclimatization of Hamma is nearly twelve feet high. The leaves are persistent, pennate, with four folioles, small, oval, rounded, terminating with a short point, of a pale green at the nervures, almost blueish in the young shoots, becoming dark green with age. The flowers, disposed in bunches, are of a pretty, ornamental aspect, and diffuse a fragrance of vanilla, which attracts the visits of bees and other insects. They bear four sepales, green, convex, and unequal, and four to five white petals, unguiculate. The stamens, as in all the plants of this group, are ten in number, three of which are larger than the others. Their filaments are only joined at the base, and in the part where they are free are of a bright scarlet colour. The style is filiform, ascending, and terminated by a single stigma. The fruit is a pod, with wrinkled skin, three to four inches long, and one to one and a quarter in width, containing two or three albuminous seeds, as large as a harico bean, and of a light brown colour. These seeds possess a remarkable peculiarity. The funiculum which connects them with the pod, and through which passes the nutritive juices which serve to develop them, attains a considerable growth, and forms a prismatic arils with rounded angles, fixed by its point to the pod, and on the base of which is attached the seed, by means of the radicle. These funicular arils are of a light yellow colour, and of a pretty firm consistency, when the pod has just been plucked, and has not gone much beyond the point of maturity, but they soon become soft when placed in a heap. The largest do not weigh quite one gramme (6 to 9/10).

Some time ago, Mr. Hardy, Director of the Garden of Acclimatization of Hamma, gave me, as a subject for study, a handful of those arils proceeding from the last pods gathered from the tree contained in the garden. I brought them home and placed them in a large glass, intending to examine them on the following day; but the following day being a Sunday I for got my arils, and when on the Monday I went to examine them, the mass had begun to ferment, and gave a very acid reaction on test-paper; the surface was completely covered with mildew, which I removed, and found at the bottom a liquid portion, which I separated. This liquid, exposed to the sun, gave me a gummy substance, of a greenish yellow hue, which retained a soft consistency even after a long insulation, and which had the characteristics of similar bodies (gums and dextrines)—viz., soluble in water, insoluble in alcohol and ether, and precipitated by acetate of lead. Under the influence of alkalies, a solution of this substance acquires a fine yellow colour, which possesses all the brilliancy of gamboge; acids discolour it completely.

The quantity of gum at my disposal was too small to enable me to undertake more complete researches. I confined myself to this preliminary examination, with the intention of continuing it when the tree in the Garden of Hamma shall yield a fresh crop of pods.

The proportions of gummy matter contained in these arils must be very large, if I may judge by the quantity obtained from the few arils which had been given to me. Whether this substance can be utilized or not as a gum, or as a colouring substance, it appears at all events to me to constitute an interesting product. If I may judge by the abundance of flowers, one tree alone may supply a considerable quantity of gum, and it is so easily extracted that it could be obtained at a cheap rate. It would be sufficient to gather the pods, separate the arils, heap them together for a day or two, in order to soften them, and then to press them. The liquid thus obtained could be solidified by the action of the sun. The seeds could also be saved, for it is to be presumed some use could be found for them, if only, at first sight, to extract meal from them. I am not aware whether they possess any alimentary value, either for men or cattle, not having had a sufficient number to experimentalize upon. Lastly, if, according to the vulgar idea, all that smells strong is good in medicine, the odour, *sui generis*, of the *Schottia latifolia* gum might indicate some therapeutical properties.

These are the points which I should like to see investigated by the scientific men who reside in the Cape Colony. P. M.

11 Impasse Darfour, Alger.

RISE AND PROGRESS OF THE HOSIERY MANUFACTURE.

BY WILLIAM FELKIN.

It is not possible to fix the epoch of the invention of the art of weaving, or of the first use of a weaving-loom. But there can be little doubt that in the ages immediately following the flood, the employment of rushes and twigs in weaving articles for domestic use, by plaiting or otherwise wattling them, and of twine or threads spun from hair, wool, fibres of trees, flax, cotton, silk, and other suitable materials, by netting or looping them, had become general. By these kinds of rudimentary weaving, fringes, fishing-nets, girdles, and other useful or ornamental articles, were obtained. The use of these materials by handicraft skill led, at a very early period, to the construction of a rude apparatus for weaving cloth, by extending threads longitudinally as warp, probably from one branch of a tree to a neighbouring one, and passing a woof thread across them, over one or more and under one or more of the adjoining threads, till all had been thus traversed; and then the warp threads, having been altered as to their position by raising some and lowering the others, the woof-thread was repassed through them back again, and so on till the warp was entirely filled up. In Chinese and Indian annals, as also in the Bible, the loom, or one or more of its important parts, as the beam, the shuttle, &c., are mentioned; and there is reason to believe that the Tabernacle veil of the Jews, the priests' vestments, as also the mummy cerements of the Egyptians, were wrought in looms of a construction very similar to those now in use. Babylon and Damascus were seats of these manufactures of cloth; the latter continues so to this day. Some are, however, of opinion that a looped fabric was then known. In weaving, or rather knitting hosiery, by hooks or long skewers of wood or iron, it is supposed we have the ancient practice perpetuated whereby Joseph's "coat of many colours," and the "garment woven without seam," taken from the person of Christ, were wrought. In this operation one continuous thread only is used, of which successive loops or stitches are formed, and the loops of each round or row are drawn in turn through those of the preceding row. Though it has neither warp nor weft, and can scarcely be called cloth, except it be felted, yet this tissue is superior to any other for many purposes from its elasticity and closely fitting the body in wear. The art of knitting hosiery continued to be practised by hand only, and mainly as a domestic employment, working up thread spun from the long wool of sheep or goats until the sixteenth century of the Christian era. Its highest attainment was to furnish, at high prices, a few silk-knitted hose for our Henry VIII. and his daughters Mary and Elizabeth. Before that time, if stockings were desired to be cool and elegant, they were shaped out of linen or silk cloth by scissors, and then sewn up.

About 1589, the Rev. William Lee, M.A., a clergyman then living at Woodborough, near Nottingham, finding a lady to whom he was attached always more attentive to her knitting than to his addresses, in grief and anger determined to supersede her employment by constructing a machine which should, by its power and speed render hand-knitting useless. He made the attempt, and met with difficulties so great in the complex movements and nice adjustment of parts requisite in the machine to be made, and so unlike any then known or thought of in mechanical science, that he was long greatly baffled and almost in despair. Without previous practical knowledge himself, he could not find the needful skill and experience in others. The knitting mesh or loop is so different from the simple crossing of the threads in common weaving, that to effect it mechanically was an operation which required original power of analysis and combination of an extraordinary kind. Instruments and forces must be applied in ways and for purposes which, for aught that appears, were before unattempted. At length he succeeded ; and the stocking frame still remains in attestation of the greatest triumph of mechanical genius then, or for many ages afterwards, known. A minute description of this machine would be out of place here : it will be sufficient to mention that Lee placed a series of hooks of peculiarly ingenious form and adaptation side by side in a uniform line and firm position. He passed the weft thread, of which alone the fabric was to consist, along these hooks (called also "needles"), and by the use of a row of cleverly formed moveable instruments, called "jacks" and "sinkers," rows of loops were formed one after the other on the hooks, and others on them in succession. This was done with surprising rapidity compared with the usual hand process. By the use of the hand-knitting pins or skewers, 100 loops may be formed in a minute : on Lee's first frame, using coarse materials, 500 loops, and in his second from 1,000 to 1,500 loops were made per minute ; by the machine now worked by hand, even when the loops are of such fineness as can scarcely be distinguished by the naked eye, 10,000 loops may be made per minute ; but, by circular power, 60,000 in the same time. The first machine was soon taken by its inventor to London ; and having formed great expectations proportionate to the profound thought and skill he had shown in its conception and completion, and his consciousness of the immense step he had made in administering to the comfort and advantage of his countrymen, he sought the approval and countenance of his sovereign. She visited him, attended by her kinsman Sir William Carey and Lord Hunsdon, and saw him work his machine at Bunhill Fields. The frame was a twelve-guage, and working upon coarse worsted yarn, altogether unfit for royal or fashionable use. Elizabeth was disappointed, because she hoped to have found silk hose making on it. Lee had desired a patent monopoly in acknowledgment of his so-far successful effort. The Queen is said to have thus written—" My Lord, I have too much love for my poor people, who obtain their bread by the employment of knitting, to give my money to forward an invention which will tend to their ruin, and thus make them beggars. Had Mr. Lee made a machine that would have made silk stockings, I should, I think, have been somewhat justified in granting him a patent which would have affected only a small portion of my subjects; but to enjoy the exclusive privilege of making stockings for the whole of my subjects, is too important to grant to any individual." Lee was stimulated to alter his frame in order to produce silk stockings. After throwing aside his wood jacks for iron ones, and increasing the fineness from six to twelve needles, and as many loops in an inch in width in each row, he, in 1597, produced silk hose: these the Queen accepted and wore, praising their agreeable elasticity and beauty of texture. Nevertheless she refused the entreaties of Lord Hunsdon, and granted neither money nor patents. Perhaps her Exchequer was poor, or she might dislike to seem careless of employment for her subjects by creating further monopoly of labour. It is probable that afterwards a patent was issued of a limited character. Such large hopes of profit from this new invention were entertained, that Lord Hunsdon, a descendant of the Tudors, bound himself by deed to Lee, learnt the art of frame-work knitting, and became the first stocking-maker's apprentice. There can be no doubt that this nobleman supplied the funds necessarily expended in the improvement of the first stocking-frame, and in the construction of several others. Lee had given himself wholly to them, neglecting clerical duties and all other means of existence. He was never seen at Court, and seldom anywhere else but in his workshop. His prospects of profit and success gradually faded away. He soon saw his great but politic and parsimonious patroness laid in her grave; and after waiting patiently for some years to ascertain whether her successor would encourage him to keep the invention at home, also having lost his patron, Lord Hunsdon, the continued neglect of James I., and his refusal to grant patent or money, he decided to accept, though with much regret, the pressing offers of the illustrious Sully, and transfer it and himself to France.

The manufacture was established at Rouen; and Lee was introduced by the Duke de Rosny to Henry IV., who gave him a gracious reception. That great monarch was, unhappily, soon assassinated; his minister retired from public life, and all Lee's bright hopes were at once destroyed. Again having been flattered and disappointed, his fortitude forsook him and he fell into a deep melancholy. An alien, almost an outcast, he sickened, and sent for his brother James from Rouen; but it was too late. After twenty-two years of deferred hope and severe effort, he died alone, of a broken heart, at Paris, in 1610. "Many a heart has been broken upon the wheel whose revolutions have made the fortunes of thousands." James Lee returned to England, leaving one frame at Rouen, and set up the others at Old Square, London, where they were soon sold to a merchant of Italian extraction, and the trade became established in that city. Mead, an apprentice of James Lee, was sent with a machine to Venice. For want of tools, needles, sinkers, and workmen, the manufacture failed there in 1620. Leaving London, James Lee settled in Nottinghamshire, and with the money he had received for the frames he had sold, and 500*l.* for cancelling Mead's indenture, he began to construct others, and so established the business of frame-work knitting in that county; from thence it spread over the counties of Leicester and Derby. Aston, a miller of Thornton, Notts, joined James Lee, and they added the "lead-sinkers, thumb-plate, and lockers" to the machine, which greatly simplified it, and have been in use ever since. In 1670, "trucks" were placed on the "solebar," by Needham, a London workman. In 1711, the "caster back and hanging-bits" were added by Hardy, of London, and are still used. With these improvements, the stocking-frame seemed to have reached an almost perfect state as to the quality and rapidity of construction. It was composed of 2,066 pieces, and required eleven movements to form one course of loops. No increased power or facility of operation was acquired by any subsequent contrivance until towards the middle of the present century. London continued for ages to be the centre of the hosiery manufacture. A Frame-work Knitters' Company was established by royal charter, dated 19th August, in the fifteenth year of Charles II. This still survives, but is powerless for any useful trade purpose. Its arms are a stocking-loom, supported on the right hand by a clergyman, and on the left by a woman presenting a knitting-pin.

The stocking-frame soon spread in great numbers all over France—there are now at Troyes 5,000 or 6,000—Spain, Austria, Saxony, in which latter kingdom there are at present upwards of 30,000 frames at work. These still continue to furnish employment to many industrious mechanics. In 1669, there were 660 English frames, 400 of which were in London, and three-fifths of the whole wrought upon silk. 100 only of these frames were then in Notts. In 1695, there were 1,500 frames in London, of which 100 were destroyed on account of disputes about wages. These had increased in 1714 to 2,500 in London, 600 in Leicester, and 400 in Nottingham. Altogether there were about 8,600 in this country. The trade soon began to escape from the London Company's coercive protection, and rapidly increased in the midland counties. This portion of the history of stocking-weaving is curious and instructive. Its results were, that, by 1753, the frames in London had declined to 1,000, and increased in Nottingham to 1,500, in Leicester to 1,000; the total number having risen to 14,000. Meantime cotton hose, first woven in 1730, were getting into notice and demand. Specimens of stockings made at intervals during the years 1790 to 1850 from Arkwright's yarn for the most part, of great excellence, and quaintly fashioned, are shown in the present Exhibition. They are the manufacture of the late John Allen, Esq., of Nottingham, and are well worth careful examination. Invention, having for its object to vary by the improvements of this frame, the kind and style of production, began about 1750, and has continued ever since in vigorous operation, reaching a very high point indeed. The midland counties have long been famous for mechanical skill and invention.

The "tuck-presser," which was attempted in 1730, and applied in 1745, was followed by Jedediah Strutt's Derby rib-patent in 1759. By this invention a variation of the uniform or plain-looped work of the stocking-frame was effected by machinery, which applied "points" to such of the "hooks" or needles as held the loops it was desired to operate upon, and then removed these loops to the hooks to the right or left hand, which would cause an alteration in the face of the work, and if repeated, produce interstices. The principle to be carried out was simple, but required great skill in its application by Mr. Strutt. An addition was thereby to be made to the machine, breaking in upon its uniform action. It involved the entire control of any loop and consequently over each hook across its face. This principle lies at the bottom of Morris's patents of 1763 and 1781, whereby "eyelet" (œillet) hole-work was produced, as seen in the open work in the ankle and insteps of ladies' hose. Under Crane's patent, 1768, looped nets were made. Else, in 1770, made the "pin" lace machine by further change in this machinery. This principle of control and selection, modified in its application, produced the "knotted," by Horton, 1776; "twilled," "stump," "mesh," and "point," machines, the latter by Lindley, in 1778. Indeed, although Lee's machine was, considering his times and circumstances, an astonishing effort of genius, it was succeeded after the time of Strutt by very extraordinary variations and additions. By some of these, adaptations were made of the stocking-frame to the production of fancy hosiery; by others to make imitations of pillow-lace. Thus in 1769 and 1777, Robert Frost patented machines, in one of which he introduced perforated hollow long squares of wood, and in the other a long solid square of wood having knobs on the surface, working on the principle of a barrel organ upon the loops at pleasure. On this plan the first machine-wrought lace was made by him. Is it possible that Jacquard's grand idea came from knowledge of this important invention? In 1782, the warp-machine was constructed by Tarratt, on the plan of operating upon every thread of a warp, using these warp threads only and looping them one to another, instead of using only one continuous weft thread looped upon itself and without warp threads at all. By the warp-machine either a solid tissue or lace meshes, or a combination of both, may be obtained. It is a curious machine, and is now adapted to make an innumerable variety of articles. Dawson patented his improved warp-frame in 1791. These efforts to modify the machines were made for the most part by working men, with a view to obtain a perfect imitation of twisted pillow lace. They issued at length in the construction by John Heathcoat, in 1809, of the bobbin-net machine, which after many improvements, and the application of the Jacquard apparatus and steam power to both bobbin and warp-net machines, has given to Great Britain the present machine-wrought lace trade, in which a return has been made of nearly 5,000,000*l.* sterling per annum, and to France and Austria very important branches of their manufactures.

But to return to the more direct history of the hosiery trade. It sustained many depressions. These led to "under fashioning," and so-called "spurious" work. About 1776, 300 frames were broken in or near Nottingham on this account. Out of 20,000 English frames in 1782, 17,350 were in the midland counties. Lowered wages caused increase of speed to be obtained; and the machinery was so increased in numbers, that in 1812, Blackner enumerated 29,590; though in the deep distress of 1811 there had been 687 destroyed by Luddism. Wages continued to fall in the hosiery trade, and the value of machinery decreased to less than a third of the cost. About 1834 the pressure on wages was so great that the trades' union, bound by a secret oath, decided on a general turn-out of the three counties. This would have thrown at least 50,000 people out of work. They, however, at the instance of the writer of this paper continued at work, and *gave up the oath*, which it is believed has never been re-imposed.

In 1844, such was the depression and suffering of the people in this trade, that the writer was induced by sympathy with them to take an actual census of the machines in their gauges, widths, materials worked up, and actual wages received after charges for rent, standing, &c., were deducted. 240 parishes were visited in the counties of Nottingham, Leicester, and Derby, and the frames enumerated. To these were added returns from other parts of the three kingdoms. This account has been reprinted in Muggeridge's Reports as Commissioner to inquire into the condition of the hosiery trade, and has been accepted as the basis of later estimates of the trade. It will be used accordingly in the statistics which are given below. In 1844 there were in Leicestershire 6,933 frames using cotton materials; 9,875 woollen; 1,582 mixed; 168 silk; and 2,303 not at work. Total, 20,861. In Derbyshire, 4,380 cotton; 1,454 silk; 171 mixed; and 792 out of work. Total 6,797. In Nottinghamshire, 12,440 cotton; 2,094 silk; 299 mixed; 46 woollen; and 1,503 not at work. Total 16,383. In other parts of England, 1,572.

In Scotland, 2,605. In Ireland, 265. Total stocking looms in the three kingdoms, 48,482. In all former estimates the number of frames not at work had not been taken into account. This will in some measure give the reason for the large apparent, though not real, increase under long-continued bad trade.

The number of persons directly employed by these machines would be when fully at work, about 100,000, one at each, and another winding, seaming, &c., the rest taking work out and in. The wages did not average in 1844 quite 7s. a week for those at the machines throughout the trade, a lower sum than earned by any other staple trade. The hours of work were long, and the labour severe. The returns were calculated to be for silk hosiery, 333,763*l.*; cotton, 998,700*l.*; worsted and mixed, 1,223,750*l.*; flax, 6,500*l.* Total, 2,562,763*l.* Composed of materials, 705,780*l.*; wages, expenses, and profits, 1,856,983*l.* 150,000 lbs. weight of silk; 6,000,000 lbs. of cotton; and 8,000,000 lbs. of worsted and mixed were consumed. Up to the date of that census these frames had been almost entirely worked in dwelling-houses, or collected in small shops only. Since 1844, the demand for hosiery has exceeded the supply; and thus a gradual but most important improvement has taken place throughout the trade. But the years 1861-2 have been exceptional, from the dearth of cotton wool; depriving us also of the United States market, where previously we had a most important outlet for our goods. The hours of labour have been lessened, and the rate of wages has risen from fifty to 100 per cent. since 1844, according to the classes of goods made. By an invention orignated by Mr. Brunel, but improved and made more useful since, a circular head, garnished with hooks at its circumference, is used to produce a looped sack—therefore without a seam. It works with almost incredible speed. One of these will turn off, using eight feeders to deliver the yarn, 350 rounds, or a yard in length, of medium quality per minute of a head twelve inches round; or 150 dozens of women's hose in a week. Several of these heads can be managed by one person. The quantity of yarn used and number of dozens produced are immense. The prices at which they are sold is according to weight, but very low indeed. They are cut into shape by scissors, and are sewn up by hand or by stitching machines. Instead of ruining the trade as was feared, they have proved to be pioneers of the use of stockings in lands where they were previously not known or not worn: and have helped to raise wages through the trade. Women overlooking these "roundabouts" earn 12s. to 20s. a week with ease. The men employed about them gain 20s. to 35s. weekly. There are 1,500 sets (each averaging ten to twelve heads) in the trade, making hose, shirts, drawers, &c. They are worked in factories, and by steam. That is the case also with the "rotaries," which are forty inches and upwards in width, making goods in a straight line from side to side, and producing four, six, or eight hose at once. Of these there are probably 1,500 at work, at which the men get 20s. to 30s. a week wages. Those are making hose principally. The "circulars" and "rotaries" are believed to have increased five per cent. per annum in number for some years.

There are about 800 warp frames making pieces for gloves, &c. The wages are from 16s. to 35s. per week. The number of this class of machines thus employed is about as it was ten years ago. Many hands are employed in finishing hosiery goods; cutters, stitchers, menders, bleachers, pressers, folders, &c. Women earn in some of these operations 16s., and men 25s. to 30s. weekly. In the whole English machine-wrought hosiery trade there are directly and indirectly employed in ordinary times, 120,000 hands. In 1850 there were 1,230 frame-smiths, 600 needle-makers, and 340 sinker-makers. The wide steam rotary machines are costly, and require highly-skilled hands to keep them in order. Yet it is thought not impossible, that gradually the greater part of the English hosiery frames may be brought into factories. Attempts to construct wide rotaries, so as to put in fashion—*i.e.*, to widen or narrow by the machine, and without stopping it for the removal of the loops, have been at length successful. One such machine, patented a few years since, has been improved upon by M. Tailbuis, of Paris, was at work in the International Exhibition of 1862. It is calculated to produce very regular goods in fine qualities, if not driven at too great speed. Another improvement of the same patented machine had been made by Messrs. Hine, Mundella, and Co., of Nottingham. Their machine of 100 inches wide, worked by power, makes while narrowing thirty or forty courses of loops per minute, and when not narrowing, fifty to sixty courses. Fourteen dozen of medium size pantaloons, fashioned by narrowing, have been made upon it in a week. The effect of so large a measure of success may be to diminish the cost of many fashioned articles; and so, by enlarging demand for them, cause "rotaries" capable of giving fashion perfectly, combined with regularity of loops and due elasticity, to be more and more sought after.

It may be here stated, in dismissing the subject of inventions, that the justly celebrated mechanican, Mr. Josh. Whitworth, amidst his other inventions, constructed a very ingenious circular knitting machine. This is the only one put together on different principles to that of Lee. Though many years at work, it has not come into general use.

Much of the cotton yarn used in making English hosiery, is supplied from Staleybridge, Ashton, and Bolton. The amount consumed is so large as to have contributed much to the business of that district. Any difficulty in obtaining a supply at reasonable prices, is of serious moment to the hosiery trade. The consumption of animal wool has also increased in this business. Silk has remained stationary for some time.

Narrow-hand frames have not been fully employed of late. Probably twenty-five per cent. have not been at work for some time. They are not generally rendered unavailable if required by the wants of the trade. The amount of the consumption of materials, and the returns have been very largely increased by the greater number and speed of the power machinery employed. The entire returns of the trade of this country in hosiery, which in the reports of the Exhibition of 1851 were stated to be 3,600,000*l.*, amounted in the last average year 1860 to 6,480,000*l.*, consisting of materials, 2,630,000*l.*, and wages, finishing expenses, and profits, 3,850,000*l.* This great increase has been in the lower and medium classes of goods. The trade in shirts and drawers has progressed with surprising rapidity. In many of these things the materials constitute from five-eighths to three-fourths of the entire cost.

How much of this return is consumed at home, and what may have been our exports, it is hard to say. The Custom-house returns of exports, whether of hosiery or lace, are so much below the mark as to be useless. The export of hosiery from this country has certainly increased considerably to most parts of the world since 1851. The most steadily enlarging markets have been our colonies of India, Australia, Canada, and the Cape of Good Hope. The demand for our hosiery under the French treaty has fallen far short of general expectation. The duties and expenses are too heavy to admit of competition in France, with French manufacturers.

Were the whole of our actual production consumed at home, it would only be 4s. a year for each individual of the population. If cotton and animal wool be regularly obtained, in sufficient quantities and at moderate prices, this entire trade may double itself in the next ten years, as it has done in the last.

It is gratifying to observe the advance made in the physical condition of the work-people in this trade. The worn and anxious countenances by which these men were during the first half of this century easily distinguishable, are only seen among the relics of the past generation of stocking-makers. They now know their rights ; but, contrary to the practice of former evil times, employ only peaceful means to obtain them. Of late, disputes have not often occurred, and have been in most cases settled by joint arbitration of the masters and the men. During the commercial crisis through which this business has been passing in the last year, (1862), tranquility and good feeling have prevailed, though the privations have in many cases been severe. These are hopeful signs of future profit and satisfaction both to employers and employed, as well as to the communities dependent on their operations. With our brother manufacturers abroad we trust our rivalry will always be amicable, and even mutually advantageous, increasing the usefulness and excellence of the articles produced by each, and issuing in enlarged demand from us all for labour, and securing fair profits from its employment.

Gloves.—The manufacture of gloves is principally carried on in the towns of Worcester, London, Yeovil, and Milborne Port. In Woodstock and Witney the gloves made are what are known as beaver—viz., of buck and doe leather for military and hunting purposes. In Hexham and Nantwich a trade still lingers for tanned gloves, known by these names, and in Leicester and Nottingham for cotton and cashmere gloves. In the old gloving towns of Ludlow, Leominster, and Derby, the trade is quite extinct.

The introduction of foreign kid gloves many years ago stimulated to improvement the principal manufacturers, who, by studying the proper fit and good wearing qualities of their gloves, have maintained their position in the face of competition; but now that all gloves are admitted entirely free, many small makers have given up.

The number of hands employed is very considerable, particularly of women in rural districts, occupied in the sewing, who have the great advantage of working at home; and in the intervals of domestic duties are enabled to earn four or five shillings per week, as an addition to the family income.

In recent years a large and increasing trade has arisen in gloves cut from cloth of woollen thread or silk, made specially elastic for this purpose in the towns of Nottingham, Trowbridge, and Norwich. The manufacture of gloves not having extended to our Colonies, this article forms an item in our list of exports both to the Colonies and America.

The export to France under the recent treaty has not had time for development, and is affected by the large quantities of kid gloves made there by many makers of excellence who compete very closely together.

A demand is springing up for what are called "dogskin gloves," an English speciality.

Cotton-gloves, made in Saxony, being produced at very low prices, owing to the cheap supply of labour, are becoming a considerable item of import, affecting the trade in Leicester and Nottingham.

Belgium has only been a producer of gloves within about twenty years, and was previously dependent on France for them. The manufacture has been largely developed at Brussels, which ranks high for exportation. As the glovers also dress their leather, they are enabled to produce them cheaper in consequence.—*Report of Jurors.*

STAINED GLASS AND GLASS USED FOR DECORATION.

BY APSLEY PELLATT.

The adoption of painted windows* was concurrent with the improve-

* "The terms 'Painted Glass,' and 'Stained Glass,' are commonly used as if they were synonymous. I have, however, adopted the former, from a belief, that although not strictly correct, it is, on the whole, a more correct expression than the latter. For a glass painting may be entirely formed of painted glass, that is, painted with an enamel colour, but it would be impossible to execute a glass painting merely by staining the glass. Most glass paintings are formed by combining the two processes of enamelling and staining, &c."—'An Inquiry into the Ancient Glass Painting,' &c., by Charles Winston, Esq. J. H. Parker, Oxford.

ment in architecture and especially in the introduction of the early English and Gothic, which succeeded the Saxon and the Norman.

From the 12th to the 13th centuries, the large expenditure in England and on the Continent on cathedrals, churches, and religious houses, induced a demand for decorated glass windows, and the early archaic style was then generally introduced into windows, which were not only beautiful in themselves, but conferred a beauty upon the interior architectural decorations of these ecclesiastical buildings.

At this period, and for centuries subsequently, the archaic style was adopted; it consisted of a perfect mosaic of rosettes, flowers, leaves, and other designs. The borders consisted of small pieces of variously coloured glass, secured by lead to the iron framework of the windows, in conformity with the outline of the design. In the centre, secured in a similar manner, were the medallions of a single or group of figures. The borders were usually harmonious and pleasing, the drawing of the figures were often grotesque, and in some cases almost amounting to caricature. The leading of the glass, being arranged to follow the outlines of the pattern, appears hard when viewed in close proximity; but, like the severe outlines of Raffaelesque subjects on china, when viewed at a proper distance this harshness nearly or wholly disappears. Many patrons still adhere to this severe archaic style, while others, in keeping with the taste of the present time, admit a modification of more correct outlines of the figures. A good specimen of the coloured mosaic treatment, with its borders of a flowery kind, the lesser spandrils being fitted with a flowing ornament of various colours upon a red ground, is to be found in the circular window of the north transept of Lincoln Cathedral as recently restored by Messrs. Ward and Hughes. The lower lights are in contrast with those above, on the gray or grisaille mosaic treatment, the chief parts of the white glass being shaded or worked with brown or black lines of enamel colours, intersected with small portions of coloured mosaics, the gray chiefly predominating.

The manufacture of coloured glass in small effigies, opaque mosaics, and vessels, dates as far back as the Egyptians, Phœnicians, Romans, &c. Its introduction for windows in the style termed archaic was during the 12th century. The art was considered not merely as decorative, but as a pictorial representation of Scripture history, aiding Christian teaching. The repose and solemn subdued effect of light passing through the varied coloured glass contributed to the character of the subject sought to be impressed upon the mind. The first or archaic style commenced at the latter end of the 12th and the beginning of the 13th century. Examples are to be found at St. Denis and Bruges, and in Canterbury, Lincoln, and Salisbury Cathedrals. The second or decorated style was introduced about the end of the 13th century. Good examples may be seen at Strasburg and Gloucester (recently re-leaded by Messrs. Ward and Hughes). The third or perpendicular style, from 1380 to 1430. Another style, the cinque-cento, dates from 1500 to 1550, examples of which are chiefly to be found on the Continent—viz., at Brussels, Liége, &c. The examples of the perpendicular being at Cologne, Winchester, York, and at St. Margaret's, Westminster.

In the early English, such as the north transept of Lincoln Cathedral, the figures are less grotesque than in most other examples of that date The figures were generally placed in medallions, canopies having not then been introduced. The next period, the decorative, is marked by an extensive use of canopies ; the drapery was more flowing and graceful, especially in the coloured mosaic and grisaille borders. About this period the yellow stain was introduced, which pleasing colour softened the white used in the earlier styles, and had a good effect when stained in portions, the cased red or blue being taken out to receive the yellow. The third, or perpendicular style, is marked by its being more soft and silvery, and also more delicate and refined than the preceding, having no rounded or projecting cornices. The cinque-cento style is of Italian origin, and more picturesque, being evidently influenced by the progression of oil painting. All these styles obeyed the spirit of their times, glass-painting agreeing with the state of the arts of each period, and in harmony with the architecture and the taste of its various epochs.

The principal difference between ancient and modern glass windows arises from the latter being brighter and of a higher key than the ancient, while it has less tone and richness, which, like the paintings of Titian and the old masters, may be viewed for any length of time without fatigue to the eye. Continental glass being thinner and of a higher key than the English, a fictitious surface and tone is obtained by enamel painting, which takes off the lurid glare, but deadens and too much lowers the tone ; this ineffective imitation is easily detected. Modern windows of inferior materials, being charged with bright colour at a higher key, transmit too readily through the glass bright rays of different colours antagonistic to each other, which fatigue the eye and form an unpleasant contrast to ancient glass, or to that which has been recently made on the same principle, and which for want of a better term we shall call antique.

Although homogeneous flint glass is so essential for chandeliers and household use, and especially for optical purposes, the reverse is required for coloured window glass, technically called pot metal, to imitate that of the thirteenth century. Every colour of the spectrum, viz., violet, indigo blue, green, yellow, and red, are produced in glass by the use of the oxides of the following metals—viz., gold, silver, chromium, tin, copper, iron, manganese, cobalt, antimony, nickel, and uranium ; carbon also produces yellow for pictorial purposes. Window glass, although almost indestructible by time, whether coloured or of a greenish white, when long exposed to the action of the atmosphere, is liable to partial surface decomposition, and if not too much decomposed, prevents advantageously the too free passage of the rays of light through it : old glass thus affected softens and blends the pictorial effect, and the colours remain sufficiently vivid and brilliant without fatiguing the eye. Modern amateurs and glass-painters have had their attention drawn to the fact, that the agreeable blending and harmonising effect of ancient glass, although occasionally due to surface decomposition, owes its chief charm to the retention of the striæ and small bubbles in the body of the glass. The constituents of such glass have been perfectly vitrified, and the colours fully developed, but being less transparent than when thoroughly fined (like the ordinary clear coloured glass) becomes less dazzling and more subdued. To succeed in making striated and bubbly-coloured glass, having a horny or gelatinous appearance similar to the ancient, the fining process must be arrested during the latter part of the fusion, by reducing the heat of the metal to a sufficient consistency for working, before the bubbles and striæ are fully driven off: great attention is necessary on the part of the manufacturer to reduce the temperature of the furnace just at the right time to prevent the metal becoming too clear. This imitation of the ancients constitutes the chief improvement since 1851, as regards the vitrified material.

Although these gelatinous striæ and bubbles are quite apparent on close inspection, they disappear when seen from a proper distance, a portion of the light becoming absorbed, but retaining the full richness of the colours. Pot-metal blues, greens, and rubies, &c., by this system of embodying in the mass the hindrances to the too free passage of the light, are far superior in effect to those of the ordinary, cheap, modern, clear, bright-coloured glass. No person of taste should require the latter which will fail to produce what is termed the peculiar "dim religious light" of the ancients, resembling the reposing colours of the spectrum.

Blue is often used as a background to groups or single figures, as well as to the drapery and borders, and may therefore be considered the prevailing colour; and after this are ruby and green, all pot-metal colours.

About the year 1850, Messrs. Powell and Son commenced manufacturing antique glass, of white and various pot-metal colours, a considerable portion of which, especially the blue and ruby, was equal to the best specimens of ancient glass of the thirteenth century. This was selected by Messrs. Ward and Hughes for the four windows painted by them, and erected in the Temple Church, London, about the years 1853 and 1854.

Messrs. Hartley, of Sunderland, and Messrs. Lloyd and Summerfield, of Birmingham, have also produced antique glass. This glass is striated, bubbly, and gelatinous, and sometimes the ruby is streaky. Pieces of dark and light ruby are occasionally leaded separately, and placed side by side, to give the effect of shading without the use of enamel colour. A national debt of gratitude is due to Charles Winston, Esq., author of a work on 'Ancient Glass Printing,' in two volumes, for his long, persevering, and successful efforts to revive the rich colours and low tone of ancient glass, the best specimens of which are to be seen in the four windows of the Temple Church, painted at his suggestion and under his superintendence. If the colours in these windows equal the best of the ancient, of which there is little doubt, it is owing to the various specimens he caused to be analyzed, and the synthetic experiments he made, which enabled him to reproduce the glass, and furnish recipes gratuitously to the glass maker.

Foreign manufacturers have no doubt availed themselves ere this of Mr. Winston's liberality, and as wood fuel and open pots succeed best for glass dependent upon carbon as a colouring constituent, no doubt they will ere long rival our productions of antique glass for windows.

Messrs. Clayton and Bell, in their artistic treatment of the severe early archaic style ; Messrs. Ward and Hughes, in their window for St. Anne's Church, Westminster, of the style of the 13th century, the figures of which are treated in keeping with modern taste, similar to those in the Temple Church ; Messrs. Powell and Son, in a window wholly of antique glass, of their own manufacture ; likewise Messrs. Lavers and Barraud, Heaton, Preedy, and other artists, have availed themselves of English antique glass, much of which rivals the ancient in rich colour and low tone, and has a crispness and shellac appearance, so well calculated to absorb the rays, and retain the richness and beauty of the ancient colours.

While, therefore, most of our continental neighbours exhibit windows of inferior material, fully equal or superior in artistic merit to their painted windows of 1851, the English, availing themselves of the superiority of the antique glass, excelled their exhibits of 1851. The Exhibition of 1862 may be considered so far as a triumph over that of 1851 ; the artistic progress has, however, been less than might have been anticipated.

"The various attempts which have been made to imitate the richness and depth of the ancient material, by coating the glass with enamel paint, have produced no other effect than that of depriving it of its brilliancy, and, consequently, the glass paintings in which this expedient has been resorted to, of one of their chief distinguishing merits.

"In all the glass paintings of earlier date than the last quarter of the 14th century, until which period the glass was not over clear, substantial in appearance, or intense in colour, the artists seem to have relied for effect principally on the richness and depth of the colouring. In these works the means of representation may be said to have been reduced almost to the lowest degree.

"We are strongly impressed that the difference of effect between such ancient and modern glass does not depend on the state of the surface, but on the composition of the material, and this result has been strengthened by the result of some experiments recently made, by which the very great difference in the composition of modern glass of the 13th century is clearly demonstrated."

The cheaper sorts of white and coloured glass, as alluded to in the foregoing extract, from the Report of the Commissioners of 1851, counterfeit the ancient glass, by coats of enamel colour, which only produces a misty and cloudy effect, merely blinding or shutting out a portion of light; but it cannot give the depth and richness of ancient colours. If varnish colour be used for such a purpose it will only serve a temporary object, and even if the enamel colours be burnt in, they are not always to be depended on, being liable to crack off by long exposure to the action of the atmosphere.

Bertini and others obscure a portion of the back by roughing, or by a layer of white or neutral colour, so that little or no light may pass through the main figure of the subject, which rather resembles fresco than transparency. The latter is generally considered to be one of the essential conditions of glass painting.

Brown enamel colours, more or less dense, are used for stippling and shading white or coloured pot-metal, but if too thickly laid on at one time will be liable to crack off in a few years; several coats and frequent firing are necessary to produce permanency in the various dark shades. Examples of coloured enamel painting, by Backler, may be seen at Arundel Castle, the seat of the Duke of Norfolk. They are wholly enamel, and have no pot-metal colours; similar also are several glass paintings designed by West, and painted by Jervis, in the Royal Chapel at Windsor. These may be considered as simply semi-transparent pictures, wholly out of the category of what is generally known as stained or painted glass, by mosaic or grisaille treatment for ecclesiastical purposes.

Referring to former explanations on the striated gelatinous colours, called antique, used since 1851, as they were then shadowed out by Mr. Winston, and since produced by him and adopted by many of our English artists, but as yet feebly followed by continental painters, it is somewhat remarkable, that while clearness of metal constitutes the greatest improvement in flint glass, the reverse should be the case for window glass: in fact, that while homogeneity should be the essential property of flint glass, impurity is equally necessary for the successful imitation of the ancient glass, in attaining the same depth of colouring, and the absorption of the rays to be found in the coloured glass of the 13th century: it, therefore, seems anomalous that the inferior fuel, for melting the materials, also that the metals, sands, and alkali possessed by the ancients, which was less pure than those used by the moderns, should have furnished greenish white, and pot-metal coloured glass, so exactly suited to produce the best effects for pictorial windows.

Resuming our remarks upon enamel painting, there was the brown painted smear, and stipple shading, also a darker enamel for lines and shadows by hatching, or repetition of lines, serving as shadow upon white or pot-metal colours. There are several methods of shading, some being smooth, employed in early examples, and the latter being darker, employed in the later grisaille of larger works.

It may be asked, does the grotesque style of the past age harmonise with our present mode of thought? How far does the recent Exhibition, considering the present advanced state of the fine arts, meet the requirements of the 19th century? We reply, it is the contrast between 1851 and 1862 that affirms the fact, that in most of the English exhibitors, and several of the foreign, the art of glass painting has advanced with the times both in style and artistic execution. It is, however, much to be regretted, that few of the windows can fairly be seen to advantage, owing to too much interior light, and the exterior borrowed lights of the Exhibition building being so inferior.

Continental glass artists generally adhered to the early grotesque style in imitation of the past age: and in that respect in 1851 were superior to the English; and with the exception of the beautiful windows painted by Bertini and his school, that style is still retained.

Bertini's windows in 1851 and 1862, may be classed in the mixed style of the old Mosaic, and the enamelled style of the 19th century. The excellence in design and execution of the former was generally admitted, although insufficient transparency was occasioned by the too great opacity of the principal central figure. The Madonna and Child of Bertini, of 1862, may be considered as one of the gems of this Exhibition.

The art of glass painting should have a special mode of treatment, impressed upon it by the nature of the material, as oil for canvas, and fresco for ceilings and walls. Glass being the medium through which the light passes, transparency must be its condition; different degrees of transparency are admissable, but when a large portion of the glass is so opaque as almost wholly to preclude the transmission of the rays, an essential condition is infringed.

The style of the 16th century, or earlier periods, modified by the taste and feeling of the 19th century, should be supported by our designers and glass painters. With good original designs, improved antique glass, judiciously leaded, with a proper degree of transparency, first rate drawing, good shadows, and well arranged colours, forming as a whole, a work of art, rich, harmonious, and impressive, patrons will not be wanting for the decoration of our ecclesiastical or domestic buildings.

No doubt artists are influenced considerably by their patrons, each of whom may have his settled convictions as to style, &c. We should, however, endeavour to preserve the beauties, and avoid the defects of the drawing of the earlier ages; but no reason exists, that, as pottery, carving, statuary, and the fine arts have generally advanced, why glass painting should be impeded, or restricted in its progress towards the perfection of the art.

(To be continued.)

THE TECHNOLOGIST.

EXPLOSIBILITY OF COAL OILS.

BY T. ALLEN.

So recent has been the introduction of coal oil into general use for burning in lamps, that few persons have as yet had satisfactory opportunities of obtaining a knowledge either of its peculiar properties or of the peculiar processes lately invented for extracting oil from coal in quantities sufficient to constitute a new and important article of commerce.

Some of the qualities of coal oil sold in the market having proved dangerously explosive, the directors of fire insurance companies have become alarmed, and have increased the rates of fire insurance on property where such oil is stored or burnt in lamps, deeming it to be extra hazardous, like camphine and "burning fluid." But a manifest difference being discoverable in the inflammability of the oils supplied from different establishments, it is evident that some mode of distinguishing the safe from the unsafe oils has finally become indispensable for the security of the insurers as well as for the satisfaction of the insured. Accordingly, in compliance with a request of the board of directors of the Rhode Island Mutual Fire Insurance Company, the following investigations have been made to determine, by practical experiments, the comparative explosibility of coal oils, and the consequent probable danger of the use of them in lamps for lighting manufactories and dwellings.

Several of the experiments may appear to be very simple; but as they serve to exhibit instructive facts for popular information, they are none the less valuable for dispelling unfounded fears of danger, and for inducing due caution where there may exist causes for alarm.

All the liquid products of the distillation of coal are popularly considered as "coal oils;" but there is an extraordinary difference in their volatility and inflammability, from the explosive flash of volatile spirits, resembling ether and alcohol, to the dull heavy blaze of a smoking tar. The several peculiar qualities of the products of the distillation of bituminous coal will be most readily learned from a description of the processes practically adopted by the distillers for obtaining them.

The process of making common coal gas by the distillation of bituminous coal in red-hot iron retorts or ovens, set over furnaces, is well known; but it may not be generally known that before the iron retorts become heated red-hot, a tarry liquid or oil first comes over into the main gas-pipes, and is collected in a separate cistern. This dark liquid has an exceedingly strong and disagreeable odour, and the only use of it at first was that of making coal tar. A nearly similar tarry oil had previously been discovered in ancient times flowing naturally out of crevices of rocks on the surface of the earth like springs of water. This peculiar tarry oil received the name of "petroleum," from the original Greek words signifying "rock oil," as being descriptive of the source from whence this extraordinary liquid was first obtained.

The natural petroleum so nearly resembles the artificial tarry oil obtained by the distillation of bituminous coal, as above described, that the same name will be applied to designate both of these products, as being alike the results of the distillation of the same material. The question is often asked, Whence is this petroleum produced?

The region of our country where the oil-springs are found gushing forth on the surface of the earth is near the frontier line dividing the anthracite coal-fields of the seaboard of the United States and the bituminous coal-field of the great valley of the Mississippi. In this intermediate region are vast beds of bituminous coal, originally composed of the woody fibres of peat and other vegetable bodies, organised by the action of sunshine on the surface of the earth, and then covered over securely from accidental combustion. The coal is, however, exposed to a heat in the depths of the earth, which is increased regularly 1 deg. from fifty to seventy feet of descent, the temperature at 200 feet depth having been found to be 85 deg. in an English coal mine. The decomposition of the coal at great depths is constantly going on, and the coal gas is often heard in the galleries of coal mines rushing in hissing streams through crevices, and forming the explosive "fire-damp," which renders the safety-lamp of Sir Humphrey Davy a blessing for the preservation of the miners.

One of the deserted coal mines near Newcastle, having a 4-inch pipe connected with its chambers, has continued to distil sufficient coal gas to form a jet of flame from its open aperture on the surface of the ground "nearly sufficient to light a small town," as a recent writer has stated. From the end of a similar pipe, inserted in a drill-hole in the rocky strata on the banks of the Kanawha river, in Western Virginia, perforated to the depth of about 1,000 feet to obtain salt water, sufficient coal gas to light a city has continued for several years to rush forth, commingled with the salt water. The gas is used as fuel to boil the salt water for the production of salt. In a furnace beneath a salt pan, 100 feet long and five feet in width, the writer beheld the flame of burning coal gas, sweeping throughout in one continuous sheet, waving and flashing in wreaths of resplendent brilliancy, whilst at the same time a steam-engine was operated briskly by the same natural flow from the earth into an adjacent furnace beneath a steam-boiler. Sufficient coal gas was here discharged to evaporate the brine for making about 400 bushels of salt per day. Happening to arrive at a spot where another similar drill-hole had just been completed, an equal volume of coal gas and salt water appeared jetting upwards from the drill-hole in the rock thirty or forty feet into the air, with loud belching sounds resembling the asthmatic pantings of a powerful locomotive engine. The coal gas here naturally elaborated, was perfectly pure and free from the disagreeable odour which characterises the coal gas artificially elaborated in city gas-works.

The petroleum being separable by distillation from the coal at a more moderate temperature than coal gas, there is reason to believe from analogy that the same process of elaboration of petroleum goes on naturally beneath the earth as is artificially accomplished on its surface. The fact of the increased heat of the interior of the earth, in the vicinity of both the gas-springs and oil-springs in the valleys of the Alleghany mountains is manifested in the numerous "hot-springs," which gush forth unceasingly between the adjacent mountains in Western Virginia, together with numerous "sulphur springs." Indeed, this distillation of the carburetted hydrogen gas and oil from the bituminous coal, under intense pressure at great depths in the earth, constitutes a natural process of coking, whereby the flaming bituminous coal becomes gradually converted into anthracite or flameless coal.

The constantly decreasing supply of whale oil, and correspondingly increasing price of it, has recently stimulated industrial enterprises to seek out other sources of supply of this necessary article. The long-neglected oil-springs freely offered in tiny streams naturally flowing from the earth, have at last attracted attention. Impatient, however, of the stinted supply thus freely offered without labour, even some of the same resolute men who have pursued the whales among the icebergs of the polar seas and to the remotest waters of the globe, have laid down their harpoons and taken up steel drills to tap the very fountains of coal oil, in the hidden depths of the earth, in the western valleys of Pennsylvania.

The results of some of the attempts to obtain a more abundant supply of coal oil, or petroleum, have proved so successful as to appear marvellous and incredible. From one of these recent drill-holes, termed "oil-wells," the petroleum gushed up with such violent force as to discharge the stream high in the air, and the flow continued so abundant that it reached the furnace of the steam-engine used for working the drill-rods. Becoming thus kindled, a vast flame lighted up the surrounding country at night. Before the conflagration could be extinguished many hundreds of barrels of petroleum flowed in a blazing flood into the adjacent rivers. In another instance, the reservoirs of petroleum being tapped by the drills earlier than anticipated and before a supply of empty casks was provided, the gushing stream was turned into a ravine and there collected by a dam to preserve it for use. Over considerable extents of valleys an abundance of petroleum has been thus obtained from reservoirs, in which it has been gradually accumulating from the natural process of distillation of bituminous coals in the depths of the earth. The ample supply of petroleum available from these sources has quite recently reduced the price of it to about fifty cents per barrel, and has nearly superseded recourse to the artificial distillation of bituminous coal. This unexpected gift to the children of men may well excite their wonder and their admiration of the provident care in anticipating human wants thus manifested by a bountiful Creator.

Both the artificial and natural petroleum in the crude state of a tarry oil are found unfit to be burnt in lamps. After numerous attempts to refine the crude petroleum by a second process of distillation, three remarkably different products were separately obtained. Each one of these three substances having a different evaporative or boiling point, like water and alcohol, they are readily separable during one continued process of distillation, by gradually increasing the heat beneath the still.

The first product that comes over from the condenser is the volatile spirits resembling ether and alcohol, called naphtha, benzole, benzine, &c., which boil at a lower temperature than alcohol (about 150 deg. to 160 deg. Fahrenheit). Naphtha evaporates as rapidly as ether, producing similar lethean effects on breathing the vapour, and even exceeds ether and alcohol in inflammability.

It appears to be the common practice of the distillers of petroleum, or coal tar, to keep the heat beneath the stills very low until this naphtha has time to become evaporated at its boiling point of 160 deg., and to flow, from the condenser in a crystalline stream into a cistern arranged to receive it. When, by the test of a hydrometer, its specific gravity is found to become increased to a certain degree by containing some of the heavier coal oil, the stream from the condenser is diverted into another cistern designed for receiving the second product of the distillation, being a heavier coal oil, commonly known as "kerosene."

The exact point where the naphtha becomes exhausted and the kerosene begins to flow, is a nice question to be decided upon by the distiller. The extreme inflammability of the naphtha renders it unsafe for burning in lamps ; and it cannot be advantageously reduced to vapour to be mized with coal gas, because it does not form a permanent gas ; for the vapour, like that of alcohol, becomes condensed to a liquid whenever it is cooled, as occurs on its passage through cold iron gas-pipes under ground. The only available use of naphtha is for dissolving India-rubber, and for mixing with painters' oil as a substitute for spirits of turpentine. For these reasons naphtha is nearly worthless for sale in the market; and as it constitutes ten or fifteen per cent. of the petroleum used for distillation, there is a strong temptation to the distillers to divert the current of naphtha into the kerosene oil-cistern to gratify the cupidity of purchasers by thus affording the oil at a low price. Thus both sellers and buyers are alike tempted to disregard the danger resulting from mixing the naphtha with the kerosene oil.

To gratify purchasers of coal oil by an extraordinary low price, it has been stated that dealers have contracted for the waste naphtha and residuary heavy coal or tar for preparing a mixture of about the same specific gravity as kerosene oil, and resembling it in appearance. The hydrometer is not, therefore, available for detecting this spurious article, and there remains no other mode of ascertaining its dangerous character than by actually testing its inflammability experimentally by the degree of heat indicated by a thermometer, at which it will become kindled by the application of a lighted match, and begin to exhibit a lambent flame flickering over its surface, as over that of blazing alcohol. If the sample of oil contains much naphtha, it will be found capable of emitting sufficient gaseous vapour to take fire at the ordinary temperature of the air on plunging a burning match in a cup of the oil. Other samples will require to be heated at 90 deg., and even to 160 deg., before they can be similarly kindled. There is all this difference in the inflammability of the article sold in the market for coal oil. Judging of all the qualities of coal oils by some few cases of the explosive inflammability of the lowest grade in the market, they have all been subjected alike to doubts and suspicions. As the coal oils offered for sale by establishments of known respectability are really most valuable and economical substitutes for whale oil for purposes of illuminations, it is unwise, as well as unprofitable, to embrace them all in one sweeping clause of condemnation without experimental examinations to determine the facts in relation to this novel subject of inquiry.

The presence of naphtha in kerosene oil essentially contributes to the brilliancy of the light for illumination, whilst at the same time it improves the combustibility of the oil by a less tendency to emit smoke. It is, therefore, for the interest of the consumer of coal oil to retain as much of this light volatile spirits as can be safely used ; for it really seems like throwing away bread to reject so valuable an element of human comfort and enjoyment available as a source of light and warmth. The present waste of this material, which is now suffered to take place from fear of its wonderful combustibility, will probably be obviated ere long by new artificial chemical combinations, as ether has been reduced to alcohol and wood sawdust to a kind of sugar, so that its violent explosive tendency may be thus subdued to a more safe and manageable condition for general use in lamps.

It has, therefore, now become an exceedingly important and interesting question for insurers as well as for the insured, having property exposed to risks of fire from burning kerosene oil in lamps, to investigate carefully and judiciously the real extent of the danger and hazards resulting from this use of it for illumination, so as not needlessly to restrict the general enjoyment of this economical and valuable substitute for whale oil, and even coal gas. This investigation has become the more important as the source of supply of coal oil appears to be limited only by the supply of the vast beds of bituminous coal stored up in reserve in the depths of the earth for future generations of mankind.

To ascertain the comparative qualities of the kerosene oil made in different parts of this country, samples were procured and tested by the simple process of pouring some of each kind of oil into a cup by itself, and by placing them all afloat together in a basin of water heated by a spirit lamp, and with a thermometer immersed in the water to indicate the temperature while gradually rising from 60 deg., to 212 deg. During the progress of the increase of temperature, blazing matches were passed over the surface of the oil in each cup successively at short intervals of time, until the increased heat caused sufficient gaseous vapours to arise from each to take fire; which they all finally did, at degrees of temperature varying from 80 deg. to 162 deg., exhibiting faint flames quivering over the surface of the oil, precisely like those hovering over the surface of spirits of wine or alcohol when similarly kindled. The flames were quite as readily extinguished by a blast of the breath, and not the least symptom of any explosive character became manifest when each one took fire. Until the evaporative point of each sample of oil was produced by the increase of heat applied, and until lambent flames were kindled, burning matches were extinguished when plunged into the coal oil, as effectually as if they had been similarly plunged into water. The average heat at which all the samples emitted sufficient vapour to admit of being kindled was about 125 deg. of Fahrenheit's scale.

After ascertaining the temperature requisite to kindle the several samples of coal oil, it next becomes an interesting subject of investigation to ascertain the heat to which coal oil is ordinarily elevated whilst burning in lamps. The results of actual experiments showed that in glass lamps the temperature is increased about 6 deg., and in metallic lamps but 10 deg. or 12 deg., above that of the apartment; which, being 67 deg., produced a heat in the oil of about 71 deg. to 79 deg., leaving a considerable range of temperature below the average of 125 deg., above stated.

Finding by actual observation that only the gaseous vapours arising from the heated oil exhibit the phenomenon of flame whilst ascending, and combining chemically with the oxygen of the air, it became manifest that no explosive action could be anticipated to take place from any kind of oil or inflammable spirits, unless these gaseous vapours were first evolved by a previous increase of temperature, and then brought into contact with the atmospheric air before applying a match thereto. There being no room left for either the gaseous vapour of the oil or for atmospheric air to combine therewith, in the chamber of any lamp entirely filled with oil, every attempt to produce explosive action with a full lamp, at all temperatures up to the boiling point of water, utterly failed when lighted matches were applied to the open orifice of the lamp. The only result produced by increasing the heat of the coal oil was an increase of the evaporation of the gas, and a higher jet of flame steadily rising, as from the jet of a gas-burner. So long as lamps are kept full of oil, or even of explosive camphine and "burning fluid," there can be no explosive action whatever. For this special reason it may be adopted as a safe rule to cause all lamps containing highly inflammable liquids to be kept as full as practicable by being daily replenished.

As nearly all the published accounts of the explosions of camphine lamps, and of the consequent dangerous and frequently fatal consequences that have ensued, represent the occurrences to take place during the process of filling them whilst empty, the chamber of the lamp or of the feeder being then occupied by gaseous vapour commingled with atmospheric air, an experiment was made with a glass factory lamp under similar circumstances, as being favourable for exhibiting the most violent explosive action producible by means of coal oil. Accordingly a lighted match was plunged into the orifice of a burning lamp containing a little kerosene oil of the ordinary temperature, without producing any perceptible explosive effect. In this state it was also filled safely. To test the effect of increasing the heat of the coal oil higher than 80 deg., the lamp, whilst still burning, was placed in a basin of water, the temperature of which was gradually raised to the boiling point. During the progressive increase of temperature burning matches were continually inserted into the orifice of the lamp without perceptible effect in kindling vapour, until the heat became increased to nearly the temperature at which the oil had been found susceptible of being kindled in an open cup. The only mode of producing a slight explosive puff on inserting a burning match, was by violently skaking the lamp to increase the evaporation and mix the gaseous vapour more thoroughly with the atmospheric air. But when the temperature of the coal oil became further increased to about 160 deg., the rising gaseous vapour entirely filled the chamber of the lamp and expelled the atmospheric air so completely as to cause lighted matches to be extinguished within the chamber, whilst the ascending gas continued to blaze with a slight flame above the open orifice. Indeed with the sample of oil which did not emit sufficient gaseous vapour to become kindled at a temperature below 125 deg., it required dexterous manipulation to so apportion the gaseous vapour and the atmospheric air as to exhibit the faintest action of an explosive character.

Continuing the experiment with the kerosene at a still higher temperature than 212 deg., by pouring it into an iron ladle over a hot fire, the gaseous vapour arose therefrom still more rapidly, until it became a visible smoke ascending regularly in a column from the ladle even whilst heated red-hot, without becoming kindled into flame until a lighted taper was brought into contact with it ; then the gaseous vapours became resolved into a bright column of steady flame without any evidence of an explosive tendency.

Whale oil, tallow, rosin, and pine sawdust were similarly exposed in the same heated ladle with precisely similar results, showing that the kerosene was no more explosive than either of these substances, and that they all alike became decomposed at a high temperature, into their constituent elements of carbon and hydrogen, or carburetted hydrogen gas. One measure of this inflammable gas is found to form a new chemical combination with about three measures of atmospheric air when kindled, and to exhibit the phenomenon of an elongated flame whilst the combination is taking place between the ascending particles of the surface of the gas and the particles of air in immediate contact therewith. This result is manifested in the form of the flame of a lamp or gas-burner. But if one measure of carburetted hydrogen be thoroughly mixed with four or five of atmospheric air, so that the particles be all brought into intimate contact with each other, then the combination takes place simultaneously throughout, producing the sudden and violent expansive action denominated an "explosion." In order, therefore, to produce an explosion of a lamp or of any other vessel, it is only necessary to mix the gases of decomposed oil, coal, or wood with this combining portion of atmospheric air, and then to apply a lighted match to the mixture.

Dangerous explosions are thus often produced in common stoves on suddenly decomposing the wood, shavings, or paper used therein for kindling, by throwing red hot coals upon them. The carburetted hydrogen, rising in the form of a dense smoke, becomes commingled with the atmospheric air occupying the chamber of the stove, and on being kindled the whole simultaneously flashes into flame. In "air-tight stoves" these explosions have often proved destructively violent to persons and property.

Thus there may ensue dangerous explosions even in lighting a fire in a stove ; and most fearful explosions have often taken place in apartments of dwelling-houses, when about one-fifth part of the space therein becomes occupied by coal gas escaping from leakages of gas-pipes. The difference in the extent of the violence in such cases is simply due to the greatly increased quantity of the explosive gas accumulated in large rooms, as compared with the diminutive chambers of common lamps. The extent of the danger to both life and property is thus correspondingly magnified. Even adjacent buildings have thus been damaged and many lives destroyed by such explosions of coal gas.

There is, therefore, the same danger of explosions in the use of coal gas in houses as in the use of coal oil in lamps where ordinary care and caution are not exercised. Were about five parts of atmospheric air mixed in a city gas-works with one part of the coal gas, and thus distributed for use, the jet of gas kindled at a burner would communicate the flame to the interior of all the main pipes and gas-holders, and a general simultaneous explosion of all would ensue. The same parallel has been applied to excluding atmospheric air from the chambers of kerosene oil lamps by keeping them filled with oil.

To compare practically the violence of the explosion of common coal gas with that of the inflammable kerosene coal gas and of naphtha, a small tin vessel of the capacity of a factory lamp was made for the experiments; the results of which showed that the coal gas was the most readily explosible, the extent of the explosion, however, being only a slight puff from the orifice of the tin vessel.

The slightness of all the explosions in the experiments that have been recapitulated, is ascribable to the small proportion of one-fifth pure oxygen gas contained in the atmospheric air, the remaining four-fifths being composed of incombustible nitrogen. Were pure oxygen substituted for the diluted atmospheric air, the explosions would have been dangerously violent. Indeed, were the atmosphere composed of pure oxygen, the iron grate-bars of a furnace would burn more brilliantly than the most combustible fuel placed thereon, and explosions and conflagrations would continually occur with irresistible violence. It is owing to the presence of the pure oxygen gas evolved by heating saltpetre, and commingled with the carburetted hydrogen gas evolved from the ignited pine floors and partitions of warehouses, that the most frightful explosions have occurred, which have often blown up great warehouses and destroyed many lives. This fact appears to have been lost sight of in the numerous discussions of the questions of "the explosibility of saltpetre," which have been published, and in the experiments that have been made to solve practically this unsettled question. These experiments have shown that where fragments of charcoal, not finely pulverised, such as are produced from burning wood, and from cloth commonly used for bagging, are thrown upon heated saltpetre, a prolonged vivid combustion has ensued, termed *deflagration* in contradistinction to *explosion*, the contact of the two substances being confined to the surfaces of the solid masses. To produce explosive action with saltpetre and charcoal when ignited, it has therefore been found necessary to pulverise both substances very finely and then to commingle them, atom to atom, artificially with the utmost care, as is practically accomplished in the manufacture of gunpowder. When thus prepared, the saltpetre sets free sufficient pure oxygen to be chemically combined, atom to atom, with the charcoal or carbon in the confined chamber of a cannon, independently of a supply in the oxygen gas from the external atmospheric air. In this way only is an explosion directly producible by saltpetre. But indirectly, as occurs in a burning warehouse, a still more violent explosion than that of gunpowder is producible by simply mixing together the gaseous products of saltpetre and burning wood, as the following experiment, made in the laboratory of Brown University, with the co-operation of Professor Hill, will forcibly demonstrate.

Some saltpetre was put into a retort, and subjected to the heat of a furnace, to represent the action of the intense heat of a burning warehouse on saltpetre stowed therein. The gas evolved from the saltpetre was collected in a glass receiver. Some fine sawdust was put into another retort, similarly heated in a furnace, and the rising carburetted hydrogen gas was collected in another receiver inverted over water. The two gaseous products were commingled in the proper combining proportions, and introduced into a small tin tubular chamber, with a cover loosely fitted on its top, and a small hole pierced in its side, to which a lighted match was applied. An explosion ensued so violent and rapid that the top of the circular cover was burst off, from its soldered edge before it was lifted up, and the hoop of it split open and thrown to a distance with a deafening report.

After witnessing the violent and stunning explosion thus produced by a minute quantity of the mixed gases of pine wood and saltpetre, the Professor remarked that a room full of such an explosive mixture might produce the terrific effect of the explosion of a magazine of gunpowder.

The dense smoke of burning floors, constituted of carburetted hydrogen, and the pure oxygen evolved by the heat of them from the saltpetre, might ascend into some adjacent room and remain commingled, ready to explode by the first flash of flame which might reach them there.

The explosiveness in this case manifestly originates from the chemical combinations of the oxygen gas, set free by heating the saltpetre, with the carburetted hydrogen gas, set free by the heating of the pine wood, and not from any explosive property in the saltpetre itself. For this special reason saltpetre stored by itself, without the proximity of wooden floors beneath it, should not be considered in the class of a hazardous risk for fire insurance, or intrinsically dangerous.

As the dangerous inflammability of coal oil appeared to be ascribable to the naphtha not separated therefrom, the following experiments were made to ascertain the extent of the inflammable properties of pure naphtha.

Finding that the liquid naphtha evolved sufficient vapours at the ordinary temperature of the atmosphere to become instantaneously kindled into flashing flames, the cup containing it was immersed in a freezing mixture of snow and salt to reduce the temperature to the zero of Fahrenheit's scale. At this low temperature, the naphtha appeared to blaze with equal violence. Then a quantity of snow was mixed with the liquid naphtha and thoroughly stirred, for still further reducing the temperature. Even at this extreme degree of cold the naphtha continued to flame so furiously that it was necessarily thrown from the cup, upon the ice covering the ground where the experiment was made, in the open air, whilst the thermometer indicated an atmospheric temperature of 19 deg. below the freezing point. The naphtha still continuing to burn upon the surface of the ice, a covering of snow was thrown over it to extinguish the flame. Through this covering of white snow the bright flames still continued to shoot up, presenting to view the extraordinary spectacle of burning snow.

On repeating similar experiments on the comparative combustibility of spirits of wine or alcohol, camphine, and burning fluid, they did not emit sufficient gaseous vapours at the freezing point, or 32 deg. to become kindled into flame, when burning matches were plunged therein, but with a little increase of temperature they all became kindled.

The preceding experiments seem to exhibit impressively the extraordinary inflammability of naphtha, arising from the facility with which it emits gaseous vapours. Susceptible of being readily kindled into flames, even through a mantle of snow, naphtha, like ether, emits gaseous vapour, which, with surprising facility pervades the air, and the odour of it being rather pleasant than offensive, like that of artificial coal gas, the utmost caution is requisite to prevent not only unexpected explosions, but also the almost unextinguishable violence of its conflagration ; for, practically, the application of water does not subdue the conflagration of naphtha in quantity, and only the exclusion of atmospheric air appears to quench the fury of its flames. To prevent the escape of the gas through the porous wooden staves, it has been found necessary to coat the inside of the barrels with a solution of glue.

The insidious nature of the gaseous vapour of naphtha is therefore its most dangerous quality, for when stored in barrels in a warehouse, with the bungholes of the barrels open, sufficient vapour escapes into the air of a close apartment to produce a violent explosive action on introducing a lighted candle. In this way, notwithstanding the precautions used at the distilleries of coal oils, several of them have been first shattered by explosions of the naphtha vapour and then burned down.

Petroleum contains a considerable per-centage of naphtha, and consequently partakes in a degree of its dangerous properties There appears to be sufficient reason for classing these liquids as specially hazardous.

In making experiments with the tin vessel of the capacity of a common lamp (before described), a single drop of naphtha was found to yield sufficient vapour to produce as much explosive action as could be produced by the most inflammable coal oil for sale in the market, when similarly experimented with ; and after every experiment failed to exhibit the slightest explosive tendency of the best kerosene oil, a single drop mingled therewith rarely failed to yield sufficient vapour to manifest its presence by a slight explosive puff, when kindled by a lighted match. The combustion in this case was confined to the minute quantity of naphtha gas, without either kindling the kerosene oil, or dangerous results.

In all the accounts of the explosions of camphine and burning fluid lamps there appear to be no statements of any damage or injury to life or property by the mere mechanical force developed. The principal disastrous results are caused by the scattering about of highly inflammable liquids, which instantaneously spread the conflagration over surrounding combustible substances. It is sufficient to produce the most disastrous consequences, if a lamp containing any of these highly inflammable liquids, produce only a sufficient gust of an explosive character to disperse the blazing contents over the dresses of adjacent persons, or surrounding combustible matter. The rapid communication of the flames has in this way often proved fatal to life and destructive to buildings. For this reason the rates of premium for fire insurance have been enhanced on property jeopardised by the use of camphine and burning fluid in lamps for lighting factory buildings. As the accidental fall and breakage of camphine or burning-fluid lamps on a floor have often produced the loss of life and property by communicating fire, as above stated, an experiment was made to test the comparative results which might be anticipated from a similar accident to a burning lamp containing coal oil, which required to be heated to 125 deg. before it emitted sufficient gaseous vapour to be kindled by a lighted match. Some coal oil of this quality was poured out of a burning lamp upon a floor and the blazing wick dropped therein. There it continued burning until the heat of it raised the temperature of the surrounding coal oil to 125 deg., when the blaze began gradually to spread over the surface of the oil on the floor in an enlarging circle, but no sudden flash of flame spread over the whole surface at once, as was the case when burning fluid and camphine were similarly experimented upon.

To represent the effect of accidentally spilling the kerosene oil from a burning lamp upon a cotton dress, a piece of calico cloth was moistened with the oil, and then held up in contact with the flame of a lamp. The kerosene required a little time for its temperature to become raised to the evaporative point of 125 deg., before the blaze began to spread over the surface of the calico, and it was readily extinguishable by the breath when first kindled. Although a single calico dress may of itself be deemed dangerously inflammable, yet it requires more time to become ignited whilst wet with kerosene oil, but the intensity of the flame becomes finally much greater.

When a similar experiment was repeated on cotton cloth moistened with burning fluid, camphine, and spirits of wine, the blaze spread instantaneously over the surface of the cloth with terrific violence, affording ample reason for the belief of an increased hazard in using them in lamps even for household illumination ; and yet how few are the disastrous accidents which have occurred from this cause, in comparison of the vast number of cases where lamps supplied with these inflammable liquids have been harmlessly used with ordinary care.

An important incidental security, resulting from the use of kerosene in lamps, is an exemption from the crusts of coal which are found to collect on the wicks where whale oil is burnt, and which not only obscure the radiance of light, but frequently sparkle off upon adjacent combustible bodies. It is necessary often to trim the wicks of whale oil lamps, which in manufactories is frequently done by workmen impatient at the waning glimmer. The burning crusts of the wick, knocked off without regard to surrounding combustible matter in cotton mills, has often set them on fire and burned them. Turpentine is also used for lighting the wicks of such lamps, which increases the danger in cotton mills. For these reasons it is believed that the comparative hazard from fire by the use of whale oil in lamps in cotton mills, is greater than where coal oil is similarly used, of the quality before stated.

Although pure sperm oil may be free from the preceding objection, yet, so great is the temptation of a profit of about one dollar per gallon from mixing the cheaper whale oil with sperm oil, that it has become nearly impracticable to obtain a sufficient supply of the latter, even for oiling machinery. So great, indeed, has been found the difficulty of procuring pure sperm oil in England for this purpose, that the heavier coal oil has been there successfully substituted in place of it for this special purpose.

Ample capital and skill have recently been applied to the new branch of business of the distillation of coal oils, and no deficiency of an abundant future supply will hereafter occur for purposes of illumination, or, when properly prepared, for lubrication of machinery. It appears that an entire cargo of coal oil has recently been exported to Italy. The supply of coal oil will not fail until the supply of coal in the depths of the earth becomes exhausted. How long this may continue has already become a curious subject of calculation.

The consumption of coal for purposes of navigation, and for motive power in the useful arts, is manifestly destined to go on, increasing with an increasing population to a vast extent, whilst no compensating supply is accumulating in new deposits or formations of fresh beds of coal to replenish the decreasing stock. In anticipation of the exhaustion of the coal mines of England, the question of restricting the exportation of coal has been debated in Parliament, and a recent writer has published in the 'London Quarterly Review' an estimate, limiting the supply to a period of about one thousand years, and then, he observes, "recourse must be had to the vastly more extensive coal fields of North America." In a sort of geological inventory of the stock of coal on hand in the possession of some of the principal nations of the earth, it appears that there are about 135,000 square miles of area of coal fields in the United States, 18,000 square miles in British North America, 12,000 in Great Britain, 3,500 in Spain, and only 1,700 in France. The possession of abundant supplies of coal and iron by races of men having the intelligence and vigour to use them effectively, constitutes, at the present day, the basis of natural greatness, as exhibited in the effects of the annual production of seventy millions of tons of coal by Great Britain for the development of manufactures, commerce, and physical comforts of the people.

These facts impart to the present subject of inquiry exceedingly interesting as well as instructive considerations connected with the probable future supremacy in the useful arts and national power of the people of different countries of this earth. The coal fields of this western continent have only recently began to yield up their hidden treasures of mineral coal and petroleum. Our country is still literally "the new world." Provided with a tenfold greater supply of coal and iron than Great Britain, and with far more than all the rest of the continent of Europe besides, this physical power is destined to be developed with a paramount influence on the affairs of men in remote ages of futurity, after the present wilderness of North America shall have been made to "blossom as the rose." Inspired with glowing anticipations of the future destiny of America, resulting from the possession of vast regions of fertile land and mineral treasures hidden beneath its surface, Bishop Berkely inscribed his prophetic verse—

"Westward the course of empire takes its way."

The preceding experimental facts have been investigated for the special purpose of showing that all these bountiful provisions, stored up for the future well-being of man on earth may be safely used with due care and forethought, without which even a draught of cold water might prove a fatal beverage. The minuter details have also been added, to dispel unfounded apprehensions of danger in the use of coal oils properly distilled at establishments of known credit and respectability, and to awaken caution where there is real cause for alarm, that these gifts of a bountiful Creator may be rendered subservient to human enjoyment and happiness.

Providence, Rhode Island.

PHOSPHATE NODULES.*

BY THE REV. GEORGE HENSLOW.

Like all other sciences, that of agriculture has of late years made rapid strides in advancement, and one of the most important points that has engaged the attention of scientific agriculturists is the employment of manures specially adapted to particular crops; amongst which are those derived from artificial and mineral sources. It is our purpose to narrate the discovery and introduction of the use of "phosphate nodules," or "coprolites," (as they are generally but wrongly called), as a manure more particularly requisite for root crops. Although thousands of tons are annually† prepared from different localities, but few of our farmers, who derive vast benefit from them, have any idea that my father, the late Professor Henslow, of Cambridge, merited their thanks.

In the year 1839 Professor Liebig first suggested the use of superphosphate of lime from bones for agricultural purposes.‡

Again, in 1843, he strongly advocated the more general use of phosphates. "A field," he says, "in which phosphate of lime, or the alkaline phosphates, form no part of the soil, is totally incapable of producing grain, peas, or beans.'' §

Again, he declares that "if a rich and cheap source of phosphate of lime were open to England, there can be no question that the importation of foreign corn might be altogether dispensed with after a short time." He here (p. 176) speaks in allusion to the coprolites‖ discovered by Dr. Buckland in 1842. The enthusiastic chemist concludes his letters with the following remarks:—"What a curious and interesting subject for contemplation! In the remains of an extinct *animal* world, England is to find the means of increasing her wealth in agricultural produce, as she has already found the great support of her manufacturing industry in the remains of a *vegetable* world. May this expectation be realised, and may her excellent population be thus redeemed from poverty and misery!"

Previous to Dr. Buckland's discovery, guano had begun to be imported (1841) from islands in the South Seas, where it forms a stratum many feet thick,¶ being the accumulation for ages of the excrement of many sea-

* From the 'Leisure Hour.'

† An estimate, taken by Mr. C. W. Johnson, of the annual consumption of superphosphate of lime made from "nodules," miscalled "coprolites," gives 72,000 tons, at an expenditure of £360,000 ('Midland Counties Herald,' Feb 20, 1862).

‡ 'Organic Chemistry of Agriculture,' p. 184. Taylor and Walton. 1840.

§ 'Familiar Letters on Chemistry.' Taylor and Walton. 1843.

‖ Fossil excrements and bones, etc., of saurians, in the lias near Clifton, containing about 18 per cent. of phosphate of lime.

¶ The author has in his collection a small penguin that was embedded in the guano, possibly above 3,000 years ago!

fowl. It was at that time used as a manure with great advantage on the coast of Peru, where the soil is otherwise extremely sterile.

The percentage of phosphate of lime in guano is about 29. Its first trial in England (in Mr. Skirving's nursery at Liverpool, upon grass and turnips) established its reputation as far superior to any known manure; the price, moreover, of its importation being only from 20s. to 25s. per cwt.

By the year 1844 the application of guano had become various and abundant. But hitherto Liebig's speculations had not been realised in England. It was in the year 1843 that Professor Henslow and his family were staying for a few weeks at the pretty and retired village of Felixstow, on the Suffolk coast; and, though at that time generally condemned as a watering-place, yet it is seated on one of the noblest bays in England, with excellent and safe bathing, possessing a maritime Flora of much interest, with a fine denudation of one of the most remarkable of our British strata; having, moreover, the alluvial soil filled with fragments of Roman pottery, mixed with the well-preserved remains of deer, oxen, and every description of animal, including snails (!), which the Romans had fed on 1,400 years ago, intermixed with coins and other objects of antiquarian curiosity. On the north of Felixstow high cliffs face the sea, the lower and greater portion consisting of "London clay," a blueish grey bed crumbling under exposure to the atmosphere, and abounding in large septaria or nodular masses of stone, of about three feet in diameter. Vast quantities of these are collected for the purpose of making cement. A little flotilla of boats may often be seen a mile or two out at sea dredging for them.

Superimposing the London clay is the "red crag," so called from its peculiar yellowish-red colour, due to the great prevalence of oxide of iron. It is for the most part a sandy bed, abounding in vast quantities of rolled and water-worn organic remains. Numerous sharks' teeth, varying in size from half an inch to four inches in length; portions of whales' bones, especially the ribs, and the petrous tympanic bone of the ear;* innumerable fragments of marine shells, together with layers of nodular masses of indurated clay, the miscalled "coprolites," constitute the characteristic features of the red crag. These nodules appear to have derived their origin from the London clay, in which many were found, by the late Mr John Brown, of Stanway; differing, however, from the former, in the absence of the peculiar dark-brown colour on the exterior surface, and from bright yellow being often disclosed in the interior by fracture.†

In consequence of the sea's encroachment at this point of the eastern

* So abundant have these "whales' ears" subsequently proved, that the Professor had at one time in his collection no less than 32 dozen! A description of them may be found in Owen's 'British Fossil Mammals.'

† Hence the names of "eggs" and "fruits," locally given to those of a somewhat roundish form.

coast, and beating violently against the basement of the cliff, landslips frequently occurred, thus causing a succession of little semicircular "bays" in the London clay,* the fallen parts shelving from within a few feet of the beach, to as many from the summit of the cliff, some seventy or more above—the width and depth of these depressions being about 100 feet each. The surface of this sloping portion was strewed over with the débris of the red crag, including vast quantities of "nodules." It was these latter that drew the Professor's attention when geologizing, accompanied by the writer, then first initiated into the delights of this science. Taking a few home that struck him as being peculiar in form, he examined them carefully ; finding that not unfrequently some fossil organic body was embedded in the nodules, he strongly suspected them to be phosphoric in their nature, more especially as his first impression was that the majority, if not all, were genuine coprolites. This view he communicated to the Geological Society, and he also published a few remarks in the 'Gardener's Chronicle' (p. 43, 1844). He, however, subsequently considerably modified this idea, being by more extended observation convinced that they were either nodular concretions, or mere hardened masses of London clay, which had been rolled into various shapes at the time the crag was deposited, and which had subsequently undergone some alteration in their mineral character, being highly "charged" with phosphate of lime. Some of these nodules were transmitted to Mr. W. H. Potter, Fore street, Lambeth, who proved, as the Professor suspected, that they contained a large proportion of phosphate of lime (56 per cent.) He at once saw that now was the time for Liebig's anticipations to be realised, and that there was a vast source of profitable material opened for any enterprising agriculturist. Deeming it inconsistent, as a Christian minister, to engage in any pecuniary speculation, he did not hesitate a moment to lead others to profit by his discovery. He communicated it to an eminent manufacturer, who immediately desired a ton of nodules to be forwarded to him ; and although the idea of manufacturing on any large scale could not then be entertained, in consequence of an exaggerated notion of their value being afloat, so that a higher price was often demanded for the raw material than for the manufactured article, yet, as soon as a more reasonable value was assigned to the nodules, they became a staple commodity of trade.

Thus was the dream of Liebig's fond imagination realised; a dream, indeed, as many, including the Professor himself, considered it to be ; for thus he spoke of it : "Devotedly as we may all desire such a consummation, let us neither too hastily adopt, nor too hastily reject, these speculations of the German chemist. If he is correct in supposing that the phosphate of lime contained in fossil bones and coprolites, can be economically converted to the same purposes as that in recent bones, his

* Since the year 1843, this peculiar feature has almost entirely disappeared.

observations will be worthy of the most serious attention of agriculturists."

This, too, has proved to be the case; nearly twenty years have elapsed since those words were penned, and a new era was opened in the history of agricultural science. Experiment after experiment has been tried, and the value of this new artificial manure has ever been more and more highly appreciated.*

In 1848 a new discovery was made. "It had long been a remark of common notoriety, that the soil of the lower part of the chalk formation possesses remarkable powers of fertility, very little or no manure being required to produce many crops; especially in the application of bone manures, in most instances it was positively useless."† This occurs upon the out-cropping of the "upper green sand" deposit, which is immediately below the chalk at Farnham, in Surrey. Mr. T. Mainwaring Paine, in December, 1847, forwarded some "marl" to an eminent chemist, and the result proved that a large percentage of phosphate of lime was contained in the soil; nor was this all: in trenching for drains through the gault, the lower green-sand was exposed, upon which the former reposes. This, too, proved to contain layers of "mortar-like" substance, with nodular masses interspersed, highly charged with earthy phosphates.

On the publication of Mr. Paine's interesting discovery, Professor Henslow called attention, in the 'Gardener's Chronicle,' to the Suffolk nodules, which were then being raised at the rate of sixty tons a week; as well as to the fact that he had previously suggested to Mr. John Deck, a practical chemist of Cambridge, to analyze some of the nodules so abundant in the upper green-sand stratum in that neighbourhood. Having followed the Professor's suggestion, they were proved to contain earthy phosphates, in proportions varying from fifty-seven to sixty-one per cent. The Professor had communicated his views in a letter to the 'Bury Post,' July 3rd, 1845, nearly three years previous to Mr. Paine's re-discovery, concluding with the words—"Whether these various nodules, thus abounding in phosphate of lime, can be made available for agricultural purposes, must depend upon the possibility of their being collected at a cheaper rate than an equal quantity of bones can be. Perhaps this is a point not yet sufficiently determined; though my own opinion is decidedly in favour of their being sufficiently abundant in some places to make it worth while to collect them." This was soon to

* An interesting paper (amongst many) may be found on page 155 of the 'Gardener's Chronicle' for 1846, by Mr. J. B. Lawes, on the relative effect of this manure upon turnips and grain crops, in which he shows that the latter will receive little or no benefit unless *nitrogenous matter* be in the soil as well. At the present day we believe it to be pretty generally abandoned for manuring corn: its great use consists in hurrying the young turnips over the tender and critical age of childhood, when they are mercilessly attacked by "the fly."

† From an article in the 'Agricultural Gazette,' page 121. 1848.

be realised. A few years have since elapsed, and now every tenant who owns a scrap of "upper green-sand" in the neighbourhood of Cambridge riddles his acres with pits. Walk from Cambridge along any of its roads into the country, and within distances varying from the suburb to two or three miles, the eye will not fail to see one, two, three, or more pits in the adjoining fields. The process of acquiring the nodules there is considerably more laborious than in Suffolk. Pits are dug, and the "marl" or clay is thrown into circular trenches, in which a rake or harrow is drawn round and round by a horse, while water is continually being pumped into it. By this means the clay is washed away, and fossil shells and nodules are left behind. At Felixstow, all that is requisite is to sift the sand from the nodules, which are then thrown together into a heap, to be conveyed at once to the manufactory.

When residing lately at Steyning, in Sussex, the writer himself found a pit from which sand had been excavated in the lower green-sand deposit, containing a mortar-like band,* with a few characteristic fossils, and an abundance of balls of indurated clay, about one and a half feet beneath the surface. Suspecting them to contain phosphate of lime, as they much resembled specimens from Farnham, in his collection, he transmitted them to Messrs. Barton Brothers, chemists, of Brighton, who kindly undertook to analyze them. The result proved that they contained over eighty per cent. of phosphate of lime—higher, in fact, than any the writer has yet heard of.

Such is a brief account of the discovery of "phosphate nodules," which in less than twenty years has formed a new epoch in the history of agricultural manures. Practical men have reaped golden fortunes from the discovery, though few of the thousands who have benefited by it, know where the phosphate nodules originally came from, or that it was Professor Henslow—ever ready to impart his scientific knowledge and discoveries—who first pointed them out. He rests from his labours, but the results of his active disinterested mind will be of lasting benefit to his country.

* This "band" is recognised by geologists, and described as a "phosphate paste" intermediate between the gault and lower green-sand. It is about $1\frac{1}{2}$ feet in thickness, and remarkable for its uniform continuity. It was doubtless this same band which Mr. Payne discovered re-appearing on the south side of the North Downs at Farnham, Steyning being situated on the north side of the South Downs.

ON THE EDIBLE FISHES OF MASSACHUSETTS.

BY DAVID HUMPHREYS STORER, M.D.

The Flounder (*Platessa plana*, Storer).—This is the most common flat-fish taken in the waters of Massachusetts. It is captured in considerable quantities throughout all the warm season of the year near the shore from the wharves and bridges ; and in the winter is speared through the ice. The finest brought to Boston market are taken from around Deer Island—and those from that locality frequently measure from 12 to 18 inches. The largest specimen of this species I have ever seen measured 21 inches in length and 17 in width.

The Flounder of New York (*P. dentata*, Storer). This species is frequently taken in the winter season at Province Town, and is occasionally brought to Boston market. It is a sweet fish, but is not generally relished as well as the *P. plana*. It is known as the Sand-dab. The largest specimen I have seen, measured 21 inches in length, and weighed 3½ pounds.

The rusty flounder (*P. ferruginea*, Storer), is from 18 to 20 inches long. This species is occasionally brought to Boston market in the winter and early part of spring, from the north-western coast of Massachusetts' Bay, and principally from the vicinity of Cape Arm, where it is taken in about 30 fathoms of water. *P. glabra* is not a common species. It is taken in company with the *plana*, and is generally known as the plaice.

The American Turbot (*Platessa oblonga*, Dekay).—This species is quite common during the summer and early part of autumn. It is taken along shore in very shallow water, and frequently weighs from 15 to 20 lb. At Province Town it is known as the plaice; in Boston market it is called the turbot. It is an excellent fish, and is considered by judges to be fully equal to the *Rhombus maximus*, English turbot. For a number of years a few specimens had occasionally been yearly brought to Boston market, when Captain Atwood, about the year 1841, conceived the project of bringing them alive by the cargo in the well of his smack. For three years he succeeded well in disposing of several loads in this manner—some being bought, by those who knew their value as turbot, and others as young halibut. When, however, in the year 1844, the fishermen commenced packing in ice halibut taken upon George's Banks, and were thus enabled to keep the market supplied with that fish in a state of perfect preservation, the species we are considering could not be sold. In the lattter part of 1847, Captain Atwood brought to Boston a smack load of most excellent turbot, alive, and sold but two hundred weight—the remainder died upon his hands, while species of infinitely inferior quality met with a ready sale in the market.

The Spotted Turbot (*Pleuronectes maculatus*, Mitchill), is not used here as an article of food, although Dekay informs us that in New York it is considered a delicate fish.

THE NEW YORK SOLE (*Achirus mollis*, Cuvier.)—Although Dr. Dekay speaks of this species as being common in the waters of New York, it is rarely found in Massachusetts. It is considered a very delicate fish for the table. Its length is about six inches.

THE LUMP FISH (*Lumpus anglorum*, Willoughby).—The whole appearance of this fish is very forbidding. Richardson tells us that "the Greenlanders eat its flesh, either cooked or dried, and its skin raw, throwing away only the tubercles," and Dr. Neal observes, "that it is purchased at Edinburgh for the table." With us, however, it is not used as an article of food.

The COMMON EEl of Massachusetts is taken along our entire coast, as well as in the rivers and ponds of the State. At some seasons, spring and winter, for instance, great numbers are brought to market from the mouths of the neighbouring rivers, upon the muddy bottoms of which they live. So great is the demand, that, sometimes, it cannot be answered.

During the winter this species is speared, holes being cut through the ice for this purpose. In spring the markets are usually supplied from the rivers, where they are taken in nets. At Medford nets are stretched across the river, having in their middle a large bag capable of containing from 15 to 20 bushels ; as the eels are going up or down the river they are caught, and are kept alive for the supply of the market, in large ditches, excavated near the river, which are supplied by the tide-water. About 3,000 pounds are yearly taken at Watertown. Those taken in summer, when they are able to procure the brill and other fishes upon which they feed, are much the larger and richer, weighing from one to nine pounds.

THE SUN-FISH (*Orthagoriscus mola*, Schneider).—This inedible fish is occasionally met with during the summer season in Massachusetts Bay, sluggishly swimming near the surface. It sometimes weighs 500 lbs. Its liver, which weighs eight or ten pounds, is very oily, furnishing two or more quarts of oil, which is used by the fishermen to grease their masts ; it is also sometimes used by painters, although not preferable in this respect to other fish oil. It is considered by many fishermen a valuable application for sprains and bruises, and by such it is preserved for these purposes.

THE SHARP-NOSED STURGEON (*Acipenser oxyrinchus*, Mitchill).—This fish is sometimes taken measuring even ten feet. But little attention has as yet been paid in this country to the value of the sturgeon fishery in an economical point of view. The several species we possess might unquestionably be made useful. The following observations of Professor B. Jaegar contained in the 19th vol. of Hunt's Merchant's Magazine (New York), for 1848, are worthy of perusal :—

"The principal sturgeon fisheries are without doubt those on the

Volga, near Astracan, and those on the Don, which are carried on chiefly by the Cossacks of that country, who find this occupation much more lucrative than agriculture, which they neglect entirely, in spite of the very fertile soil of their lands.

"The fish forms an important object of fishery and commerce to many nations, as well for its flesh, as for the caviare prepared from its roe, and the isinglass from its swimming bladder.

"The city of Astracan exports every year several thousand tons of pickled sturgeon and caviare for consumption in the Russian empire; and Odessa much larger quantities for Greece, Italy, France, and other parts of Europe. When the catching of the sturgeon on the Oby, the Volga, Jaik, and Don begins, there arrive at these places from the remotest parts of the Russian empire, a considerable number of merchants, who purchase the fish and prepare them for transportation.

"The average price of one fish, without the roe and swimming-bladder is generally 12s. 6d. A large one, which weighs over 200lbs., is sold from 12s. to 25s., and contains 40lbs. of caviare, or prepared roe which is sold for 6s.

"The flesh is fat, very palatable, and much better in the summer after the fish has been some time in fresh water. That which is not eaten fresh is cut into large slices, salted, peppered, broiled, and put in barrels, when it is preserved in vinegar and fit for transport. A considerable quantity of this fish is smoked. The wholesale price of pickled sturgeon is from 25s. to 50s. a hundred weight. The caviare is prepared in three different manners, namely:—

1. Two pounds of salt are added to 40 pounds of roe, and dried upon mats in the sun. The price for 40 pounds is 4s.

2. Eighth-tenths of a pound of salt are mixed with 40 pounds of roe, then dried upon nets or sieves, and pressed into barrels. This is sold for a little more.

3. The best caviare is that where the roe is put into sacks made of tow-cloth, and left for some time in a strong pickle. These sacks are then suspended, in order to let the salt watery substance run off, and finally squeezed, after which the roe is dried during twelve hours, and pressed into barrels. This roe, of which 40lbs. are sold for 6s. at the place, is that which is sent all over Asia and Europe, as a considerable article of commerce, and known by the name of caviare;—it is eaten with bread like cheese.

"Another very profitable part of the sturgeon is the swimming-bladder, of which isinglass is made. For this purpose it is cut open, washed, and the silvery glutinous skin exposed to the air for some hours, by which process it can be easily separated from the external skin, which is of no use. This glutinous skin is placed between wet cloths, and shortly after each piece is rolled up and fastened in a serpentine form on a board; after they are partly dry they are hung up on strings in a shady place.

"This valuable and extensive article of commerce is the isinglass of our shops, and is sold there for about 10*l.* a hundred weight. There is also isinglass made from the swimming-bladder of the cat fish, and of some others; but as this is very inferior to that from the sturgeon, it brings scarcely 2*l.* a hundred weight.

"The sturgeon is found in immense quantities in the United States and North America, from Virginia up to the highest habitable northern latitudes, where they ascend the rivers from three hundred to five hundred miles up. The Potomac, Delaware, Hudson, and principally the Kennebec, as well as many other rivers, contain such a quantity of sturgeons that from these rivers alone, without counting those farther north of Maine, according to my calculations, the annual export of pickled sturgeon, caviare and isinglass, would be worth nearly 100,000*l.* Pickled sturgeon and caviare is a favourite food of the descendants of Spain and Portugal in South America, as well as of the inhabitants of the West India Islands, principally during Lent; and isinglass would be an article of home consumption, as well as for shipment to the European market.

"But the sturgeon is not a very favourite dish in our country, it brings scarcely 2½d. a pound in the market, and the roe and swimming-bladder are always thrown away—our fishermen, therefore, are not much encouraged in catching these fishes, though, according to careful observation, from 30,000 to 40,000 sturgeons could be annually taken in the rivers of the United States.

"The sturgeon was highly appreciated by the ancient Romans and Greeks. It was the principal dish at all great dinner parties, and Cicero reproved epicures on account of spending so much money for this fish. Pliny says that this fish was served at the most sumptuous tables, and always carried by servants, crowned with garlands of flowers, and accompanied by a band of musicians. Even at this time one pound of fresh sturgeon costs about 16s. in Rome, where the fish is very rare."

GLASS FOR HOUSEHOLD USE AND FANCY PURPOSES.

BY APSLEY PELLATT.

Before entering upon the consideration of the various descriptions of glassware, it may be convenient to state a few of the distinctive properties of good glass, and the difficulties the manufacturer has to overcome, in order to produce superiority of quality.

Glass has become of immense importance : it is technically termed metal, and is conducive, from its many and important qualities, alike to the comfort and convenience of man, and to the elevation of his mental powers. To the property of translucency, &c., possessed by glass, man is indebted for his knowledge of the most exalted as well as the most minute of the great Creator's works ; other properties of glass, its power of resisting acids, and its non-conduction of the electric fluid, constitute it a material of great value and importance. Glass is materially divided into two specific classes—simple and compound.

Simple glass is that in which only silica and flux are the constituents, the flux being either soda, potash, lime, magnesia, alumina, or mixtures of some of them, in which case the glass is simply a silicate of an alkali. Of such is plate, window, and bottle glass of every description ; the difference of quality depending entirely upon the character of the materials.

Compound glass* is that in which, besides silica and alkali, the oxide of a metal is also a component part. This glass is called in England, flint glass, and on the Continent crystal, and from it, in England, are made all articles of luxury and domestic use. The object of introducing a metallic oxide into glass is to add to its density (an object of great importance for achromatic purposes), whereby greater brilliancy is obtained, the rays of light not being allowed to pass so straightly through, as in the simple glasses, but being more refracted or broken (so to speak), as they pass through. This quality is further taken advantage of by the glass cutter, who aims to produce such patterns upon the objects he manufactures, as further tend to break the rays of light. Flint glass being usually employed for the manufacture of articles of luxury, quality is of immense consequence, as but a very trifling inferiority in any of its properties renders it of comparatively little commercial value ; whereas, the price is looked upon as a secondary object, if the quality is decidedly superior. The manufac-

* 'Traite sur l'Art de Vitrification et des Verres Colores,' &c.—D'Audenart, Paris, 1825. 'Cyclopædia of Useful Arts and Manufactures,' by Tomlinson, under the head Glass.—G. Virtue. Lardner's 'Cyclopædia,' Porcelain and Glass Manufacture.—Longman and Co. Pellatt's 'Curiosities of Glass Making.'—Bogue, Fleet Street.

turer has, therefore, to turn his first attention to the production of quality. This is not easily attained, for two special reasons: 1st, the difficulty of procuring the materials in a state of perfect purity; and 2ndly, the difficulty of anticipating the exact amount of deoxidation, which may take place during the fusion of the materials into glass. Deoxidation alone, supposing all the materials to be perfectly pure, will affect the *colour* of flint glass; and if oxygen be not supplied, the materials, when fused, will produce not a white, but a green tinted glass.

It is, therefore, found necessary to employ oxygen in all mixtures of flint glass; and this important agent exists most conveniently in the black oxide of manganese; which substance has a very strong affinity for oxygen, parting with it so slowly, that it is only as the other materials in fusing become quite deoxidised that it furnishes them gradually with the necessary oxygen. If too much of this material is used, the glass takes a light purple tint, and is also rendered of a more frangible character, in consequence of having an excess of oxygen.

With these few preliminary observations, the prominent question before the Jurors is, has there been progress in the quality and manipulation of glass, since the last International Exhibition? Does the glass exhibited in 1862 show progress, as compared with 1851? The Jurors have great pleasure in stating, from their knowledge of the goods produced for several years past in their various localities, and from their recollection of the goods exhibited in 1851, that laudable progress has been made in all branches of this class.

The Jurors have had brought to their notice no improvement or alteration in the constituents of flint glass. At the International Exhibition of 1851, a Council Medal was awarded to Mons. Maes, of Clichy, near Paris, for the employment of zinc in place of lead, under the impression that this mixture would be superior to the ordinary one, especially for the manufacture of glass for optical purposes; it being considered that glass of zinc would be more homogenous than glass of lead. It does not now appear that any advantage has arisen from the use of zinc, as far as the Jurors know, for flint glass. The want of brilliancy of zinc glass is not compensated for by any special advantage it was thought to possess, although Mons. Maes was fully entitled to an award for his spécialité.

In comparing the manufactures of glass in England and other countries, consideration must be had to habits, tastes, and local advantages or disadvantages. Without in the least degree depreciating the efforts of foreign countries in the manufacture of glass, the Jurors would submit that the quality of the British glass* ranks so high, chiefly

* D'Audenart states that the English preceded the French in the art of making glass with the oxide of lead. "Cela vient, dit-on, de ce que le com-

because the quality of the fuel, and the materials generally, are superior. The first enables the manufacturer to use a greater proportion of silica in his glass, thereby producing a closer and stronger texture of body, preventing what is technically known as "sweating" in plate glass; and by the second, the greater purity and brilliancy of colour in flint glass is obtained. Another great advantage secured by the country possessing fuel of the greatest power, is that in superior qualities of glass, the manufacturer is enabled to fuse his materials in covered and larger crucibles, entirely protected from the action of the fuel; and this is a great advantage, inasmuch as the colour of the glass is very much deteriorated by the carbon of the fuel passing over the fluxed materials, the carbon absorbing oxygen rendering the glass of a green tint. The same cause (the presence of carbon) prevents the use in uncovered crucibles of the oxide of lead, except to a small extent, the deoxidation of the metal resulting in the formation of metallic lead, which by its own density falls to the bottom of the crucible. In judging, therefore, of the comparative value of the qualities of glass made by this and other countries, allowance must be made for these as well as for other considerations. Again, as to the formation of glass into objects of general utility or luxury, the Jurors would remark, that to the habits (domestic or social) of different nations, the progress in the manufacture of specially useful or ornamental articles is to be ascribed.

Whilst from the more domestic habits of this country, much progress has been made in the production of works of every day life, our continental friends have, from their more social habits and mode of living, been engaged in the manufacture of articles of ornament, suited to the drawing-room, boudoir, &c. The Jurors regret that the same attention has been found wanting in the foreign department to articles of general use; they must at the same time admit the superior excellence of the foreign manufacturer in articles of luxury and vertu. The Jurors would particularly notice the advance made by the British exhibitors in the *forms* of articles for general use, which is in a great measure to be attributed to the taste nurtured by the schools of design throughout the country; the endeavours by many manufacturers to encourage a better appreciation of form on the part of purchasers, and the general advance of the public in Art knowledge. Much of this also is due to these National and International Exhibitions, particularly to the latter, in which the exhibitors learn from each other by competitions in the arts of peace.

The greatest advance the Jurors have to notice, is that made in *engraved glass.* In the English department much taste is shown in the

bustible le plus abondant chez eux, le charbon de terre, &c. Mais enfin ils virent qu'il etait temps d'imiter nos voisins d'outre mer, et d'empecher l'introduction de leurs cristaux dans notre patrie. Nous fimes donc l'analyse de leurs produits et nous reconnues distinctement les substances qui les constituaient."

adaptation of the antique and other styles of ornamentation to articles of daily use, and some fine specimens of high art on tazzas, &c., are also shown. The foreign department contains some very fine specimens, particularly of figure engraving. It must be admitted, that to foreign workmen this country is much indebted for manipulation in this exceedingly delicate and pleasing art, which promises to take an equal place if not to excel that of the glass-cutter. Certain it is, that the manufacturer, by the taste and style of the modern engraved ornamentation, is driven to the use of finer and more classical shapes.

Under the head of flint glass, the Jurors would notice the improvements in it for optical purposes, made by Messrs. Chance, Brothers, and Co., a member of which firm was one of the Jurors, and Mons. Bontemps, one of the experts of this class. These gentlemen, as far back as the Exhibition of 1851, had made great progress, having patented twenty-five years since the process first discovered by Mons. Guinand,* in Switzerland. It had long been suspected that the want of homogeneity in flint glass, whereby it was rendered of but comparatively little use for optical purposes, was not due to any want of chemical mixture of the materials, but solely to the precipitation by gravitation of the heavier ingredients of the mixture. This had been successfully proved by Professor Faraday. Many years since, Sir Humphry Davy sought to remedy this, endeavouring, by long continued and excessive heat, to boil the mixture, so to speak, and thus to overcome the want of homogeneity.

This, as might be conjectured, failed, and for a very good reason; it being almost impossible to subject the whole body of the materials to the same degree of heat at the same time; by a natural law, the portions subjected to the greater heat are constantly replaced by those in a lower state of caloric; this constant interchange of particles producing striæ. They also absorbed the alumina of the pot, and the glass became of a gelatinous appearance. To obviate this defect, Messrs Chance and Bontemps followed out the experiments of Guinand, and Professor Faraday, and by constant mechanical agitation during the fusion of the materials, overcame the gravitation of the heavier matters, and thereby a much greater homogeneity of the mass was obtained. This discovery has led to a much greater certainty in the manufacture of flint glass for optical purposes, which previously was a matter of accident.

In plate glass, the Jurors remark, with satisfaction, the superior quality which both the British and foreign departments continue to produce. This is a manufacture almost perfected. That there has been no retrogression is certain, although advance now becomes very difficult. In the attempt to improve the colour of plate glass, the Jurors would warn manufacturers against the use of manganese, or other materials to

* 'Some account of the late Mr. Guinand, of Brenets, Neufchatel, Switzerland.' by S. P. de B.—Longman and Co., 1825.

whiten or destroy the greenish tint of the glass; because in all cases in which extraneous matters are used for the purpose, the glass so treated, after continued exposure to light and to the action of the atmosphere, rapidly becomes discoloured, and such productions obtain a bad character. Purity of material, and great care in the chemical atomic proportions of the matters used, should alone guide the manufacturer to a good and useful glass. The Jurors would also caution the plate-glass maker against using an excess of alkali, which he is tempted to do to save time in fusing. Such glass readily "sweats;" that is, the alkali effloresces upon the surface of the glass, rendering it soon cloudy, and requiring constant wiping. This description of glass is unsuited to many purposes, and consequently obtains a reduced price in the market. The specimens of crown glass, German sheet glass, both white and coloured, as well as of bottles in every variety of metal, are all, most creditable to the manufacturers who exhibit them.

ON IMPROVEMENTS IN MACHINERY AND APPARATUS FOR CLEANSING AND PURIFYING CASKS.*

BY ROBERT DAVISON, C.E.

In the paper which the author had the honour of reading before this Association in the year 1849, on the "Desiccating Process" he took occasion to mention its application amongst others to the purifying of brewers' casks, and further stated that upwards of one million casks had, at that time, undergone the process. It was not, however, made clear that the cask had to undergo a previous operation—namely, that of cleansing—which was effected by machines of peculiar construction which completely removed all adhering matter from the inside without resorting to the expensive and injurious system of unheading.

The object of the present paper is not only to confirm all that was then stated as to the efficiency of the hot air system, by stating that upwards of eleven millions of casks have since been treated in like manner; but to illustrate still further the importance of a proper system of cleansing casks before any purifying process is applied.

It may seem at first sight but an indifferent matter to bring before an important Association like the present. But when it is considered that there are no fewer than 2,400 public brewers in the United Kingdom who brew something like 20,000,000 barrels of beer annually, and assuming that at least an equal number of casks require to be

* Read before the British Association.

cleansed, it becomes a matter of considerable importance *how* and at what cost this enormons amount of work is acomplished.

As regards the cleansing process—it is worthy of note, that the first successful introduction of machinery for this purpose was in the year 1843, when the author, in concert with Mr. W. Lymington, produced the machine already referred to, as well as the improved mode of purifying. Previous to this period the only known method of cleansing was by the introduction of steam or hot water, or both, assisted by a chain placed inside, and a rolling motion given to the cask by hand. By such means it will not be difficult to see how *uncertain* would be the internal state of the cask.

The machine invented in 1843 consisted of a double frame suited to the form and size of each cask, revolving one within the other, and at right angles to each other, in such a compound manner as to cause a chain of peculiar construction, assisted by hot water, to traverse completely over every portion of the cask and so effectually remove all adhering matter. These machines still continue to be held in high repute in many first-rate establishments—and, so far as cleansing is concerned, they are nearly, if not quite, equal to anything which has since been attempted in this way. There is, however, one objection to them —namely, they are only calculated to cleanse one cask at a time; this, in such establishments as the two leading Burton houses (whose demand for casks each day amounts to thousands), has been a complete bar to their introduction and use.

The new machine now placed before the Association not only gets over the difficulty in respect to the number of casks cleansed at one time, but is superior to the old machine in point of speed generally.

This machine consists mainly of two circular discs, with an upright shaft or spindle in the centre, which has a screw at each end (the threads being cut right and left handed). The two discs have likewise each a corresponding female screw, which, when turned round on the upright spindle (the same being temporarily fixed) it will be easy to see, will cause the discs to advance or recede from each other, according as they are turned to the right or left hand. Such is the mode by which the casks are either secured or released from the machine—that is, by turning in one direction the casks are effectually secured between two discs ; by turning the reverse way, they are released.

Any number of casks which the bottom disc will contain, and even a second tier (if desired), can be fixed and afterwards cleansed at one operation—say two sets of 5 or 10 casks.

A compound motion is given to this machine not dissimilar (so far as the outer action is concerned) to the old machine ; but from the fact of the cask being placed in an upright position in the machine, and likewise surrounding the middle shaft or spindle, the casks themselves, when the machine is set in motion, are *twirled* about in a manner altogether peculiar and effective. The best cleansing medium is found to be a small quantity of sharpshingle along with two or three gallons of hot water.

The time occupied in cleansing ordinary dirty casks is 5 minutes, and very bad mouldy casks about 12 minutes. Thus it will be seen that one of these machines is calculated to cleanse easily 100 ordinary dirty casks, or 60 mouldy ones per hour, at the mere expense of two or three labourers and an insignificant amount of engine power. In large establishments, where unheading is still resorted to, the saving to be effected by this new machine must of necessity be great.

With regard to purifying both new and old casks, there can be no doubt that the wisest course for *new* casks is to divest the wood as much as possible of the coloured juices before it is made up into casks, which is easily done by hot water or steam, and afterwards drying by currents of hot air. Old and tainted casks are found to be cured (within 1 in 200) by partial steaming and afterwards applying currents of hot air at 450 degrees Fah.

Experience, having sufficiently proved the soundness of this mode of preparing casks for a most important branch of trade, it may seem almost needless to suggest any other method of performing the same work. But the author being the first to discover the importance of applying heated currents to such a purpose, he feels it incumbent on him to state that there is still another element which he believes must, ere long, supersede, to a considerable extent, the one before referred to ; it is that of superheated steam, the use of which was discovered lately by the author in rather a singular manner: While engaged in some experiments with superheated steam, it occurred to him, seeing that there was an indicated temperature at the time of between 600 and 700 Fah., that it would be well to try its effect upon a very bad stinking cask which, being obtained, was subjected to the heat for 10 minutes, when it was pronounced perfectly sweet. It is only necessary to add that the same result has followed many repetitions of the system, and although all have not been attended with the same success, the author feels that it has not arisen from any fault in the principle, but rather from a want of sufficient practical data as to the exact temperature and the amount of time which the casks can be safely exposed to this powerful agent.

CHEMICAL MANUFACTURES ON THE TYNE.*

BY MESSRS. J. C. STEVENSON, R. C. CLAPHAM, AND T. RICHARDSON.

SALT.—Salt works were formerly very numerous in this district, establishments having been formed at Howden Pans, Hartley Pans, Jarrow, North and South Shields and other localities. This trade was carried on by several of the most wealthy families in the neighbourhood, in the beginning of the last century, and about 200 pans were employed in producing salt, which was extracted from sea-water and brine springs. Shields salt was the most celebrated salt in the kingdom, and was, produced in such quantities at South Shields as to give a character, and even a nomenclature to this town, which to this day is divided into East Pan and West Pan Wards. The remains of a large hill are still to be seen, formed from the ash of the salt pans. After a time these ashes took fire, and Mr. R. W. Swinburne—to whom we are indebted for this information—states that the Chapter of Durham are in possession of a picture representing the burning hills of South Shields. The production of salt from sea-water in this locality has given place to that obtained from the brine-springs and rock-salt of Cheshire, and illustrates what great changes took place in altering the *locales* of manufactures. A considerable quantity of white salt is still made on the Tyne from sea-water, in which rock salt from Cheshire and Ireland is dissolved, in order to diminish the cost of evaporation. Two improvements have been successfully introduced in making white salt, which have the saving of fuel as their object. Mr. Wilkinson employs the waste heat of coke ovens for this purpose, and Mr. Fryer dries whitening with the heat which escapes from his salt pans.

ALKALI (for this and the last century).—Two gentlemen, Mr. W. Losh and Mr. Thomas Doubleday, were engaged, unknown to each other, with a series of experiments on the best plan of converting common salt into carbonate of soda. Each of these chemists appears to have used very similar processes, and when the late Lord Dundonald came to reside in the neighbourhood, he was soon on intimate terms with both parties. Both Mr. Losh and Mr. Doubleday tried numerous plans at his lordship's suggestion ; but after spending upwards of 1,000*l*., Mr. Doubleday would seem to have tired of making an outlay which promised little or no result. The first plan tried was to effect the decomposition of common salt by means of oxide of lead, and to carbonate the caustic soda, while the insoluble chloride of lead was heated to form a yellow pigment, long known as Turner's yellow. Another process consisted in decomposing common salt by sulphate of iron. The resulting sulphate of soda was fluxed with coal, and the sulphide of sodium which was formed was carbonated with sawdust. This plan was also worked some time afterwards at an alkali manufactory situated near Blyth. Another

* Read before the meeting of the British Association.

process tried was founded on the neutral decomposition of common salt and sulphate of potash. This operation was regularly carried on by Mr. Losh and Mr. Doubleday, whenever the price of the two potash salts allowed a profit being made, and the chloride of potassium was as regularly sold to the Yorkshire alum makers. Mr. Losh resided in Paris in 1791, where he acquired a knowledge of chemistry, and soon after his return home a company was formed to manufacture soda at Walker. The original partners were Lords Dundas and Dundonald, Messrs. Aubany, and John Surtees, and John and William Losh. They obtained their salt from a brine-spring found in a coal-pit at Walker, and the heavy duty upon salt at that date, which was 36*l.* per ton, was avoided by evaporating together a concentrated solution of the brine-spring and sulphuric acid, thus forming sulphate of soda, and avoiding making salt. Another plan adopted by Mr. Losh to avoid the duty was to add ground coke or ashes to the concentrating salt pan before the salt was formed, and use it in this damaged condition for the manufacture of sulphate of soda. This was about the year 1796; Messrs. Doubleday and Easterby, in 1808, commenced making sulphate of soda by decomposing the waste salts from the soap-boilers, which consisted chiefly of common salt and some sulphate of soda. Their chief supply was obtained from the Messrs. Jamieson and other soap-boilers at Leith. They purchased their sulphuric acid at first, but between 1809 and 1810, they got the plans of chambers from Messrs. Tennants, of Glasgow, and erected the first chamber on the Tyne at Bill Quay. They imported the first cargo from Sicily about the same time, and its arrival in the river excited great attention. At first the Government returned them the import duty on the sulphur, which was used in making acid, and the present Mr. Doubleday remembers having received, at the end of the year, as much as 1,500*l.* This however only lasted some three or four years, when the duty was repealed. This firm, then trading under the name of Doubleday and Easterby, also erected the first platina retort for making rectified vitrol, and which cost them 700*l.*, and before long they had three retorts in operation. The alkali which they made was used in the crude form in the manufacture of soap, in which they were also engaged. In 1816, after the conclusion of peace, Mr. Losh returned to Paris, where he learned the details of the present plan of decomposing sulphate of soda, which he immediately introduced in his works at Walker, and thus may be said to have been the father of the modern alkali trade in this country. Mr. Doubleday gave the plans of his chamber, furnaces, &c., to the Messrs. Cookson when they commenced their alkali works at South Shields, and these gentlemen made Wright, Mr. Doubleday's foreman, a present of a silver tea service in consideration of the services he had rendered. This trade has been developed in an extraordinary manner in this locality, where about 47 per cent. of the whole produce of the United Kingdom is now manufactured. The peculiar advantages of the district are also being recognised by the fact that the celebrated firm of Messrs. Tennant have purchased land with the intention of removing the greater part of their works from Glasgow to the banks of the Tyne. Charles Cooper, an overman at Walker Colliery, informs us that he was employed by Mr. Losh in 1798, and that crystals of soda were then manufactured and sold by Mr. Losh. The salt obtained from the brine spring on the premises was evaporated in small lead pans, and was afterwards decomposed by litharge. The soda so produced was crystallised in small lead cones, and when it had stood sufficiently long to crystallise, the cones were turned up side down to run off the mother liquor. The crystallising process was then only carried on in the winter months. C. Hunter, Esq., of Walker, further informs us that in 1816 he sold about half a ton of soda for Mr. Losh to a Mr. Anderson, of Whitby at 60*l.* per ton. The following details will embrace a brief account of the source of the raw materials, and the various improvements which have been recently introduced :—

Source of Sulphur.—Until within the last few years Sicilian sulphur was almost exclusively employed in this district for the manufacture of sulphuric acid—the pyrites from Wicklow being the only other source of supply. This latter, however, was not sufficiently abundant to render the manufacturer independent of the great fluctuations which have recently taken place in the price of sulphur, on account of the demand consequent on the vine disease. During the last few years the following additional sources of supply have become available :—1st, Belgian; 2nd, Norwegian; 3rd, Spanish or Portuguese; 4th, Italian; 5th. Westphalian pyrites. 1. The Belgian pyrites has the advantage of being shipped at Antwerp at a moderate freight to the Tyne. It is a very hard, compact material, containing about 50 per cent. of sulphur, and therefore nearly approaches a pure bi-sulphuret of iron. The burnt residue from one manufactory on the Tyne (the Walker Alkali Works) after being roasted in a lime-kiln to burn off the small remaining portion of sulphur, is regularly used as an iron ore at the adjoining iron works. It contains no copper, and from three to five per cent. of arsenic. 2. The Norwegian pyrites is shipped at Levanger. It contains 44 per cent. of sulphur, is easily broken, and does not readily flux in the kiln. The quantity of copper it contains being less than 10 per cent., the burned residue cannot be profitably smelted for copper. 3. The most extensively used pyrites is shipped from Huelva, in Spain, and Pomeron, in Portugal. The mines are situated on each side of the boundary between the two countries. They were most extensively worked in ancient times, but their recent development has arisen from the use of the ore as a source of sulphur. Containing only 2 to 4 per cent of copper, it was unable to compete with the richer ores which from time to time became available in different parts of the world, but the mining is now rendered profitable by the value of the sulphur being realisable as well as that of the copper. The percentage of sulphur varies from 46 to 50

The practical difficulty in burning this ore, namely its great fusibility at the point where the combustion of the sulphur gives rise to considerable heat, has been overcome by the adoption of kilns, first used in Lancashire, in which the area of the surface is large in proportion to the weight of the charged pyrites. The use of cupreous pyrites has led to the introduction of the manufacture of copper on the Tyne, which will this year amount to between 700 and 800 tons. The ordinary process of smelting is employed—but the moist method is also being tried, the advantage being that, by this method, all the ingredients of the mineral are utilised, the oxide of iron making an ore of similar quality to hematite. The smelting process, however, is still preferred in the large manufactories. In 1860 several cargoes of an ore containing free sulphur imbedded in gypsum were imported from the Island of Milo, in the Archipelago. From the small quantity of sulphur contained in it (19 up to 24 per cent.) there was great difficulty found in burning it, except the large masses. Subjoined is an analysis of one parcel of it :—Sulphur 24·00 ; gypsum, 62·20 ; sand, &c., 6·00 ; water, 7·00. Still more recently, Professor Ansted has discovered a deposit of free sulphur in Corfu, of which he has been kind enough to forward a sample, but we believe it has not been used in commerce. When sulphuric acid is wanted quite free from arsenic, Sicilian sulphur must be used. So largely has pyrites displaced sulphur in the production of sulphuric acid, that in 1862 only 2,030 tons of sulphur were consumed, against 72,800 tons of pyrites ; and, reckoning the above quantity of sulphur as equivalent to 4,500 tons it appears that 77,300 tons of pyrites are annually used for the manufacture of sulphuric acid, along with 2,500 tons of nitrate of soda. Assuming a produce of 120 per cent. on the pyrites, this is equal to a production of 92,760 tons of sulphuric acid, calculated as concentrated. This quantity of sulphuric acid is nearly all consumed where it is made, for the manufacture of other chemicals, such as soda and manures, the quantity sold being 6,440 tons, but this might be more correctly described as consumed in other works, for the quantity sent to a distance is very small. Four-fifths of the sulphuric acid is used for the decomposition of common salt.

Salt and the Alkali Trade.—The ordinary Cheshire salt is almost exclusively used for the manufacture of alkali, the exception being in one manufactory, where the waste heat of coke ovens is utilised in evaporating the liquors formed by dissolving rock salt. The anciently extensive salt works of Shields are now represented only by one or two comparatively small manufactories of salt, intended entirely for domestic use. Nearly all the salt used in the alkali works is carried by canal to Hull, Goole, or Grimsby, whence it is brought to the Tyne at a nominal freight, generally by foreign vessels, that take it as ballast when coming to the Tyne for an outward cargo of coals. This is the only practical result of the repeal of that portion of the navigation laws that prevented foreign ships carrying cargoes coastwise. The annual decomposition of common salt in the district is 90,000 tons, requiring 73,800 tons of sulphuric acid, and producing 100,000 tons of dry sulphate of soda. The whole of this quantity is used in the manufacture of alkali. A few hundred tons are consumed in the glass manufacture, but are left out of this account, as no account has been taken of the sulphate of soda made from the nitrate of soda in the sulphuric acid process. The alkali is produced in the four forms of—1. Alkali or soda ash, 43,500 tons. 2. Crystals of soda, 51,300 tons. 3. Bicarbonate of soda, 7,450 tons. 4. Caustic soda, 580 tons. The manufacture is so well understood that only local peculiarities and recent improvements need be noted.

Alkali.—All the Tyne soda ash is fully carbonated, sawdust being generally used in the furnace for this purpose, so that it contains merely a trace of hydrate of soda. The greater part of it is also refined by dissolving, settling, evaporating, and calcining ; producing thus an article of great whiteness and purity.

Caustic Soda.—This manufacture is as yet quite in its infancy in this district. In Lancashire very large quantities are made from the "red liquors" which drain from the soda salts. These liquors always contain caustic soda, sulphuret of sodium, and common salt. In Lancashire, where a hard limestone is used for balling, the percentage of caustic soda is large, while the sulphuret exists in small proportion, and it is easily oxidised. It would seem that the London chalk which is used here produces a lime, chemically much less energetic, forming less caustic soda, and holding sulphur more loosely in combination. Consequently, the Tyne red liquors require a very large quantity of nitrate for their oxidation, and yield so little caustic that this process has been abandoned in favour of the well-known method of boiling a weak solution of alkali with lime. This has the advantage, however, of producing a richer and very pure article, sometimes as strong as 74 per cent.

The improvements (besides such as have been already noticed) which have been introduced into the alkali trade since the last meeting of the British Association in Newcastle, may be divided into those which have been generally adopted, and the special improvements of individual manufacturers. 1st. Economy of labour has been attained by using larger furnaces, in which a workman can manipulate a larger charge with less toil, and by various other appliances purely mechanical. 2nd. Economy of fuel has been largely attained by the application of the waste heat and flame from the ball furnaces to the surface evaporation of the tank or black ash liquor. Formerly this was evaporated in hemispherical cast-iron pans, each with a fire below. 3rd. Economy of water and fuel by the adoption of the circulating tanks for lixiviating balls, first introduced at Glasgow by the late Mr. Charles Tennant Dunlop. They are so arranged as regards their connections with one another that water runs into the tank which has been most nearly exhausted, and liquor of full strength runs off the tank which has been most recently filled. The balls are always under the surface of the liquor, and thus escape the partial decomposition and consequent formation of sulphuret which resulted from the balls being subjected to successive washings and drainings off. 4th. Use of cast iron decomposing pans. 5th. Gay-Lussac's process for recovering and using again the waste nitrous acid in the manufacture of sulphuric acid has been adopted by several manufacturers; others consider that the expense of the erections and of working the process may be better applied in providing an additional amount of space in the leaden chambers. Special improvements.—1st. Revolving ball furnaces, invented by Messrs. Elliott and Russel, of St. Helen's, and used in the Jarrow Chemical Works. (See Jury Report by Dr. Hofmann.) 2nd. In the Walker Alkali Works the waste gas (carbonic oxide) from the blast furnaces of the adjoining iron works is conveyed by flues to the evaporating and calcining furnaces. The advantage obtained is not only economy of fuel, but a hot flame free from smoke and dust, and dispensing with the stoker's labour and tools. For easily regulating the bottom heat of the cast iron pan in which salt is decomposed it is found very useful. The carbonic oxide is, however, found not to burn very well in the presence of muriatic acid gas.

Hyposulphite of Soda.—The manufacture of hyposulphite of soda has largely increased of late years, and we believe in 1838 it was not made at all upon the Tyne. In 1854 the produce only amounted to 50 tons a-year. It has gradually risen to 400 tons per annum. In addition to being used in photography, it is largely employed as an "anti-chlor" in paper-making, and from the Tyne the markets of Europe and America are chiefly supplied. In 1852 Mr. W. S. Losh obtained a patent for the manufacture of hyposulphite of soda from soda waste, which has been the means of greatly lessening the price, and consequently extending its application in the arts. On account of its greater stability, hyposulphite of soda has nearly superseded the use of the older salt of sulphite of soda as an "anti-chlor," the latter being chiefly confined to sugar refineries as a deoxidiser. Dr. Jullion has recently obtained a patent for the production of hyposulphite of lime, to be used as an "anti-chlor," but it has not yet been introduced in commerce, the apparatus for its manufacture, in course of erection at the Jarrow Chemical Works, being not yet completed.

Hydrochloric Acid.—In the decomposition of common salt, vast quantities of hydrochloric acid are necessarily produced, and it is an important question for chemical manufacturers to apply the best means for its condensation. Since the visit of the Association in 1838, few branches of manufacture have received more attention, and there are few in which greater improvements have been effected than in condensing muriatic acid gas; and this has arisen not only on account of the necessity of preventing injury to agriculture, so that heavy claims for damage might be avoided, but also in consequence of the commercial value attached to hydrochloric acid in the production of bleaching powder, bicarbonate of soda, oxychloride of lead and other products. The methods generally adopted in condensing are well known, and we shall only allude to some of the improvements practically applied. The drying furnace usually used is what is called an "open furnace," to which the heat of the fire is directly applied, and we believe that the greatest difficulties in the way of a perfect condensation in former times arose with the gases from this furnace. The heat required to drive off the gas from the crude sulphate of soda is very great, and when the gases arrived in the condensers it was found difficult to absorb them, even when a very large quantity of water was used, and the muriatic acid which was thus produced was of so low a strength that it was commercially almost useless. In former years, also, the draught through the condensers was always obtained by a connection with a high chimney, but in some of the works this plan is now abandoned, and the whole of the vapour or gas which escapes passes through a 12-inch pipe always open to view. At present these gases are conducted through long flues or pipes and cooling shafts, and on entering the foot of the condensers the heat is reduced to about 140 deg. Fah., at which point the gases easily condense, and a strong acid is at the same time obtained. A rather different method has been pursued for some time at Messrs. Allhusen and Son's works. Instead of the heat from the fire being conducted directly on to the drying materials in the furnace, which is generally done, a "close furnace" is used, in which the flame from the fire passes over a brick arch and under the bed of the furnace, and not in immediate contact with the materials. This furnace has no connection with a chimney for its draught, and the gases from both the pan and dryer pass into one condenser. The hydrochloric acid passes off from the furnace unmixed with the smoke from the fire, and at a lower temperature than by the ordinary method, and is consequently more easily condensed, and obviates the necessity of long flues or cooling shafts. Messrs. C. Allhusen and Sons have given us the following results of some recent experiments with this class of furnace. The charge of salt usually used was 8 cwt., the moisture varied from 6 to 9 per cent., and the sulphate of soda contained from 1·75 to 2·25 per cent. of undecomposed salt:—

	Salt undecomposed.	Moisture per cent.	Theoretic weight of Acid.	Acid obtained.	Loss per cent.
1st Experiment	1·75	7·0	502·0	495·06	1·4
2nd "	1·70	7·0	498·0	489·00	1·8
3rd "	2·25	7·0	498·0	484·08	2·6
4th "	1·80	7·0	498·0	490·04	1·6
5th "	1·70	7·0	498·0	485·00	2·6
			Average . . .		2·0

As a further instance of the care that is now bestowed in condensing, we append also the result of some recent experiments conducted at the Walker Alkali Works to ascertain the actual quantity of muriatic water condensed. The daily produce was conducted into large stone cisterns prepared for the purpose, and the strength, depth, &c., was carefully ascertained. The salt used was also tested daily for moisture and impurities, such as sulphate, sand, &c. The former was found to average 6 per cent. and the latter 1 per cent. during six months' trial, thus leaving 92·5 per cent. Na. Cl. =57·7 H. Cl. in 100 parts of salt used.

The crude sulphate of soda produced was also daily tested for common salt left undecomposed, which is deducted below :—

		H. Cl.	Test of Sulphate.
January .	100 parts of salt gave	58·3	2·59
February .	,, ,,	53·0	2·24
March .	,, ,,	54·2	2·26
April .	,, ,,	57·4	2·14
May .	,, ,,	58·4	2·98
June .	,, ,,	53·9	2·12
Average H. Cl.		55·8	2·45
H. Cl. left in sulphate of soda		1·52	
		57·32	
Loss per cent.		0·38	
		57·70	

A patent was obtained in 1860 for the use of the weak acids in the place of water in condensing, which has been successfully carried out in the above works, and it will thus be seen that the whole of the acid produced was obtained and calculated without difficulty. Muriatic acid is not entirely free from impurities, and on account of its containing arsenic, iron, sulphuric acid, &c., it is not applicable to all purposes. The total quantity of hydrochloric acid produced is about 180,000 tons per annum.

Manganese.—Manganese is imported from Germany and Spain; but it is chiefly from the latter country that the richest ores are now obtained, which are found in hills consisting of schistose rock, which sometimes rise to a height of 800 feet from the level of the plain; but it is also found in "pockets," and, in the latter case, it is quarried by picks, and occasionally gunpowder is used. The quality of the ore varies from 50 to 90 per cent. per oxide, and to obtain the richer ore men and boys are employed to break and sort it, which is then put into sacks and carried a distance of twenty to thirty-five miles, on mules' backs, to the ports of shipment in the Mediterranean. The richest ores are obtained at Calanas, in the province of Huelva, thirty miles north of the ancient Roman fishing town of Huelva. We are indebted to Mr. S. F. Gething for this information, who also informs us that he imported to the Tyne, in 1857, the first cargo of Spanish manganese. Manganese ore frequently contains peroxide of iron, copper, cobalt, titanium, &c., but no means has hitherto been taken to separate them. Manganese is used in the manufacture of glass, iron, and of bleaching powder, and for the latter it is imported to the extent of 14,400 tons annually. Several patents have been taken out for the recovery of the manganese from the waste chloride of manganese solutions, but, generally, with indifferent success. The most successful, however, is the process of the late Mr. Charles Dunlop, of Glasgow, in which the manganese is precipitated as a carbonate, and finally oxidised. This patent has, we believe, been successfully worked at St. Rollo, in Glasgow, and has, to some extent, superseded the use of native manganese. Still more recently a patent has been obtained by Mr. Clapham for the separation of the free hydrochloric acid contained in the waste manganese solutions, and for its application in the manufacture of bleaching powder.

French Limestone, locally called Cliff, is imported as ballast from the Seine, and also from the coast of France, to the extent of 14,000 tons annually. It forms part of the upper chalk bed in the secondary deposits, and is nearly pure carbonate of lime, and, although very like chalk in its appearance, differs from it to some extent in being compact, harder, and less susceptible of retaining water. It is always used in this locality in preference to other limestones in making bleaching powder.

Bleaching Powder.—Since 1838 the method pursued in the manufacture of bleaching powder has entirely changed, and the quantity made has far more than doubled. At that time it was made by decomposition of manganese and common salt with sulphuric acid, which was a rather costly process, and the price was about 28*l.* per ton. It is now manufactured from what was at one time the waste muriatic acid referred to above, and the price has been reduced to one-third. During the last few years the demand for bleaching powder has been increased, partly on account of the extensive use of esparto grass from Spain, in the manufacture of paper, which has been found to require a large quantity of chemicals to bleach it, and nearly all the Spanish grass imported to this country is shipped to the Tyne. The quantity of bleaching powder now made is 11,200 tons annually.

Soap.—The first soapery in this locality was begun by Messrs. Lamb and Waldie, about the year 1770, at the Westgate, whence it was removed to the Close. The works were purchased by Mr. Thomas Doubleday, in 1775, and continued under the firm of Doubleday and Easterby until the year 1841. Other manufactories were built in Sandgate and at the Ouseburn, all of which have been abandoned. Very little hard soap was made until the end of the last century; what was used was Castile soap. Up to 1770 soft soap was chiefly used for both domestic and manufacturing purposes. The chief improvements introduced have been the use of palm oil, bleached by Watts' process, and the manufacture of the ley by boiling the alkali with the lime instead of the so-called "cold process." The total quantity now manufactured exceeds 6,000 tons per annum. The prices of various materials at the present time are as follows :—Tallow, first sort, T. C., 43s. 6d. ; fine American rosin, 36s. to 39s. ; best yellow soap, 33s. to 35s. ; best mottled soap, 33s. per cwt.

To be continued.

THE TOOT-POISON OF NEW ZEALAND.

By W. Lauder Lindsay, M.D. and F.R.S. Edin., F.L.S., &c.

During a tour through the New Zealand provinces in 1861-1862, the writer was struck with the abundant evidences which everywhere presented themselves of the ravages produced among the flocks and herds of the settlers by the *Toot-plant*, one of the most common indigenous shrubs of those islands. In many cases of losses by individual settlers brought under his notice, the amount from this source alone had been from 25 to 75 per cent. In Otago particularly were such losses felt during the height of the gold mania there, from July to December 1861 : the traffic between Dunedin and Tuapeka gold-fields required the service of large numbers of bullocks, a great proportion of which were lost by Toot-poisoning. In colonies which as yet, at least, have depended for their prosperity almost solely on pastoral enterprise, such losses form a material barrier to prosperity ; and the concurrent testimony of the colonists in every part of New Zealand proves the great desirability of determining the nature of the Toot-poison, the laws of its action on man and the lower animals, and its appropriate antidotes or modes of treatment. With a view to assist in the attainment of these aims, the writer had made notes, on the spot, of a large number of instances of the poisonous or fatal action of the plant on man—adults as well as children—and the lower animals, and had brought specimens home for chemical examination. The chief results of his investigations may be thus stated :—

1. The Toot-poison belongs to the class of *Narcotic-irritants.*

a. Its action on man includes the following symptoms :—coma, with or without delirium ; sometimes great muscular excitement or convulsions, the details differing in different individuals ; during convalescence, loss of memory, with or without vertigo.

b. In cattle and sheep, they include vertigo, stupor, delirium, and convulsions ; curious staggerings and gyrations ; frantic kicking and racing or coursing ; tremors.

2. The poisonous portion of the plant,

a. To man, is generally the *Seed*, which is contained in a beautiful, dark purple, luscious berry, resembling the blackberry, which clusters closely in rich pendent racemes, and which is most tempting to children ; occasionally the young *Shoots* of the plant, as it grows up in spring :

b. To cattle and sheep, in almost all cases, is the young *Shoot*, which is tender, and succulent, resembling in appearance and taste the similar state of asparagus.

3. The following *Peculiarities* exist in regard to the action of the Toot-poison :—

a. A predisposition must exist, such predisposition being produced in cattle and sheep by some of the following conditions or circumstances :—The animal is *not habituated* to the use of the plant ; it suddenly makes a large meal thereof after long fasting, or long feeding on drier and less palatable materials, or after exhaustion by hard labour or hot, dry weather. From some such cause, the digestive system is deranged, and is susceptible of more serious disorder from the ingestion of food to which the animal is, at the time, unaccustomed. Hence Toot-poisoning frequently occurs in animals which have just been landed from a long and fatiguing sea-voyage during which they have been underfed or starved, to whom the young Toot-shoots present the most juicy, fresh, pleasant diet.

b. On the other hand, the same kinds of animals, *habituated* to the use of the Toot-plant, not only do not suffer at all, but for them it is regarded as quite equal in value to, and as safe as, clover as a pasture food. It is an equal favourite with cattle and sheep, whether they have been habituated or not.

c. The predisposition in man is probably produced by analogous conditions depressing the tone of his nervous and digestive systems, or directly deranging them. *Children* are affected out of all proportion to *adults*.

d. Adults who have suffered from the poisonous action of Toot under certain circumstances have been exempt from such action under certain others—the same parts of the plant having been used, and apparently in the same way, in both sets of instances. Moreover, the Toot-berries enjoy, both among the Maoris and colonists, an enviable notoriety on account of the agreeable and harmless wine and jellies they are capable of yielding, the former whereof especially has long been greatly prized. The *seeds*, however, in these cases probably do not enter into the composition of the said wine and jellies.

4, The current *Remedies* for Toot-poisoning among the settlers are, in regard to—

a. Cattle and sheep—mainly bleeding, by slashing the ears and tail. Belladonna has been variously tried, and favourably reported on ; by others, stimulants are regarded as specifics (carbonate of ammonia, brandy, or a mixture of gin and turpentine, locally known as "Drench") Whatever be the nature of the remedy, there is no difference of opinion as to the necessity for the promptest treatment, since, at a certain stage of the action of the poison, *all* remedies appear equally inefficacious.

b. In man the nature of the remedy is still more varied, though emetics and stimulants seem the most rational of those usually had recourse to.

5. The *Toot-* or *Tutu*-plant is the *Coriaria ruscifolia*, L. (the *C. sarmentosa*, Forst.). The plant is variously designated by Maoris and settlers in different parts of the New Zealand islands; and this of itself indicates how familiar it is, and how abundantly and widely distributed. The genus *Coriaria* is a small one, and, if not belonging to a subdivision of the natural order *Ochnaceæ*, probably represents a separate order closely allied thereto and to the *Rutaceæ*. The most distinguished botanists, however, are at issue as to its precise place and alliances in the vegetable system. They are in similar dubiety as to the *species* of the genus, and the *varieties* of the species *C. ruscifolia*, L. In New Zealand there appear to be at least three *Coriarias*, which some botanists regard as mere varieties of *C. ruscifolia*, L., and others consider separate species. The writer had made, in July 1862, an examination of all the species of the genus *Coriaria* contained in the Hookerian and Benthamian Collections at Kew, the result whereof was a strong conviction of the necessity for a critical revision of the whole genus, throughout all its species, wherever distributed. The writer considers the specific names of the Toot-plant (both *ruscifolia* and *sarmentosa*) objectionable, as not truly applicable or descriptive; and proposes the specific term *C. tutu*—the Maori name of the plant, as more convenient to indicate the *type* of the species, leaving such terms as *ruscifolia*, *thymifolia* and *sarmentosa*, to represent varieties or other species, as a subsequent critical examination of the genus may render necessary or desirable.

In contrast to, and in connexion with the toxic action of *C. ruscifolia* the writer may remark on the better-known poisonous properties of *C. myrtifolia*, familiar as an adulterant of senna, and on those of other species of the genus *Coriaria*. He announces his belief that the whole genus *Coriaria* must be considered endowed with poisonous properties, probably of the narcotico-irritant class, and that, as such (especially in reference to the extent and importance of the economic losses caused by such species as Toot), it is eminently deserving of thorough scientific investigation.

Under this head he may point out the fact that—

a. While certain animals seem to be themselves exempt from, or insusceptible to, the action of the poison, they may, by feeding upon certain species, or certain parts of some species of *Coriaria*, and thereby assimilating or secreting the contained poison in their tissues, communicate poisonous effects, or become poisons, to man or the lower animals, to which they (the animals first mentioned) have become articles of diet. He would cite a recent instance in connexion with *C. myrtifolia,* in which several persons near Toulouse were poisoned by a dish of snails which had been fattened on its leaves and shoots.

b. That Royle in reference to the fruit of *C Nepalensis,* Peschier of Geneva in regard to *C. myrtifolia,* and other authorities in regard to other species of *Coriaria,* have published instances of their *harmless* or even *beneficial* effects, under certain circumstances, on man or the lower animals. Such conflicting statements would appear to indicate that there are peculiarities in the action of the poisonous principles of all the *Coriarias,* or discrepancies in the records of instances of the said action, which discrepancies or peculiarities demand reconciliation or explanation at the hands of competent scientific experts.

A VISIT TO A BONE BOILING FACTORY.

BY N. P. BURGH, C.E.

I believe that very few have any clear conception of the extent of the trade in bones, home and foreign, and the various uses to which they are applied, I therefore think that a brief account of a visit to the factory of Messrs. L. Cowan and Sons, Hammersmith Bridge Works, which I recently made in company with the Editor, may be interesting to the readers of the TECHNOLOGIST.

This factory, it should be observed, is on a large scale, being a complete *multum in parvo,* for here are carried on the several processes of soap-making, sugar refining, bone boiling, and charcoal burning, gas making, and a variety of other business operations. It is with the bone boiling process, &c., that I propose chiefly to deal.

The workmen employed are so numerous that they form a rifle corps in themselves, and have their own armoury, band, &c.

We import from abroad about 65,000 tons of bones annually for burning, for crushing, for manure, and for other purposes, and as much, or more, is collected at home. The prime cost of these bones is about three-quarters of a million sterling, while the after and subsidiary products add largely to their value.

The uses of the bone and its constituents are various. In order to explain the processes of its conversion into a commercial article, we must trace it through its several stages of manufacture.

Arrived at the office, and having obtained the permission of one of the affable and polite proprietors to inspect the works, with the assistance of an intelligent guide, we proceed to go over the entire range of buildings. On descending to the ground floor we first see a large quantity of bones in heaps in various places, some being in hampers, some in closed bins or receptacles, some in carts, and others in piles on the ground. On inquiring their uses, and the cause of the separation, we are informed that the very best are converted into animal charcoal, which is the chief product of the establishment, the large marrow bones are sent to France, and the thin bones are used for making knife, tooth brush, and other handles ; the ends of the bones are cut off by a steam saw, and used for buttons, small toys, &c. The bones are carefully selected into heaps, and each kind is boiled separately in open pans by steam at a low temperature, or not more than 212°. Marrow bones take from $1\frac{1}{2}$ to 2 hours; common bones, such as blade bones, small bones, &c., from 3 to 9 hours ; and the ends of the marrow and other bones require 10 hours to boil. The fat, which is white from fresh bones, and brown from old bones, is skimmed off, and as the pans are hung on an axis, the contents are emptied at pleasure into a truck on wheels beneath. The bones are then allowed to drain, and are transmitted to their required places.

When bones are submitted to destructive distillation, the gelatine and albumen which they contain is abundantly productive of ammonia; hence a copious source of that alkali and its compounds ; the residue is a mixture of the earthy part of the bone with charcoal, commonly termed bone black.

Bone black possesses the extraordinary property of appropriating to itself the colouring matter of nearly all fluids that are filtered through it, and so powerful is its agency in this respect, that in testing the quality of some bone black offered for sale, a dark coloured claret was so completely discoloured in a single filtration, through a depth of twelve inches of the black, as to be undistinguishable by the eye from the purest spring water. The introductiou of this powerful auxiliary has created a complete revolution in the process of manufacturing and refining beet sugar on the Continent, and cane sugar in the sugar colonies of the East and West Indies. The only drawback to its use was its cost, because formerly it was thrown away as soon as repeated filtrations had saturated the black with the colouring matter and impurities of the syrup, to such an extent as to deprive it of its efficacy ; but the discovery of a mode of renovating, or as it is technically termed, "*revivifying*," the bone-black has obviated this difficulty, by causing the manufacturer to use the same charcoal for an indefinite length of time with but little loss in quantity or quality. The process of revivification is simple and inexpensive.

Messrs. Leblay and Cuisinier have published a new process for reviving exhausted charcoal. They find that the power of absorbing colouring matter is restored on treating the charcoal with a weak boiling solution of caustic alkalies. They also state that the original absorbing power may be very much increased by pouring over it a weak solution of sulphate of lime.

If (says Mr. A. Aikin,) we throw into the fire a bone, even of the most solid kind, and from which all oily matter has been carefully separated (an old tooth-brush will serve for an example), it will be found first to crack, and then to burn with a large and bright flame, in consequence of the combustible gases into which the animal matter of the bone is in part resolved. If the bone is taken out of the fire as soon as it ceases to flame, it will be found to be of a bluish-black colour, from the charcoal which is the residue of the decomposition of the animal membrane. If the blackened bone be returned to the fire, the whole of the charcoal is at length consumed, and nothing remains but the white earth of the bone, commonly called bone-ash.

If instead of a single one a heap of bones is employed, and a fire is kindled in one part, it will spread by degrees to the whole heap, giving out more or less flame, and a strong heat; and in the treeless steppes of Tartary, and the pampas of South America, the inhabitants make up for the want of other fuel by burning the bones of their cattle, it being considered that the bones of an ox will produce heat enough to cook its flesh by. This, therefore, is another to be added to the many uses of bone. But by burning bone in an open fire, no other product is obtained from it except the ashes, while the horribly noisome odour of the gas which escapes combustion, renders this process a sore nuisance in any inhabited neighbourhood.

The decomposition of bone by heat in close vessels, whereby the action of atmospheric air is excluded, is well worthy of minute attention, both in consequence of the large scale on which it is carried on as a process of chemical manufacture, of the importance of the products obtained, and of the interest which it possesses in a scientific point of view.

The animal matter of bone is the only constituent part of this substance susceptible of decomposition by a heat brought up to low redness: in considering, therefore, the action of close heat on bone, the earthy ingredients may be considered as passive. The animal matter is either a substance analogous to skin, or is a mixture of membrane and jelly: the former opinion is supported by some of the most eminent modern chemists, but it is of no sort of importance to our present purpose which opinion is adopted, as all three substances are composed of the same ultimate elements and nearly in the same proportions. The four simple substances, then, of which the animal matter of bone is composed, are carbon, hydrogen, nitrogen, and oxygen; and of these the three latter, when in an uncombined state and at the usual temperature and atmospheric pressure, are in the form of gas. Now, when it happens that three substances, habitually gaseous, are combined with one naturally solid, and when these four substances are likewise capable of uniting together by two and threes, or, in other words, of forming binary and ternary compounds, the attraction that holds together all the four is easily disturbed by a moderate increase of temperature; in consequence of which the same elements, by arranging themselves differently, produce two or more different substances.

This is the case in the present instance. On exposing bone shavings even to a lamp heat, they are observed immediately to become black; shewing that the new compounds that are the result of this decomposition are not capable of combining with the whole of the carbon, but that part remains in the state of charcoal intimately mixed with the earthy matter. This mixture goes by the name of bone-black, or animal charcoal.

Part of the carbon combines with part of the oxygen, and forms carbonic acid, while part of the hydrogen and part of the nitrogen produce ammonia; the carbonic acid and the ammonia, as they are formed, combine and produce carbonate of ammonia, which, therefore, is another of the useful substances resulting from the decomposition of bone. Part of the oxygen and hydrogen combine and produce water; and part of the oxygen, the hydrogen, and carbon, by combining, produce a volatile oil of a strong and peculiar odour, which goes by the name of animal oil. The remainder of the carbon and hydrogen, with probably some nitrogen, combine and produce an inflammable gas. Thus the decomposition in close vessels of the single substance, bone, produces five new substances; namely, animal charcoal, carbonate of ammonia, animal oil, water, and an inflammable gas. A low red heat volatilises all these substances, except the first; which, therefore, when the process is performed on a large scale in iron vessels, remains in the retort separated from the other four compounds. The water, the carbonate of ammonia, and part of the oil, are condensed, and remain in the receiver; the inflammable gas, holding in solution another part of the oil from which it derives an inconceivably nauseous odour, passes off through a pipe, and is either conveyed into the ash-pit of the furnace, whence it is drawn up among the burning fuel and is consumed, or is set fire to as it issues from the mouth of the pipe; by either of which methods its noisome smell is for the most part avoided. The ammoniacal liquor likewise combines with a little of the oil, from which, however, it may for the most part be separated by redistillation; enough, however, of the oil remains united with it to produce that particular modification of odour by which spirit of hartshorn (for so this substance is commonly called) is distinguished from pure ammonia; or, by other processes, unnecessary here to mention, the ammonia is obtained entirely free from the oil.

As animal charcoal is the great product in Messrs. Cowan's establishment, our guide kindly explained to us the process of producing it which is thus: the bones are put into cast-iron retorts, which are carefully sealed—the furnace being heated to a great temperature for about 6 to 12 hours, according to the nature of the bones. As will naturally be presumed a waste occurs, 3½ cwt. of bones will produce from 2 to

$2\frac{1}{4}$ cwt. of charcoal, is of a deep black in colour, and charred in appearance. The charcoal is put in square wrought-iron cases carefully sealed, to cool, which occupies about 10 hours. After cooling, it is elevated by a steam platform, which can be raised, lowered, and stopped at a moment's notice, and as we were elevated from the ground floor to the crushing room by it, can testify as to its practicability. The charcoal, when cool, is crushed in horizontal mills of cast iron, at the rate of about one ton per hour. It has to pass through two mills in order to be crushed sufficiently fine, 1-6th to 1-8th of an inch square or diameter ; the finest or dust is again re-crushed between two horizontally revolving stones called French burrs. This last is used for making ivory black, a chief ingredient in blacking. The main use of the animal charcoal is as a purifier for sugar, but as the charcoal retains superficially some of the tenacious matter of the sugar as well as the impurities, it is found requisite to reburn the charcoal. For this purpose revolving retorts are used of the following dimmensions : inside length, 9 feet, inside diameter, 3 feet 9 inches ; number of revolutions, 1 in 3 minutes ; power required, 1 nominal horse to each retort. Those at Messrs. Cowan's are their own patented invention, and certainly display great conception on their part. The impure charcoal is washed and put into the retort at the front end by a door, 14 cwt. occupying 13 to 14 hours to effectually revivify, when it is taken out into square cases on trucks, and put into another compartment to cool, the top part being sprinkled with water to prevent the air from mixing with it. After remaining 10 or 12 hours, it is laid on the floor to a depth of about 3 to 6 inches, and allowed to effectually cool, after which it is put into bags of 1 cwt., and sent by barges to the respective city customers, the refiners, who pay only an agreed price for the use. We were surprised to find that the gas from the charcoal was treated as that from coal, and used to light up the entire factory, offices, &c, We were also told that the ammoniacal liquor was converted into sulphate of ammonia, by evaporation in open pans.

Many are the uses to which bone-ash is applied. When ground to moderately fine powder, it is the material of which the cupels of the gold and silver assayers are made, being at the same time very infusible and sufficiently porous to absorb the litharge and other impurities, while the fine metal remains on its surface.

When levigated and washed over, it forms an exceedingly useful polishing powder for plate and other articles. It is likewise the only material from which phosphorus is at present prepared. Part of the phosphoric acid is separated by the action of sulphuric acid from the lime with which it is combined in the bone-ash ; and this portion, when mixed with charcoal powder and strongly heated in an earthenware retort, is decomposed; the phosphorus is liberated in the form of vapour, and is consolidated by coming in contact with the cold water in which the beak of the retort dips. It is afterwards purified by filtration through leather in hot water, and is finally melted, likewise under water, in conical moulds, by which it assumes the usual appearance of stick phosphorus.

Many are the things thrown away as useless which, when circumstances allow of their being collected in considerable quantities, are found to be applicable to a variety of useful purposes; and in none is this observation more remarkably exemplified than in the subject of the present illustration. Thus, on investigation, we find that bone contains a considerable quantity of valuable nutriment, which may be extracted with greater or less ease in proportion as its cohesion is more or less overcome—that in its entire state it forms excellent handles for small brushes, and is also applicable to a variety of other similar uses—that the worker in steel employs it for case-hardening small and delicate articles—that, in proportion to its weight, it is the most valuable and active of all manures, and contributes in no inconsiderable degree to improve and increase the agricultural produce of all the districts where it is employed—that, in the absence of other combustibles, it may be and is largely used as fuel in the plains of Tartary and South America—that, by its decomposition in close vessels, it produces hartshorn, ammonia, and animal charcoal—and that, when burnt to ashes, it becomes useful to the assayer, furnishes a valuable polishing powder, and is the material from which phosphorus, that curious and interesting substance, the most combustible of all solids, is produced.

Our guide then showed us over the remainder of this large establishment, viz., the extensive departments for producing sugar and soap; the latter being made in large quantities, the description of these would however occupy too much space, and are already pretty well known.

THE TECHNOLOGIST.

ON THE ENGINEERING MANUFACTURES OF THE TYNE AND NEIGHBOURING DISTRICTS.

BY PERCY WESTMACOTT, C.E., AND J. F. SPENCER.

The north-eastern districts of the United Kingdom, long pre-eminent for mining operations in coal, and more latterly ironstone, have also been gradually rising into importance as the seat of most extensive engineering manufactories.

The unlimited supply of coal, an intelligent, hardworking, and enterprising population, together with the engineering necessities of such a large mining district, and convenient seaports, have combined to create a large and increasing demand for all classes of engineering manufactures.

As early as the year 1747, the Gateshead Iron Works were commenced, and the present proprietors, Messrs. Hawks, Crawshay, and Co., have now one of the largest engineering establishments on the Tyne. In 1793 millwright work was undertaken at Chester-le-street, paper, lead, corn, and other mills being constructed, and supplied to all parts of England, Scotland, Ireland, and abroad; in 1826 a large foundry business was added. In 1809 the Walker Iron Works, owned by Messrs. Losh, Wilson, and Bell, were commenced, and, as in the two establishments previously mentioned, the variety and extent of engineering work rapidly increased, as the demand arose, for an improved class of machinery and motive power. Mr. Losh, the late senior partner of the firm, is well known in connection with the introduction of wrought iron railway-wheels, an improvement that has materially tended to perfect the efficiency of the rolling stock. The manufacture of Losh's patent wheels was at one time a very large and important branch of the Walker Iron Works.

It may be interesting to notice, at the early date of 1784, the erection on the Tyne of one of Watt's steam engines for the owners of Walker Colliery, by Boulton and Watt. Mr. Losh purchased this engine in 1805 for the Walker Alkali Company, and it may yet be seen working daily at Walker, with its wooden beam and bed plate, and sun and planet crank motion.

In 1817, Mr. Robert Hawthorn, the present senior partner of Messrs. R. and W. Hawthorn, established the Forth Bank Engine Works, receiving as a partner his brother William in 1820. The increase from eight men in 1817 to nearly 1,000 in 1862 indicates very forcibly the progress of this well-known establishment.

Table showing the Average Number of Men Employed by Messrs. R. and W. Hawthorn, from the Commencement of their Works in 1817 to the Year 1862.

Years.	Average Men.	Years.	Average Men.
1817	8 to 10	1838 to 1842	511
1818 to 1822	42	1843 to 1847	726
1823 to 1827	108	1848 to 1852	907
1828 to 1832	216	1853 to 1857	890
1833 to 1837	318	1858 to 1862	984

In 1830, Mr. T. D. Marshall, of South Shields, commenced the building of steam tugs, and fitting them with machinery.

In 1838, the Hartlepool Iron Works were established by Messrs. Thomas Richardson and Sons. These works are now of considerable magnitude.

In 1844, the Tees Engine Works, now owned by Gilkes, Wilson, and Co., were established for the manufacture of large iron bridges, and similar constructions, locomotives, marine and stationary steam engines, and foundry work.

In 1847, the Elswick Engine Works were commenced with about 200 men, and although then only engaged in the manufacture of hydraulic and general machinery, there has been a later period (1858) when, with the manufacture of the Armstrong guns, the number of hands employed has amounted to upwards of 4,000.

In 1847, Mr. Renoldson, of South Shields, established shops for the construction of engines and boilers for tug steamboats.

As the increasing commercial interests of this country and the improvements matured in steam power, gave a fresh impetus to engineering manufactures, the undoubted advantages and facilities of this district were appreciated and availed of by Messrs. Palmer Brothers in 1852; Messrs. Morrison and Co., in 1853; Messrs. Thompson in 1856; and Mr. David Joy, of Middlesbro', in 1862.

In referring briefly to the progress and present condition of the engineering manufactures of the Tyne and neighbouring districts, it will be necessary to classify them under the following heads :—

1. General machine and mill-work ; 2. Stationary and steam engin eering ; 3. Locomotives ; 4. Marine engineering ; 5. Hydraulic machinery ; 6. Iron bridges, viaducts, lighthouses, &c.

General Machine and Mill Work.—During the past 116 years the following firms have contributed largely to the supply of first-class machine and mill-work of all descriptions:

Messrs. Hawks, Crawshay, and Co., Gateshead Iron Works ; Messrs. Thomas Murray and Co., Chester-le-street ; Messrs. Losh, Wilson, and Bell, Walker Iron Works ; Messrs. R. and W. Hawthorn, Forth Banks Engine Works ; Messrs. R. Stephenson and Co., South street Engine Works ; Messrs. Thomas Richardson and Co., Hartlepool Engine Works ; Messrs. Gilkes, Wilson, and Co., Tees Engine Works ; Messrs. W. G. Armstrong and Co., Elswick Engine Works ; Messrs. Morrison and Co., Ouseburn Engine Works ; Messrs. Thompson and Co., Spring Garden Engine Works.

With reference to the magnitude of the work undertaken by some of the above firms, it may be stated of Messrs. Hawks, Crawshay, and Co., Messrs. Losh, Wilson, and Bell, Messrs. Thomas Murray and Co Messrs. W. G. Armstrong and Co., and Messrs. Morrison and Co., that single castings have been supplied from 45 tons downwards, and there are capabilities for castings of even 60 tons.

As every description of paper, corn, lead, and other mills have been extensively constructed, it is impossible to refer to them in detail ; but the erection of a self-acting crane for delivering ballast at St. Anthony's Quay by Messrs. R. and W. Hawthorn, at the early date of 1820, is worthy of notice.

Stationary Steam Engineering.—Steam power was first practically utilised in mining operations, and its application was early introduced in the North Eastern mining districts by several of the engineering firms before referred to ; and the fact that the wants of a large mining district were almost exclusively supplied with steam power by local talent and capital is a satisfactory proof that there were the right men at the right time, to aid by their engineering experience the resources and trade of the district.

Among the engineering specialities of this district may be mentioned many large winding and blowing engines. Messrs. Hawks, Crawshay, and Co., have cast and bored cylinders of 108 inches diameter for this class of engine.

In 1822 Messrs. R. and W. Hawthorn first applied steam to drive their lathes, and in 1824 they constructed a 50 HP engine for the Plate Glass Works of Messrs. Cookson and Cuthbert, and this engine is still doing efficient duty. At this period the same firm also fitted a self-acting steam crane, for delivering ballast at Hebburn Quay on the Tyne.

Several of the firms previously mentioned have extensively supplied steam cranes of various powers—Messrs. Thompson and Co. alone having made upwards of 200.

Messrs. Morrison and Co. are noted for their large steam hammers which they have extensively supplied to the Government, the Elswick Engine Works, and other large establishments, and they have them in their own works of 15 to 20 tons weight together with two steam cranes capable of lifting 50 tons each.

Although not quite finished, yet on account of its excessive magnitude it is of some interest to note here that Messrs. Morrison and Co. are now engaged in completing a monster steam hammer for the Russian Government. The forging for the hammer piston is 40 tons, and the enlarged part of the same is 6 feet 6 inches diameter, finished size. The total weight of this hammer, when completed, will be about 550 tons; the bed alone being 240 tons, and will be cast in three pieces, in its final resting place. It is believed this will be considerably the largest steam hammer in the world.

The application of steam power to underground haulage has been successfully introduced by Messrs. Thos. Murray and Co., of Chester-le-street, the steam being conveyed to engines underground, from boilers placed above the surface. In this case there are a pair of 18-inch cylinders and 3-feet stroke, working four drums, all on separate shafts, for drawing on a plane and incline.

Messrs. Murray and Co. have lately erected two 200 high-pressure condensing engines for winding at Ryhope New Winning, the cylinders are 68 inches diameter and 7-feet stroke. These engines can deliver 2,000 tons per day, from a depth of 300 fathoms. Also at North Seaton a winding and pumping engine, cylinder, 60 inches diameter and 7-feet stroke, fitted with the first hollow plate iron beam.

Messrs. Losh, Wilson and Bell were early in the field in the construction of steam engines for mills, collieries, and iron works. This firm erected a large pumping engine about thirty years ago for Friars Goose. Also at later dates a large pumping engine for the North Seaton Colliery—diameter of cylinder 76 inches, and 8 feet stroke; 60 inch double cylinder high pressure engine for the Burradon Colliery, and many engines for blast-furnaces and winding, having steam cylinders of 38, 40 and 42 inches diameter. At the present time this firm is largely engaged in the manufacture of surface condensers for mill and other steam engines, in connexion with Mr. J. F. Spencer, the patentee of certain improvements in their application to existing and new engines. This short and limited notice of such an important subject as the development of stationary steam engineering can only serve to indicate in a very limited degree the engineering capabilities of the district.

Locomotive Engineering.—To this district belongs the undoubted honour of being the birth-place of the locomotive, and this fact must ever be recorded, when the names of Trevethick and Stephenson appear on the page of history. In a paper written expressly to record contributions to the engineering talent of the country, it would be simply unjust to forget in the now almost world-wide extension of locomotive manufacture, the Stephenson "Rocket" of 1829, or the Hawthorn "Comet" of 1835. The latter engine which was used at the opening of the Newcastle and Carlisle Railway can still be seen in daily work, at the Saw Mills of the Forth Bank Engine Works. During the past thirty-four years, upwards of 2,400 locomotives have been constructed by R. Stephenson and Co., R. and W. Hawthorn, Gilkes, Wilson and Co., and Sir W. G. Armstrong and Co. In the above number are included all the known varieties of the locomotive, from the comparatively small tank engine, to those magnificent specimens constructed by Messrs. R. Stephenson and Co., for the late Viceroy of Egypt.

Marine Engineering.—It would display an unwarrantable indifference to the birth and progress of great improvements, if reference was not made to the first practical application of steam power on the Tyne, for towing purposes, more especially as the date of such application was almost coeval with Henry Bell's "Comet" on the Clyde in 1812. It is also of interest in an engineering point of view, to place on record the names of those local firms who were the earliest in the field in making and fitting the first steam engines for Tyne tugs.

In 1814, the first steam tug, the "Perseverance," was fitted and started on the Tyne, there being at that time only seventeen steam boats in existence. The Table on the following page gives the particulars of the introduction of steam for towing purposes on the Tyne from 1814 to June 1822. From this it will be seen that the now existing firms of R. and W. Hawthorn firstly, and Hawks and Co., secondly, made and fitted steam engines for tugs as early as the years 1820 and 1821. This reference to the beginning of steam navigation and manufacture of Marine Engines on the Tyne, is the more important from the well-known fact, that almost all the ports of the United Kingdom, as well as those of foreign countries, have, to the present day, come to the Tyne for their steam tugs. From this fact it may be fairly assumed that the Tyne Engineers have from the first supplied a most important want, in a manner that has defied competition—and even now it is difficult to suggest any important improvement in the class of engine that has been working in these Tugs during the past forty years.

Some additional force is given to the last statement, by the fact that at the present time there are upwards of 250 of what may be aptly termed "native steam tugs," employed on the Tyne, besides nearly 100 more in the ports of Sunderland, Stockton, Middlesbro', and Hartlepool, and the engines in all these are almost identical in type with those fitted in 1820.

Among the evident causes for the rapid extension of marine engine construction in the ports of this district are the early introduction of steam power for towing purposes, and more lately the increasing substitution of steam for sails in the coal carrying trade, leading to the introduction of screw colliers. These latter may be fairly considered with reference to this district as native productions; and, furthermore, they have proved stepping-stones to the construction of the higher classes and larger powers of marine engines.

STATISTICS HAVING REFERENCE TO THE INTRODUCTION OF STEAM POWER FOR TOWING PURPOSES ON THE TYNE.

Date.	Name of Steamer.	H.P.	Engine Builders.	Total number employed in the United Kingdom.
1814	Perseverance	3	Crowther	17
1815	Swift	3		21
1816	Eagle	20	Watt	31
1817	Enterprise	5	Robson	40
1818	Speedwell	10	Robson	52
1819	Hope	6	Robson	64
„	Swift	3	Robson	65
1820	Tyne	10	Robson	78
„	Two Brothers	9	Robson	79
„	Indefatigable	8	Hawthorn	80
„	Duchess of Northumb.	10	Hawthorn	81
1821	Navigator	18	Hawthorn	117
„	Safety	14	Hawks	118
„	Union	4	Gibson	119
1822	Lemington Packet	7	Hawthorn	143

As before stated, Messrs. R. and W. Hawthorn were the first of the now existing firms to make engines for steamboats, and during the past ten years especially they have been extensively engaged in fitting marine engines, both paddle and screw, up to 250 HP. In 1859 they applied most successfully to the "Frankfort," 100 HP., of Liverpool, Mr. J. F. Spencer's system of surface condensation, and they have more lately applied the same arrangement with equal success to a pair of 140 HP. screw-engines which they made and fitted into the "London," for the Cadiz trade, the economy of fuel being considerable.

The same firm have also supplied her Majesty's Government, with 150 HP. horizontal screw engines for H. M. S. "Shearwater"—these engines are fitted with separate expansion valves, worked by a second link.

Messrs. Hawks, Crawshay and Co., have constructed several pairs of marine engines, paddle and screw, for river and sea service, and they date the commencement of this class of work as early as 1821.

In 1830, Mr. T. D. Marshall, of South Shields, commenced building and fitting steam tugs, and out of the 600 engines his firm have made since that date, upwards of 300 have been fitted in steam tugs. Marshall's steam tugs being well known in every port. The present firm of Marshall Brothers are still largely engaged in the construction of paddle and screw engines.

The names of Renoldson, Almond, and Hepple are also well known as producers of steam tug engines, on a large scale, and it may be safely stated that upwards of 1,000 tug engines have been made and fitted on the Tyne.

Messrs. Thomas Richardson and Co. of Hartlepool have paid much attention to marine engineering, and are now engaged in perfecting several improvements therein.

Messrs. R. Stephenson and Co. have employed a large portion of their extensive establishment in the construction of marine engines, and in addition to a long list of engines fitted, of various powers, they put on board a Sardinian frigate a pair of 250 horse power horizontal screw engines for the Sardinian Government.

In 1852, Messrs. Palmer Brothers established the Jarrow Engine Works, where have been manufactured and fitted on board a considerable number of marine engines, paddle and screw, and some of them of large power, having 90 and 80 inch cylinders. During the past eighteen months this firm has introduced surface condensation into several pairs of engines, adopting an American plan for jointing the tubes. These engines are reported satisfactory for duty and economy of fuel, and there are several pairs in hand on the same plan, having 63 and 60 in. cylinders. Of the latest and most successful of this firm's engines, may be mentioned those of the Georgia, having 60 inches cylinders, giving a high speed, and small consumption of fuel.

Messrs. Morrison and Co. of the Ouseburn Engine Works, have given much attention to the construction of marine engines up to 250 horse power, and have applied Hall's surface condenser, separate expansion gear and steam jackets, with much success.

The mail steamship "Auckland," with the improved engines referred to, of 150 horse power, has proved on her trial an economical and successful ship.

Messrs. Thompson and Co., of the Spring Garden Engine Works, have, especially since 1856, been largely engaged in the construction of marine engines up to 200 horse power, and they have also paid some attention to economy of fuel.

Messrs. Gilkes, Wilson, and Co., of Middlesbro', and Mr. G. Clark, of Sunderland, are also engaged in marine engine construction, but have not furnished any information as to extent or speciality.

In this limited notice of what is now a most important branch of engineering industry in this district, it is important to state that the north country engineer has to provide a larger and more powerful marine engine at a less cost per horse power than the engineer on the

Thames, and this unjust difference has tended materially to check in this district the manufacture of the higher class of marine engines.

Finally, it may be confidently stated, there is a general desire among the north country engineers that quality of workmanship following price should be superseded, by price following quality of workmanship.

Several of the large firms just referred to have every capability, in extent and convenience of shops and tools, for supplying the largest engines that may be required for her Majesty's navy or mail steam-ships.

Hydraulic Engineering.—It will be necessary under this head to refer separately—First to the application of machinery for removing or supplying water; and, secondly, to the application of machinery in using water as a motive power.

Extensive mining necessities require the constant attention of the mechanical engineer, especially to provide large and capable machinery for discharging water from great depths, and it is a matter of much satisfaction when such machinery can be designed and applied on the spot.

The following brief reference to the productions of local firms in addition to the supply of machinery for water work, &c., will clearly show that this district has reaped the full benefit of such local designs and applications.

Messrs. Thomas Murray and Co., of Chester-le-street, have applied steam power extensively to pumping for colliery purposes, and completed some of the largest colliery pumping engines in the district, some of them being 200-horse power, with 60 and 68 inch steam cylinders.

Messrs. R. and W. Hawthorn were very early in the field in the construction of large engines for pumping, and in 1834 they erected a single acting pumping engine with 55 inch cylinder, and 8 feet stroke for the Newcastle Subscription Water Company. This engine was the first erected in the neighbourhood with steam jackets and valves, on the Cornish principle. It was at a later date (1854) converted into a double acting engine, and is now doing duty at Newburn.

In 1845, several large pumping and winding engines were erected by the same firm, at the various collieries in the North of England, among which was a powerful pumping engine of 250 nominal horse power, at Walbottle Colliery, on the Tyne, with steam cylinders, 77 inches in diameter and 10 feet stroke; it was erected to drain a large coal-field area, where it is now working.

In 1847-8, several first-class water-works' engines were manufactured and erected by the same firm in the towns of Newcastle, Derby, Nottingham, Wolverhampton, and Brighton; and in 1858 they erected powerful double-acting, combined, high and low pressure, rotative, beam engines, at the works of the Nottingham Water Works Company, the Coventry Water Works Company, and at Altona, near

Hamburg, for the supply of that city with water, under the direction of Thomas Hawksley, Esq., C.E. These last named engines performed a duty of 110 millions, with 112 lbs. of coal, the consumption being only $2\frac{1}{2}$ lbs per indicated horse power. An arrangement for causing the governor to act directly upon the steam valves, was introduced in these engines with perfect success, giving them great steadiness in working, and effecting a considerable saving in the quantity of steam used.

Messrs. Hawks, Crawshay, and Co., of Gateshead, have constructed and erected at the Hull Water Works the largest pumping engine that has been made in this district.

The steam cylinder is 85 inches diameter, and stroke 10 feet 6 inches, the plunger pump being $34\frac{5}{8}$ inches diameter, and the same stroke as the steam cylinder. The beam engine is single acting, and capable of lifting nearly two tons of water 174 feet high each stroke. The same firm has also erected a large pumping engine for the Water-Works at Scarboro'. The steam cylinder is 45 inches diameter, and stroke 8 feet. This is a single acting beam engine, worked expansively.

Messrs. Morrison and Co., of the Ouseburn Engine Works, have made several large pumping engines. One pair was erected at Cleadon Lane, for the Sunderland and South Shields Water Company. There are two steam cylinders, each 60 inches diameter, and stroke 8 feet, worked expansively.

Messrs. Losh, Wilson, and Bell, have also erected several large colliery pumping engines.

Sir William G. Armstrong and Co., in addition to their extensive application of machinery for applying water as a motive power, have constructed the engines for the Durham Water Works, together with other pumping engines for collieries, and they have been successful in introducing a self-acting valve to water works supply pipes, that effectually shuts off the supply in the case of a pipe bursting.

Of the second division, or the use of water as a motive power, there is a distinct speciality of manufacture pertaining to this district in the machinery produced by Sir W. G. Armstrong and Co., at the Elswick Engine Works, and the following somewhat full reference to this subject may be justified by the fact that the manufacture of this class of machinery has been exclusively confined to this district.

At the meeting of the British Association for the Advancement of Science, held in the year 1854, Sir William (then Mr.) Armstrong read a paper on the "Application of Water Pressure Machinery," wherein he described the origin and principles of his invention in the system of hydraulic machinery now referred to. Since that period, many improvements have been introduced, but the principles effected remain the same.

The application of water power is classed under two conditions—viz., the one where the pressure is obtained from natural sources, the other where it is generated by artificial means. The employment of a natural supply has remained limited, owing to such supply being confined to districts generally unfavourable for the erection of works, and the important and extended application of hydraulic machinery, which has taken place in nearly all the principal docks, railways, and government establishments in this country, is due to the invention of the "accumulator" for producing artificial pressure, usually made equal in effect to a head of water of about 1,500 feet.

This high pressure system has been adopted, with economy to a great variety of purposes, such as to cranage, waggon lifts, coal drops, hoists, and tipping machines, to the working of turn-tables, traversing machines, hauling machines, capstans, &c., but in no one branch of labour, perhaps, has this economy been more exemplified than in the loading and discharging of vessels, particularly those employed in the coal trade.

Nearly 1,800 hydraulic cranes, hoists, and other machines of this description, have been applied, and 174 steam engines, having a collective power of more than 5,200 horse power, are employed in supplying the pressure required for working them. In addition to these, 177 hydraulic engines of various forms and powers have been produced, and 23 moveable bridges receive their motive power from hydraulic machines.

The most novel and noticeable arrangement for the discharge of coal from vessels, through the intervention of hydraulic machinery, is to be seen on board a vessel, belonging to Mr. Cory, moored in the River Thames. This vessel, originally built for other purposes, has been converted into a floating wharf, and is fitted up with a steam pumping engine, accumulator, six hydraulic cranes (which weigh the coal at the same time), two hydraulic capstans and a variety of appurtenances for facilitating the work by day and by night.

Rapidity of discharge is the great feature of this scheme. Steam colliers carrying 1,200 tons of coal are delivered in ten hours. Such vessels plying between the Tyne and the Thames, have accomplished the voyage in 96 hours, *i. e.* they have loaded and discharged each cargo in one tide, or made the passage in three tides each way. Two such vessels can be delivered at the same time alongside Mr. Cory's floating wharf, thus rendering the power equal to the discharge of about 5,000 tons of coal, in the 24 hours.

The application of hydraulic hoists for shipping coal, has met the difficulty formerly felt in loading from low levels, at a comparatively moderate cost, which may be seen from the following figures:—

At the Newport Docks, Monmouthshire, in the year 1862, 218,486 tons of coal were shipped from three hydraulic hoists, worked by six men. The sum paid in wages, stores, and repairs, amounted to 501*l.* 6s. 2d. The cost of supplying the pressure amounted to about 250*l.*, which gives a charge of about 0·276 of a penny per ton for the pressure, and 0·552 of a penny per ton for wages, stores and repairs. These figures are exclusive of the interest upon the outlay of capital. Before the introduction of hydraulic machinery at these docks, the cost of loading coals by hand amounted to between 5d. and 7d. per ton.

In point of despatch the hydraulic is equal with the gravitation system, both being limited by the labour of trimming the coal in the hold of the vessel.

The most remarkable application of a hydraulic machine for loading coals is the one now constructing at Goole Docks, in connection with the system adopted by Mr. Bartholomew for the coal traffic upon the Aire and Calder Canal. The barges, carrying 33 tons of coal each, will be lifted by this machine out of the water, and their contents tilted directly into the hold of the vessel to be laden.

Recent improvements in the construction of rotatory engines have so simplified and condensed their form, that the application of this class of engines to all kinds of purposes is rapidly extending. A seven-horse power hydraulic engine, worked from the ordinary high (accumulator) pressure, occupies a space of two and a quarter feet square by nine inches deep. Such engines are now being applied directly to new, as well as to the existing, dock gate crabs at the Liverpool Docks, without at all disturbing the present arrangement of the hand power gear of these crabs, which can thus still be used by hand in cases of emergency. Other engines are similarly applied directly to the crabs of hand-power cranes, swing bridges, and other hauling appliances; to capstans, machines for planing armour plates, &c. The latest improvements in hydraulic engines consists in making them with variable power, so that their consumption of water may be the better proportioned to meet any fluctuations in the amount of work to be done. An engine of this description, capable of being worked up to seventeen horse power, under an ordinary accumulator pressure of 700 lbs. per square inch, was exhibited in the collection of models at the British Association meeting.

The advantage of the system of storing up pressure in accumulators, so that a great force can be quickly brought to bear upon heavy masses, to be rapidly moved for limited distances, is well exemplified in its application to moveable bridges, and the importance is the more felt, in situations where traffic would be seriously impeded by slow action, as, for instance, at the part of the Swansea and Neath Railway, where the line crosses the mouth of the river, and the entrance to the dock in Swansea. The communication of the line is kept up over these two points, by hydraulic draw-bridges. The time occupied in lifting and drawing back the largest bridge—which has a space of 75 feet and weighs 260 tons—is under 1¾ minutes. At Wisbeach, where the plan of storing up pressure in an accumulator by hand pumps, is resorted to, a bridge weighing 450 tons, can be opened or closed in less than two minutes.

In noticing the application of water pressure, derived from natural sources, to the working of machines upon the system introduced by Sir William G. Armstrong, no better reference can be made than to the complete and extensive works erected upon the lead mines at Allenheads. The hydraulic machinery is therein employed in rising materials from mines; in giving motion to machines for washing, separating, and crushing ore; in pumping water, and driving saw mills and the machinery of a workshop.

The most recent application of water power at these mines deserves especial notice from its novelty. The district upon which the several new works are placed, is void of falls of sufficient altitude for working the engines and machines directly, but a river runs through the district which is suitable for overshot wheels, and through such mediums the stream is made to force water into accumulators, thus generating an intensified power, which is utilised by compact machines distributed in situations most convenient for their several duties. The principal objects sought in thus intensifying the pressure is to lessen the size of the pipes, cylinders, and valves of the machines, and to gain more rapid action, and also by so reducing the size of parts, to effect a saving in outlay upon the work generally.

Iron Bridges, Viaducts, Lighthouses, &c.—The art and manufacture of iron bridge building, and of other similar iron structures, which form such an important feature in railway construction and harbour improvements, are followed to a considerable extent by several engineering firms in this district.

The following brief notice of some of the most important of these works can only be taken as an index of the resources of the district in this direction.

That noble structure which spans the river Tyne, and forms a communication of road and rail at a high level between the towns of Newcastle and Gateshead, emanated, as is well-known, from the same practical mind and genius that, with dauntless courage and rare skill, threw railway bridges across the Menai Straits and the St. Lawrence River.

The superstructure of the High Level Bridge was executed by Messrs. Hawks, Crawshay, and Sons, of Gateshead. This firm has recently erected the cast-iron bridge at York, from the designs of Mr. Page; it spans the river Ouse in one arch of 172 feet in width. Also the new bridge at Sunderland, which consists of a single arch of about 237 feet span, at a level of about 90 feet above high water mark. A melancholy interest is attached to this bridge, it being one of the very last works designed and undertaken by the late Robert Stephenson.

Messrs. Hawks, Crawshay and Co. likewise constructed the wrought iron gates for the Northumberland Docks, and the iron lighthouses at Gunfleet, Calais, and Harwich; and supplied the iron pier at Madras, a work of considerable magnitude.

Messrs. Robert Stephenson and Co., have been engaged upon the construction of wrought iron gates for docks, and have made 38 wrought iron bridges, amongst which, as most noteworthy, may be mentioned the Kaffie Azzayat Bridge over the River Nile. The total length of this bridge is 1,607 feet. It is composed of four fixed openings, each 114 feet wide, and two swing openings, each 80 feet wide. The girders are box shaped, and are carried upon wrought iron cylinders, 10 feet in diameter and about 90 feet long. The gross weight of this bridge, with the supporting cylinders, amounts to 2,634 tons.

The firm of Gilkes, Wilson and Co., of Middlesbro', have recently executed from the designs of Mr. T. Bouch some lattice bridges for the South Durham and Lancashire Union Railway, of a peculiar light and cheap construction. Of these the Beelah Viaduct may be looked upon as the most interesting specimen of construction and workmanship. It is constructed upon a somewhat similar plan to the celebrated Crumlin Viaduct, from which, however, it differs in many essential points. This Beelah viaduct consists of fifteen pieces, composed of hollow columns. The span of the lattice girders, forming the roadway, is 60 feet in width. The total length is 1,000 feet, and the greatest depth, from the rail to the ground, is 195 feet. The quantity of materials used in construction consists of 776 tons of cast iron, 303 tons of wrought iron, 12,343 cube feet of Memel timber for roadway.

Sir William G. Armstrong and Co. have been engaged extensively in designing and manufacturing iron bridges. They have constructed 25 moveable and 44 fixed bridges. With one or two exceptions, the whole of the former are worked upon the hydraulic system introduced by them.

The swing and draw bridges at the Birkenhead, Liverpool, and London Docks, and upon the Swansea and Neath and Great Western Railways, are among the most noteworthy of this class. The largest fixed bridge constructed by this firm is the one which crosses the river Somme, in India, made after the plans of Mr. G. Rendel, now one of the partners of this firm. Being about one mile in length, it boasts of being the longest bridge but one in the world. It is formed with 28 spans. The girders, carrying a railway platform above, and a common roadway beneath, are of the lattice construction, the top section being composed of wrought iron boxes, and the lower section of tension bars. The girders are carried upon brick piers. The total weight of this bridge, including the pier superstructures, which are of iron, is about 4,000 tons. Sir W. G. Armstrong and Co. have also turned out from their works caissons, dock gates, pontoons, coffer dams, saddle-back barges, wrought iron dredgers, and a variety of works of this description.

There are many other firms in the district engaged in constructing classes of work similar to those before referred to. Enough, however, has been said to show the important position which this district holds in the branch of industry whose history and development have been shortly traced in this paper.

THE PRODUCTIVE RESOURCES OF CYPRUS.

BY MR. WHITE, BRITISH VICE CONSUL.

Cyprus was in olden times, perhaps, more famous for its mineral than for any other of its productions. The copper mines were especially rich, and the quality of the copper which they yielded, the "æs cyprium," was considered superior to any other. Mines of the more precious minerals, gold and silver, were said to exist, and even to have been worked in antiquity, although at the present time their existence is unknown, and no mines of any description are worked. The mineral wealth of the Island is, however, a subject well worthy the attention of the Government, and it is to be lamented that no inquiry should have been made as to their state. The copper mines, formerly so celebrated, can hardly be supposed to have been exhausted. Asbestos, or amianthus, of a superior quality is found in the country between Limassol and Baffon: it is white and silky, and the fibre is very delicate. Copperas, or blue vitriol, was an article of exportation, during the seventeenth century. Talc is very common in the Island, especially about Larnaca; a kind of rock-crystal, called the Cyprus diamond, is found near Baffon; umber is also obtained in great quantities, and is exported to England, America, and Leghorn.

If the mineral wealth of Cyprus is at present neglected, such is not the case with its salt lakes, from which much and increasing profit is derived. There are two lagunes from which the salt is obtained in Cyprus—one near Limassol, and the other near Larnaca. The salt yielded by the former is the whitest, but that of the latter the most pungent. Salt was an important source of revenue in the times of the Lusignan princes. The Venetians still later are said to have charged annually 70 large vessels with salt. The Turkish Government, till within the present year, has been accustomed to farm out the salt lakes for sums varying from 200,000 piastres to 300,000 piastres per annum—that is, from 1,800*l.* to 2,700*l.*; but this system has now been abandoned, and it has been found that the quantity of salt yielded this year is 20,000 arabas of 1,000 okes, or $1\frac{1}{4}$ tons each: allowing 20 per cent. for loss, this represents 20,000 tons of salt, which, at 500 piastres the araba, the price at which it is sold by Government, gives 8,000,000 piastres, or 72,700*l.*; this quantity, however, cannot always be sold in one year. The salt is heaped up in large mounds by the side of the lakes, and the produce of the former year must be sold before that of the new year can be touched.

The pine is almost the only tree useful for construction that grows in any quantity in Cyprus. Extensive pine-forests exist in the higher mountains, especially in Troodos; some of the trees are of considerable size, but there are no roads by which large timber can be transported to the shore. The woods are wantonly thinned by the peasants, who frequently fire them. There is no kind of provision for the preservation of the forests, a circumstance which is much to be regretted, owing to the great scarcity of trees generally in the island. Cyprus is known to have been well wooded in ancient times, when it was probably more healthy and more productive than at present. The want of trees is very much felt, and the dryness and aridity of the soil is doubtless owing to the great lack of trees, whose presence would be invaluable as a means of attracting rains to the earth.

It has been calculated that not more than 100,000 acres of land are annually placed under cultivation. This represents only one seventeenth part of the island; but as land is left to lie fallow every alternate year, we may consider that the quantity of land under cultivation is 300,000 acres, or between one-eighth and one-ninth of the island. The greater part of the cultivated land is held by peasants, or small proprietors; there are, however, exceptions, and we find sometimes as many as 3,000 echelles, or upwards of 2,000 acres held by single proprietors. Land in general is cheap, but its price varies according to its adaptation for certain crops, its means of irrigation, and its greater or less distance from any town or village. In the Messaoria land averages from 2*l.* to 3*l.* 10s. the acre. Good cotton land in a favourable position is worth about 9*l.* the acre; but madder root land at Famagusta commands a very high price, as much as 90*l.* per acre having been paid for it.

The chief products are wheat, barley, sesame, vetches, cotton, silk, madder-root, wine, olives, raisins, carobs, tobacco, and colocynth. The wheat of Cyprus is hard and small-grained. That grown in the district of Baffo is considered the best. The seed time for wheat commences in October, and the sowing is continued, as the weather permits, until the beginning of January. The harvest commences at the end of May or beginning of June. The average yearly produce of wheat is about 80,000 quarters; last year's harvest was unusually good; it is supposed to have yielded as much as 120,000 quarters.

The barley of Cyprus is of a good description, and superior to the ordinary Egyptian barley; it is sown during September, and the two following months, and is reaped at the close of April and beginning of May, thus preceding the wheat harvest by about six weeks. The average yearly produce of barley is 120,000 quarters. The harvest of the past year, which, as stated above, was very abundant, yielded 180,000 quarters. The average yearly value of wheat and barley exported, from 1857 to 1860, was 33,000*l.*

The cotton of Cyprus is of an inferior quality; it is of the short-stapled variety; American cotton-seed has, however, latterly been introduced, and its cultivation having proved very successful, its merits are becoming thoroughly appreciated by the growers. We may therefore look forward to seeing it largely introduced, and gradually supplanting the native cotton. The quantity of cotton produced is small, considering the great capabilities which the island possesses for the culture of this important plant. It was anticipated that last year's produce would be as much as 10,000 bales; but owing to the injury sustained by the plants, which were withered by the north winds, the harvest has in reality fallen short of 7,000 bales, or 1,820,000 lbs. This is perhaps only a twentieth part of the quantity of cotton which the island is capable of producing. Under Venetian rule, Cyprus, according to Mariti, exported annually as much as 30,000 bales, or 6,600,000 lb. of cotton. The greater part of that now exported goes to France, by Marseilles.

The best time for sowing cotton is in the month of May; of late years, however, the sowing has been deferred to the end of June, and even to July, in order to avoid the ravages of the locusts; much loss is caused by deferring the sowing till so late. The ground in May is still soft, and better fitted for the reception of the seed than in June or July, when it has become hard and dry. The cotton, too, which is sown early, arrives at maturity, and is fit for picking, before the October rains, which are injurious to it. It likewise arrives at a more perfect state of maturity than that planted later, the autumnal heat not being sufficiently great to open the pods, and to impart to the cotton the white, soft, and silky appearance which it acquires from exposure to a greater degree of heat.

Madder-roots are a very important and an increasing produce of Cyprus. The plain of Morphon, the village of Aghia Irene, and Famagusta, are the localities where it is produced in the largest quantities, though it is also cultivated in one or two other places. Its culture requires the greatest care, but the profit is very great. It is planted in November, January, and February, and the roots are gathered in June and in December. That picked in December is the best. The madder-roots produced at Irene are the finest, and have the richest colour; those of Morphon are the next esteemed, and afterwards those of Famagusta. At Morphon and Irene the roots are in the greatest perfection three years after planting, and it is then that they should be picked. At Famagusta they are best fit for picking eighteen months after planting; but in order to obtain more rapid profits they are picked at Morphon at two years, and at Famagusta one year after planting. Although the madder-roots produced at Famagusta are inferior to those produced at Aghia-Irene and Morphon, yet the price of madder lands at Famagusta is five times greater than at the latter places; this is owing partly to the more convenient position and the larger population of the district of Famagusta, and also to the greater profit obtained by the earlier growth of the root.

The best silk is produced in the district of Baffo; it is also raised at Varoschia, near Famagusta, in the district of Carpas, at Cythrœa, north-east of Nicosia, and at Maratassa, in the Troodos region. The silk of Baffo is chiefly yellow; that of Varoschia and Carpas, white. The cocoons of Maratassa are remarkable for the beauty, and the brilliancy of their colour. The quantity of silk produced in Cyprus averaged about 56,000 lbs., one half of which is raised in the district of Baffo; but within the last two or three years there has been a falling off in this produce. About a tenth of it is consumed in native manufactures. The greater part of that exported goes to France.

The wines of Cyprus form one of its principal articles of export; they are of two kinds, the ordinary black wine, which is coarse and heady, with a strong taste and smell of tar; this it acquires from the jars in which it is kept, and the skins in which it is transported, being always coated inside with tar, to preserve them from leaking.

The tarry taste of the wine is highly disagreeable, though the people of the country are very partial to it, and consider it wholesome. This wine is largely exported to Egypt, Syria, and Trieste. The other kind of wine, and that best known in Europe is the Commanderia, which derived its name from a commandery formerly possessed by the Knights Templars at Collossi, near Limassol. It is a sweet malmsey wine, but strong and heady. When free from the taste of tar it is rather agreeable. It keeps remarkably well, and improves with age. When new it is of a dark colour, like brown sherry; after it has been kept two or three years it becomes much paler, but with age it again becomes dark coloured, the very old Commanderia being almost black.

Large quantities of it are annually sent to Trieste and Constantinople, and some of the older and better qualities are shipped to France and Italy. It does not appear to suit the English taste, for it is never exported thither, for the trade, and seldom purchased by travellers. M. Fourcade, a former French consul, in a report made in 1844 to the French Government, states that an area of 8,000 hectares, or a little less than 20,000 acres, is occupied by vineyards, which produce annually about 140,000 hectolitres, or upwards of 3,000,000 gallons of wine. At the present time, however, it is calculated that little more than half this quantity is produced. The decrease is owing partly to the oidium, or disease of the grape, which has prevailed more or less for the last eleven years, but chiefly to an internal duty of 10 per cent., over and above the tithe and export duties, which has been lately imposed upon wines; on this account, and owing to the harassing manner in which it is collected, the peasants prefer selling their grapes or making them into raisins, rather than making wine to be subject to the payment of this tax.

The sale of carobs, or locust beans, was till within thirty-six years a Government monopoly. Since it has been abolished the cultivation of the carob tree has been greatly increased; wild trees have been grafted and new plantations are everywhere springing up. In 1852 27,000 cwt. of locust beans were exported. The exportation in 1862 was 180,000 cwt., value about 27,000*l.* It is exported principally to Trieste, and to the Russian ports in the Black Sea. The tree grows wild throughout the island, but it is more particularly abundant in the districts of Limassol and Kerinea. The finest trees are found at Lefcara. It has been observed that the plantations at a distance from the sea are more productive than those in the immediate vicinity of the coast.

Olives are one of the chief of the indigenous trees of Cyprus. They are constantly found in company with the carob trees at the base of the mountains skirting the plains, and forming a line of demarcation between the uncultivated mountain sides and the cultivated lands. Vast quantities of olive-trees are scattered over the country, especially in the district of Baffo, in a wild state, and consequently unproductive. These trees merely require grafting to render them fruitful, and capable of yielding great quantities of oil for commerce, yet, in spite of the profusion in which the tree is found, it is frequently necessary to import oil into Cyprus for local consumption.

The fruit-trees of Cyprus, as might be expected from its geographical position, are mostly those peculiar to southern countries. The palm-tree abounds in Nicosia and Lefca; it is found in smaller numbers in Larnaca and Limassol. Its presence in the villages generally indicates Turkish inhabitants, the Mussulmans being much attached to this tree. The dates which it bears are inferior to those of Egypt, and never attain the same degree of maturity. Orange, citron, lemon and cedrat-trees are largely cultivated in the gardens throughout Cyprus, though not in sufficient quantities to permit of exportation; indeed oranges are occasionally imported into Cyprus from Tripoli and Jaffa. Pomegranates are very abundant; a certain quantity is annually exported to Alexandria. The island produces two kinds of apricots, one small and of a very poor quality, which is considered unwholesome; the other kind, called the caisha, is of the sweet-kernelled variety, and very luscious; great quantities of it are eaten without inconvenience. The fig tree is very common. The prickly pear lines the hedges along the road sides, and by the gardens. A small description of cherry is found in one part of the islsnd, and sold in the markets of Nicosia and Lanarca. Apples and pears are raised in small quantities, but the quality of both these fruits is very inferior. Walnut and almond-tress are rare, but they are found here and there in the island. Peaches are not uncommon, but they are hard, and only fit for cooking. Grapes are abundant, and of excellent quality. Melons and water-melons are produced in considerable quantities; the ordinary melons have little of the aroma of the melon, but resemble more the cucumber in flavour; there is, however, another description, called tumburæ, which is sweet and well-flavoured. The water-melons are smaller than those of Jaffa, and by no means equal to them in taste.

Cyprus is very well supplied with vegetables, the principal of which are potatoes, pumpkins, cucumbers, lettuces, tomatoes, the aubergine, or purple fruited variety of the egg-plant, cabbages, cauliflower, spinach, celery, broad-beans, French-beans, lentils, onions, the *Hibiscus esculentus*, and the *Colocasia*.

The manufactures of Cyprus are inconsiderable. Formerly a great trade was carried on in native calicoes printed at Nicosia, for divan and quilt covers, which were exported to various parts of the Levant. This industry has, however, greatly fallen off of late. About fifteen years since there were as many as forty or fifty establishments for printing calicoes, at present there are but five or six. Some very pretty light silk stuffs are manufactured at Nicosia for dresses, scarfs, shirts, mosquito-nets, and pocket handkerchiefs; the latter are very good, and equal to any made in France. The gold and silk embroidery of Nicosia is greatly admired. Tanning is carried on to some extent; fine blue, yellow, and red leather is made for Turkish shoes and slippers; some quantity of it is exported to Alexandria. Three soap factories have also lately been opened at Larnaca.

Some idea of the trade of Cyprus may be gathered from the following Table, showing the quantity and the value of the articles exported from the ports of Larnaca and Limassol, during the year 1862:—

Articles Exported.		Quantities.	Value.
			£
Wheat	qrs.	9,800	12,282
Barley	„	28,075	15,280
Carobs	tons.	9,000	27,210
Madder-roots	cwt.	3,430	4,670
Cotton	lbs.	504,000	18,367
Wool	cwt.	2,500	4,762
Silk	lbs.	26,600	12,925
Silk-worm Seed and Cocoons ...	...	...	5,332
Linseed	cwt.	2,400	1,470
Sesame	„	2,100	1,714
Common Wine	galls.	606,500	25,274
Commanderia Wine	„	101,300	6,000
Raki	„	117,133	11,156
Salt	tons.	5,000	17,000
Skins and Hides...	„		1,735
Live Stock	„		6,400
Flax	cwt.	2,500	1,360
Raisins	„	1,280	770
Sundries	„	...	14,430
Total		...	£188,137

The beasts of burden in ordinary use are the camel, the mule, and the ass. The horse is seldom used, and indeed rarely seen, except in towns, and there of an inferior description. The mules and asses of the island are fine; some of the mules have an excellent amble, and are much esteemed in the Levant. A considerable number are yearly exported to Rhodes. Asses are also exported in some numbers to Syria. Oxen are employed exclusively for agricultural purposes; they are small and lean. Beef is consequently far from good in Cyprus. Cows are never kept for dairy purposes, and their milk is not drunk; the Cypriots appear even to have a prejudice against it. The flocks of goats and sheep in Cyprus, exclusive of lambs and kids less than one year old, numbered last year 400,000. The sheep are of two kinds—the small and the fat-tailed. Sheep and goat hides are largely tanned in the island; but about two or three thousand are sent to Europe, chiefly to Trieste. About 16,000 lambs' skins are yearly exported to Trieste, and about 5,000 kids' skins to Marseilles. About 3,400 cwt. of wool is exported annually to Marseilles and Trieste. The mutton of Cyprus is not very good; the flesh is coarse, and it has often a strong, rank taste. Goat-flesh is much eaten, and when fat and young is quite equal to the mutton. A considerable quantity of cheese is made from the milk of the sheep and goats: the kind called "hellûmi," and that made in the village of Agathou, are much esteemed and frequently exported to Syria. Pigs are reared very generally by the Christian population. Pork is only eaten by the better classes in winter, it being rightly considered unwholesome in summer; but the poorer classes in the country salt it, and eat it largely in that state. Poultry is very plentiful. Turkeys are abundant, and sold at moderate prices. Ducks and geese, owing to the scarcity of water, are rare. Game of various descriptions abounds: partridges swarm in many parts of the island; hares, francolin, and the little bustard, are also common. Of birds of passage—woodcock, snipe, and wild-duck are plentiful in the season. Beccaficos are abundant in October; they are very delicious. The Cypriots preserve them, partially boiled in Commanderia wine, for winter-eating. Of larger game, the moufflon is the most remarkable; it is found, and sometimes shot, in Mount Troodos, but it is difficult of approach. In the forests of Acama and Carpas, the north-western and north-eastern extremities of the island, horses, asses, and cows, are said to rove at large in a wild state. They are the descendants of domestic cattle which existed at a time when the island was more populous. The fox is the only beast of prey now found in Cyprus. Of reptiles and noxious insects, the asp (said to be the *Vipera Mauritianica*), the scorpion, and the tarantula spider, are found. The asp is much dreaded by the people of the country; it is of middling length, great thickness, of a blackish hue, with a blunt tail; its bite is fatal, death ensuing rapidly. A species of large snake is very common; but it is harmless, and said to be a determined foe of the asp. Birds of prey—eagles, vultures, buzzards, falcons, and hawks are very common.

The worst enemy, however, amongst the animal creation which Cyprus has to contend with, and the most injurious to its agricultural prosperity, is the locust. Notices are found in writers of the fifteenth century of the fearful depredations of this insect. It has been imagined that it has been at different times borne by the winds from Caramania or Syria, and thus carried across the sea to Cyprus; it has been again thought that it may have been introduced by ships bringing cargoes of grain. It seems, however, to be indigenous; and so wonderfully prolific is it, that unless active measures are taken to extirpate it, it increases in a few years so rapidly and in such quantities, as to swarm in myriads upon the face of the country, to which they are confined and shut in by the sea. When the wind, however, is strong from the land at the time they approach the coast in their flight, they are carried out to sea and perish in vast quantities. In the month of April the country is alive with locusts; they eat up every green thing, and leave literally a desert behind them. In August they deposit their eggs, and shortly after die. The spots where the eggs are deposited are easily discovered by a shiny viscous matter, with which they cover and soften the earth when about to deposit them. The male is said to be much more numerous than the female. The female lays two or even three eggs, each of which produces on an average at least thirty locusts; the egg being, in fact, an agglomeration of small eggs, in one oblong mass about the size of a pine seed, in which the eggs are disposed close together like seed in a pod. With care and perseverance, Cyprus might be freed of this plague. By a systematic and continual destruction of the insect and its eggs, it would almost disappear in the course of three or four years. The attempt was made by Osman Pasha, in 1855-56, and proved very successful; but it was subsequently neglected, and the consequence was that, although Cyprus enjoyed a few years of freedom from this pest, yet they gradually increased in number till in 1861 the spring-crops suffered fearfully from their ravages. During the past year, Zia Pasha, who for a few months was Governor of Cyprus, took the matter up actively, and through his representations the Government was induced to grant a sum of 2,500 Turkish lire (equivalent to about 2,270*l.*) for carrying out various means proposed for their destruction. At the same time, a tax of 20 okes of locusts' eggs per head has been imposed upon the inhabitants. It is calculated that from this tax at least a million of okes will be derived; the oke having been found to contain on an average 1,800 eggs, from each of which 30 locusts are produced. The number of locusts (fifty thousand millions) which might thus be destroyed in the egg is almost incredible.

ON THE MANUFACTURE OF ALUMINIUM.

BY ISAAC LOWTHIAN BELL.

The progress of the manufacture of this—so far as the arts are concerned—new metal has scarcely been such as to require much to be added to those admirable researches bestowed upon the process by the distinguished chemist, M. St. Claire Deville, of Paris. Upon the introduction of its manufacture at Washington, three and a half years ago, the source of the alumina was the ordinary ammonia alum of commerce —a nearly pure sulphate of alumina and ammonia. Exposure to heat drove off the water, sulphuric acid, and ammonia, leaving the alumina behind. This was converted into the double chloride of aluminium and sodium by the process described by the French chemist and practised in France, and the double chloride was subsequently decomposed by fusion with sodium. Faint, however, as the traces might be of impurity in the alum itself, they to a great extent, if not entirely (being of a fixed character when exposed to heat) were to be found in the alumina. From the alumina, by the action of chlorine on a heated mixture consisting of this earth, common salt and charcoal, these impurities, or a large proportion thereof, found their way into the sublimed double chloride, and, once there, it is unnecessary to say that, under the influence of the sodium in the process of reduction, any silica, iron, or phosphorus found their way into the aluminium sought to be obtained. Now, it happens, that the presence of foreign matters, in a degree so small as almost to be infinitesimal, interferes so largely with the colour, as well as with the malleability of the aluminium, that the use of any substance containing them is of a fatal character. Nor is this all, for the nature of that compound which hitherto has constituted the most important application of this metal—aluminium-bronze—is so completely changed by using aluminium containing the impurities referred to that it ceases to possess any of those properties which render it valuable. As an example of the amount of interference exercised by very minute quantities of impurity, it is perhaps worthy of notice that very few varieties of copper have been found susceptible of being employed for the manufacture of aluminium-bronze ; and hitherto we have not at Washington, nor have they in France, been able to establish in what the difference consists between copper fit for the production of aluminium-bronze, and that which is utterly unsuitable for the purpose. These considerations have led us, both here and in France, to adopt the use of another raw material for the production of aluminium, which either does not contain the impurities referred to as so prejudicial, or contains them in such a form as to admit of their easy separation. This material is

Bauxite, so called from the name of the locality where it is found in France. It contains

Silica	2·8
Titanium	3·1
Sesquioxide of iron . .	25·5
Alumina	57·4
Carbonate of lime . .	0·4
Water	10·8
	100·0

The Bauxite is ground and mixed with the ordinary soda-ash of commerce, and then heated in a furnace. The soda combines with the alumina, and the aluminate of soda so formed is separated from the insoluble portions—viz., peroxide of iron, silico-aluminate of soda, &c., by lixiviation. Muriatic acid or carbonic acid is then added to the solution, which throws down pure alumina. The remainder of the process is precisely that which is described by Mons. St. Claire Deville. The alumina is mixed with common salt and charcoal, made into balls the size of an orange, and dried. These balls are placed in vertical earthern retorts, kept at a red heat, and through the heated contents chlorine gas is passed. The elements of the earth, under the joint influence of carbon and chlorine at that temperature, are separated—the carbon taking the oxygen, and the chlorine the aluminium. This latter substance accompanied by chloride of sodium (common salt), sublimes over, and is collected, as a double chloride of aluminium and sodium. In small iron retorts, kept at as high a temperature as iron can bear, a mixture of soda (carbonate of soda), and carbonaceous matter, with a little ground chalk is placed. The metallic base of the alkali distils over and is collected in coal oil. A portion of the double chloride and sodium, along with fluxes, is exposed to a full red heat in a reverberatory furnace. The sodium seizes the chlorine combined with the aluminium, and thus liberates the latter metal, which falls to the bottom of the fused mass.

Aluminium is used in sufficient quantity to keep the only work in England—viz., that at Washington—pretty actively employed. As a substance for works of art, when whitened by means of hydrofluoric and phosphoric acid, it appears well adapted, as it runs into the most complicated patterns, and has the advantage of preserving its colour, from the absence of all tendency to unite with sulphur, or to become affected by sulphuretted hydrogen, as happens with silver.

A large amount of the increased activity in the manufacture referred to, is due to the exceeding beauty of the compound with copper, already spoken of, which is so like gold as scarcely to be distinguishable from that metal, while it possesses the additional valuable property of being nearly as hard as iron.

This alloy, or aluminium bronze, as it is termed, is a discovery of Dr. John Percy, F.R.S., and appears to be a true chemical compound. Copper is melted in a plumbago crucible, and after being removed from the furnace, the solid aluminium is added. The union of the two metals is attended with such an increase of temperature, that the whole becomes white hot, and unless the crucible containing the mixture is of refractory material, a vessel which has resisted a heat sufficient to effect the fusion of copper melts when the aluminium is added.

Mr. Gordon was the first, it is believed, who detected and determined the amount of tension wire of aluminium bronze was capable of resisting, which he found to be between that of the best iron and the best steel wire. Colonel Strange, of the Royal Astronomical Society, investigated its properties, which were given in a very able paper in the Transactions of that body. Its malleability, ductility, and capability of being finely divided and engraved upon, along with its great strength, induced the Colonel to recommend its adoption in the theodolite used in the Trigonometrical Survey of India.

At the Elswick Ordnance Works, Captain Noble, R.A., confirmed previous experiments on the capability of aluminium bronze to resist longitudinal and transverse fracture, and in addition to this he ascertained that its position to withstand compression stood halfway between that of the finest steel and the best iron.

The bronze, containing ten parts of aluminium and ninety of copper, affords an alloy endowed with the greatest strength, malleability, and ductility. The colour of the copper is affected by a very trifling addition of the other constituent, and the alloy gradually improves in the valuable qualities just mentioned, until the proportions given above are reached. After this, *i.e*, when more than ten per cent. of aluminium enters into the composition of the bronze, the alloy gradually becomes weaker and less malleable, and at length is so brittle that it is easily pounded in a mortar.

Washington Chemical Works.

THE TRADE OF MARSEILLES.

BY MR. CONSUL MARK.

A very large importation of wheat and grain was effected at this port during 1861. In the last six months of the year, $4\frac{1}{2}$ millions of hectolitres (1,547,640 quarters) arrived here from the Black Sea and Sea of Azof. The short crop of 1861, and the abolition of the sliding scale in France, conduced to this large importation of wheat, which, under the circumstances, it was expected would have been much larger. But, about the month of November, the Marseilles merchants found, much to their surprise, that very large quantities of wheat were being poured into

France by the eastern frontier, the continental railways having offered great facilities for the conveyance of grain; prices fell, therefore, to such an extent that the Marseilles speculators in grain lost very considerable sums of money. The increasing railway facilities throughout Europe, and the prevalence of steam navigation, as well as the large production of wheat in America, the Baltic, and other grain-producing countries, which can now be easily poured into French and foreign ports, whenever required, render it unlikely that Marseilles will ever again see so large an importation of wheat as occurred during the last season, which was almost entirely drawn from the Black Sea and Sea of Azof.

TABLE SHOWING AMOUNTS OF WHEAT IMPORTED AT MARSEILLES.

	Quarters.		Quarters.
1852	695,400	1857	1,479,955
1853	1,406,600	1858	1,072,204
1854	905,880	1859	696,253
1855	860,720	1860	475,112
1856	1,864,250	1861	2,063,520

Sugar.—There are several large establishments at Marseilles, which last year, collectively, refined about 50,000 tons of sugar, of which 33,000 tons were exported to the ports of Italy, the Levant, Black Sea, and Danube, the remainder having been taken up for home consumption. This large branch of foreign trade appears likely to remain stationary for the present, owing to the uncertain legislation prevailing with regard to duties and drawbacks, as well as to the fact of the successful efforts of the Belgian and Dutch refiners, whose products meet those of Marseilles, in many of the aforesaid ports. Some parts of the Mediterranean, also which formerly provided themselves with sugar through Marseilles, now import that article direct from the producing countries, and are setting up refineries of their own. A large quantity of the raw sugar which arrives from Havana, is now being brought here by Spanish vessels, which enjoy such privileges in Cuba, that they can bring sugar here at rates sufficiently low to displace a large amount of the French tonnage which was formerly employed in this particular branch of trade.

Coffee.—The importation of coffee has fallen off considerably in comparison with that of 1860, in which year it amounted to 20,000 tons, that of 1861 being only 18,000 tons. It is becoming evident, that not only are the several countries in the Mediterranean, which formerly drew their supplies from Marseilles, importing this article direct from the producing countries, but also that the high rates charged by the Paris and Lyons Railway Company seriously impede the trade in this article with the interior of France and Switzerland by way of Marseilles. It costs ten francs more to send a ton of coffee from Marseilles to Basle, than the same would cost by way of Havre to that destination. Likewise the railway was found to be so totally inadequate to the forwarding of the vast quantities of grain imported last year, that not only coffee suffered much detention here thereby, but many other important articles destined for the interior.

Oil Seeds.—There is no more interesting branch of commerce at Marseilles than that of the oil seeds imported of late years from Turkey, Egypt, India, and Africa. The importations appear to increase steadily, and they amounted last year to 1,033,020 metrical quintals (about 92,647 tons). The quantity of sesamum seed sent here, generally from the Levant ports, Bombay and Kurrachee, in preceding years, was larger than that imported in 1861, owing to the shortness of the crops in all those countries.

Table showing the Importations of Oil Seeds, in Metrical Quintals, from 1855 to 1861.

Year	Sesamum.		Arachides.		Linseed.	Cotton Seed	Cocoa nut and Palm nut	Various.	Totals.
	Levant	India & Africa.	Senegal.	India.					
1855	159,703	190,512	225,290	...	124,473	38,788	13,166	1,760	753,682
1856	194,406	376,841	270,745	21,650	167,871	99,943	19,052	10,750	1,161,259
1857	117,000	575,820	260,425	54,715	54,390	65,857	31,077	8,900	1,168,182
1858	90,690	450,375	250,245	8,155	56,578	10,515	36,440	14,375	917,372
1859	138,425	490,330	211,700	1,910	152,680	30,390	29,700	3,850	1,061,983
1860	116,900	362,095	216,570	1,170	245,750	49,070	46,585	55,830	1,023,970
1861	79,590	310,590	175,390	640	241,060	67,090	46,990	111,670	1,033,020

Metrical Quintals of 100 kilogrammes each.

Olive Oil.—The importation of olive oil during 1861 was inferior to that of the preceding year, the crops having been generally deficient throughout the countries surrounding the Mediterranean. Three qualities of oil are imported here; the most impure are chiefly imported from Algeria, Tunis, Morocco, Candia, and the Levant. These inferior oils are chiefly used here for the manufacture of soap. They are also clarified as lamp oil, and kept for home consumption, and sometimes re-exported: they are also used for lubricating purposes. A middling quality of oil is received from Corsica in considerable quantities, as also from the Riviera of Genoa and Naples. The finest qualities of oil for the table are received only from Genoa, Tuscany, and Naples. About 8,000 tons of foreign olive oil were imported in 1861.

108,000 tons of oil seeds, which were crushed here last year, yielded about 40,000 tons net of oil; in addition thereto, about 3,000 tons of cocoa-nut and palm oil were produced by the mills here. Of this large quantity of oil, one-half at least was converted into mottled and white soap. There was less oil sent away from Marseilles last year than usual, there having been a very abundant crop of colza in the north of France, which largely supplied England, Holland, Belgium, Germany, and Switzerland, countries which have generally drawn their supplies from Marseilles. About 15,000 tons of oil were sent into the interior of the country by rail. About 1,350 tons of linseed oil were brought to Marseilles last year, the low prices in England, and the duty of six francs per hectolitre, permitting the importation.

Oil-cake.—The large importations of oil-seeds here during the last few years, have led to a great increase in the manufacture of oil-cake, now so largely used both for feeding cattle and for manure, and of which considerable quantities are exported from Marseilles. The following are about the quantities of oil cake manufactured here from the various kinds of oleaginous seeds imported :—

Sesamum	214,599	metrical quintals
Arachis	119,221	„
Linseed	168,742	„
Cotton Seed . . .	53,672	„
Cocoa Nut . . .	3,825	„
Palm Nut	26,704	„
Turnip Seed . . .	85,924	„

Soap.—About 5,000 tons of soap were exported last year from this port, forming rather more than half of the general exportation of soap from France.

Silk.—The silk trade during 1861 was exceedingly depressed at Marseilles. The importations of silk at this port were seriously affected by the low freights offered by the Peninsular and Oriental Steam Navigation Company for conveying silk to England, and by the superior commercial facilities offered to purchasers in that country. The great stagnation of the silk manufacture at Lyons and St. Etienne, owing to the very limited demand for silk goods from America, likewise caused much unsteadiness in the trade here, and prices fell considerably. Even the deficiency of the crop in France has not had the effect of keeping up prices.

TABLE SHOWING IMPORTATIONS OF SILK, FROM 1859 TO 1861.

	1859.	1860.	1861.
China	7,540	7,132	7,970
Bengal . . .	1,250	308	682
Broussa . . .	840	790	922
Syria	360	463	578
Salonica . . .	157	186	156
Asia Minor . .	426	510	283
Persia	6,018	7,106	5,052
Divers . . .	562	1,049	1,412
Total Bales .	17,153	17,544	17,855

About 540,000 kilogrammes of cocoons were imported here last year, against 812,000 in 1860. Greece, Turkey in Europe, and Asia Minor, furnished during the six years ending in 1861, about 4,500,000 kilogrammes of cocoons, worth about 90,000,000 francs.

Wool.—The largest importations of wool ever seen at Marseilles occurred in 1861. Prices, nevertheless, kept rising until the autumn, when they would probably have settled down, had not a sudden demand for 16,000 bales, for the service of the United States army, been made in time to keep them up. As there are no woollen manufactures in this part of France, this commodity is generally forwarded at once to the more northern parts of the country. The trade, however, is greatly kept down by the high tariffs of the railway companies. It now costs 120 francs per ton to send wool from Marseilles to Roubaix, whilst English or German railways would convey the same for a like distance for one-half the amount. Much apprehension exists, therefore, that the wool trade of Marseilles will not be able to compete with the foreign trade, particularly in the face of the treaty with England.

TOTAL IMPORTATION OF WOOL, FROM 1856 TO 1861.

	Bales.		Bales.
1856	86,040	1859	80,210
1857	98,955	1860	102,095
1858	55,846	1861	111,098

Metals.—The trade in metals was much affected during 1861 by the American crisis, and also by the change in the Customs' tariff.

Lead occupied the first place amongst the metals imported at Marseilles : about 12,000 tons of rough ore were imported and smelted here, yielding about 5,000 tons of argentiferous lead. Nearly 13,000 tons of pig-lead were likewise landed here, and the silver extracted therefrom.

Iron and steel rank next, about 12,000 tons thereof having been imported, as also 8,000 tons of iron ore from Elba and Spain.

The following note will show, more or less, the quantity of the different ores and metals imported at Marseilles during 1861 :—

	Kilogrammes.
Ores.	
Iron	8,226,000
Copper	864,737
Lead	12,841,603
Zinc	1,050
Antimony	26,029
Manganese	858,809
Metals.	
Pig-iron	9,013,900
Iron in bars, sheet iron and old iron	2,889,263
Steel bars, plates, and wire	292,180
Copper	1,983,114
Tin	127,800
Lead	15,034,148
Zinc	357,203

Coal and Fuel.—About 32,000 tons of foreign coal only were imported here during 1861, of which a large proportion was re-exported.

The late treaty of commerce with England has caused but little change in this trade, which is likely to remain stationary, in consequence of the great development of the coal mines in the neighbourhood of Marseilles. The English coal brought here is now only used by the Gas Company for lighting the town. 320,000 tons of French coal were brought to Marseilles last year by railway, principally from the department of the Gard. About 60,000 tons of lignite were also derived from the mines in the neighbourhood of this town. Nearly 80,000 tons of small coal are used annually in this neighbourhood in the manufacture of soda. A considerable quantity of French coal was exported last year, which, together with that used on board of the steamships belonging to the port, amounts to about 10,000 tons.

Timber, Deals, and Staves.—8,400 loads of deal, 100,000 planks, and 9,000,000 staves, were landed here in 1861 from the Adriatic.

About 25,000 dozen deals arrived here from the Baltic, and 2,000,000 staves were imported from America. The timber trade with the Baltic is increasing, owing to the large demand for the building trade, which has been so active of late in France.

Hides.—The following Table shows the importation of hides at Marseilles during the last ten years, and the countries whence they have been received :—

Years.	Buenos Ayres and Montevideo.	Rio Grande.	Brazil.	Various Countries.	Totals.
1852	161,411	75,856	19,787	281,733	538,787
1853	168,092	19,000	21,699	314,733	523,552
1854	97,943	23,290	8,504	265,608	395,345
1855	90,881	58,911	15,016	468,381	633,189
1856	40,127	56,309	17,385	471,487	585,308
1857	135,113	47,257	24,891	790,478	997,739
1858	149,470	14,601	6,942	783,518	954,531
1859	107,800	35,211	1,800	742,162	886,973
1860	199,409	24,877	900	525,067	750,253
1861	125,702	15,393	1,200	426,041	563,336

Spirits and Wine.—A very large trade in spirits is growing up with the United States. As much as 1,175,000 gallons of corn brandy were imported here last year, the wines exported hence being largely mixed therewith. About 3,000 tons of wines of all sorts were imported during the year, from different countries, three-fourths consisting of the strong red wines of Spain. The exportation of wine from this port amounted to about 18,000 tuns.

The merchants of Marseilles complain greatly of their inability to send the wines of Provence and Languedoc to England. In 1859, the exportation amounted to 55,350 gallons, in 1860 to 461,025 gallons; but in 1861 it fell again to 137,300 gallons. They assert that it was intended by the new treaty that the wines and agricultural produce of France should be sent to England in large quantities, in exchange for the favours granted to the English manufacturers. They state that it is surprising that a cask of Bordeaux wine, worth 40*l*., should be imported into England at a lower duty than a cask of Languedoc wine, worth only 4*l*. The fact is that the wines shipped at this port, though infinitely cheaper than those of Bordeaux and Champagne, are so charged with alcohol, that they cannot be sent to England under the tariff, as it stands at present, owing to the alcoholic test by which it regulates the duties.

It is not likely, however, that the wines from this part of France will ever be largely consumed in England, unless much greater care is bestowed upon their preparation. The adulteration and mixing of wines is largely carried on in these parts, and is mostly effected by ignorant persons, who labour, unfortunately, under the belief that the consumers in England have no knowledge of wines, and that the national taste is fixed upon fiery port and sherry. It is no uncommon thing to see rows of casks of wine on the quays at Marseilles, marked "facon Porto," being filled up, in broad daylight, with American corn brandy, and then put on board ship for England.

Until these false notions are laid aside here, and some modification of the tariff is made in England, it is not likely that any great exportation of wine can take place from Marseilles for the United Kingdom. There is an unlimited supply of good wholesome wine to be had in this part of France, which could safely be sent to England in its natural state, and at very cheap rates.

The great development of the trade of Marseilles, during the last few years, has naturally led to a large increase of its population, and to a rapid rise in the value of all sorts of property both in the town and the surrounding districts. The working classes have generally found their labour highly remunerative, and the agriculturists in these parts are all thriving.

The large quantities of coal and lignite brought into Marseilles last year, from the different mines in the neigbourhood, gave ample occupation to the mining population during the year. The quarries in this district afforded abundant supplies of fine building stone, and they are every day becoming more available through the increasing railroad facilities. Considerable quantities of fine Roman cement were prepared in the neighbourhood, much of which was exported.

Soap is the most important manufacture at Marseilles, and there were fifty-two soap-works in full activity during the year, two-thirds of which produced the finest quality of soap, exclusively, to the value of nearly 2,000,000*l*. sterling. About 400,000*l*. worth of inferior qualities was produced by the remaining establishments. 250,000*l.* worth of the fine soap was exported. The manufacture of this large quantity of soap kept twenty-seven mills in full activity in crushing the oil seeds imported, and it gave ample occupation to a large part of the population.

Next in importance to the manufacture of soap at Marseilles stands the refining of sugar, which gave employment throughout the year to a great number of hands, and a large amount of capital was profitably invested therein.

The great facilities afforded by the Marseilles market for the importation of the various qualities of wheat from the Black Sea and Algeria, have led to the establishment of numerons flour mills, and to a large manufacture of semolina. About sixty flour mills, furnished with 400 pair of mill-stones, grind annually from 1,800,000 to 2,000,000 hectolitres (687,840 quarters) of wheat, worth about 2,000,000*l.*, thus giving employment to numerous hands, it being altogether a most thriving branch of business.

About 1,000 hands were generally occupied in 1861, in and near Marseilles, in the manufacture of salt, soda, and chloride of lime. A dozen establishments, collectively, turn out annually about 250,000 metrical quintals of soda, used principally in the manufacture of soap, and about 80,000 metrical quintals of chloride of lime.

Upwards of 2,000 hands found full occupation and remunerative wages during the year, in five large establishments which exist at Marseilles, for the manufacture of marine engines and boilers, and also for repairing the same. They turned out collectively machinery to the extent of 5,500 horse power. Between machines and boilers made, and repairs executed, work was executed by these establishments to the value of 400,000*l.*

CHEMICAL MANUFACTURES ON THE TYNE.

BY MESSRS. J. C. STEVENSON, R. C. CLAPHAM, AND T. RICHARDSON.

(Concluded from page 136.)

PRUSSIATE OF POTASH.—The first attempt to manufacture any compound of cyanogen in this district was made in the beginning of the last century by a Jew, in Oakwellgate, in Gateshead. He afterwards removed his apparatus to Corbridge, but, failing in producing a saleable article, he discontinued the operation, which was taken up by a Mr. Simpson, who ultimately succeeded in perfecting the process in works erected at Elswick. Mr. Simpson manufactured Prussian and other kinds of blue colours, and at his death the manufacture was removed to Heworth, where the Messrs. Bramwell have carried on the works since 1758. Prussian blue was the only form in which the cyanogen was produced, from which Prussiate of potash was afterwards manufactured. This salt was not known in commerce in a crystallised form, however, till about the year 1825, when the price was 5s. per pound. The price has now fallen to 11½d. Mr. Bramwell has introduced various improvements in the manufacture of this salt, employing close pots, in which the fused materials are worked by machinery, and substituting sulphate of potash for the more expensive potashes ; but notwithstanding the application of every chemical and mechanical appliance, and the low prices at which the prussiate of potash is sold, the demand has fallen off, and at present only two tons of yellow prussiate, and three-quarters of a ton of red prussiate are manufactured weekly. The decline in this trade has arisen partly from the American civil war, and partly from the introduction of the aniline colours. The celebrated attempt in 1844 to produce cyanogen from the nitrogen of the air, was made at these works, and although the efforts of Mr. Bramwell and his friends were perfectly successful in a chemical point of view, these gentlemen were induced to abandon the process as a manufacturing operation.

Alum.—The first alum works established in England were erected at Guisbro' in 1460, by Sir Thomas Challoner, who brought over a workman from France to carry out the then secret process, the monopoly of this trade being in the hands of the Pope. The works were subsequently decreed to be a royal mine, and passed into the possession of the crown. They were afterwards farmed to Sir Paul Pindar at a rental of 15,000*l.* per annum. He employed about 800 persons, and made large profits, his monopoly enabling him to keep up the price to 26*l.* per ton. The Long Parliament restored the mines to the original owners, and at the Restoration not less than five manufactories were in operation. The process is well known, but potash alum (formerly the only alum made) is now only produced at the Loftus Works, all the other manufacturers employing the cheaper sulphate of ammonia. From the mother liquors large quantities of an impure sulphate of magnesia are obtained, which are partly refined, and partly consumed as a manure, mixed with other substances. Alum and sulphate of alumina are also made from sulphuric acid and clay, or shale, but the quantities are not very large. The quantities produced annually are as follows :—Alum, &c., 4,000 tons ; rough Epsoms, 1,800 tons. Some improvements in the details have been introduced to economise labour and save materials. The precipitation of the iron from aluminous liquors by means of prussiate of iron was first employed here by Messrs. Lee and Co., and the Guisbro' Alum Company have introduced an aluminous cake, containing sulphate of magnesia, which has been found to answer very well in dyeing certain colours, as browns, blacks, &c., and in the manufacture of all kinds of coarse paper.

Epsom Salts.—The abundant supply of Dolomite on the coast of Marsden, three miles south of the Tyne, and at other places in the county of Durham, has for many years sustained the manufacture of sulphate of magnesia on the Tyne. The mineral is a tolerably pure double carbonate of lime and magnesia, containing about 21 per cent. of magnesia.

The following is an analysis by Mr. Clapham :—

Silica	10·00
Alumina . . .	1·60
Oxide of Iron . . .	0·50
Carbonate of Magnesia .	35·33
Carbonate of Lime . .	52·50

The process formerly employed was to calcine the limestone 99·93, and wash it repeatedly with water, by which, however, the lime is only imperfectly removed, the residue being dissolved in acid and crystallised. The principal source of sulphate of magnesia for many years past has been the rough Epsoms, obtained from the residual mother liquors of the Yorkshire Alum Works. In these salts protoxide of iron replaces a variable proportion of magnesia, forming a double salt, and an excess of sulphuric acid is always present.

The following is an analysis of Rough Epsom salts, by Dr. Richardson:—

Sulphuric Acid . .	23·26
Magnesia . . .	15·35
Protoxide of Iron . .	1·73
Oxides of Nickel and Cobalt	0·12
Lime	0·09
Alumina . . .	1·33
Potash	0·83
Water	48·29

Formerly these salts were mixed with washed magnesian lime, 100·0, and then calcined in order to peroxidise the iron. It is found, however, (as first suggested by Dr. Richardson), that calcination is unnecessary when the solution is sufficiently diluted, and when space is provided in the precipitating tank for the bulky precipitate of protoxide of iron, which is formed by the gradual addition of magnesian lime. This is probably the only chemical manufacture of the district, with the exception of prussiate of potash, which has greatly fallen off in extent, a more rational system of medicine having diminished the use of purgatives, and reduced the demand for Epsom salts to about one-third of what it was twenty years ago. The annual production is still 1,500 tons, two-thirds of which are made from the rough salts.

Carbonate of Magnesia.—This compound has long been produced in this district, where it was formerly, and is still to a limited extent manufactured from the mother liquors of the salt pans, known as Bittern, to which carbonate of soda is added to precipitate the magnesia in the form of carbonate. This old process has been largely superseded by the elegant process of the late Mr. H. L. Pattinson, which consists in submitting calcined magnesian limestone to the action of carbonic acid and water, under pressure. The magnesia dissolves out as bicarbonate of magnesia, from which the neutral carbonate of magnesia is precipitated by the application of heat. The quantity manufactured is said to be about 250 tons per annum.

Superphosphate of Lime.—The manufacture of this article was commenced at Blaydon, in 1844, by Dr. Richardson, soon after the publication of Liebig's celebrated report on agricultural chemistry. Various materials are employed as the source of phosphate of lime—viz., bones, bone ashes from South America, exhausted animal charcoal from the sugar refineries, coprolites from Suffolk and Cambridgeshire, phosphate from Spain, Sombrero guano, &c. Improvements have been introduced in the manner of mixing the acid with these substances in drying and in the riddling of the superphosphate. The quantity produced amounts to between 15,000 and 16,000 tons per annum.

Pearl Hardener.—This article has only recently been manufactured here, and its introduction is due to Dr. Jullion, who has applied it to the hardening of paper. It is produced by precipitating hydrated sulphate of lime from a perfectly pure solution of chloride of calcium, by means of sulphuric acid. Great care is taken in its preparation, and it is being generally introduced among the manufacturers of paper. The quantity made is said to be about 2,000 tons per annum.

Sulphate of Iron.—The first manufactory for the production of green copperas in England was founded about the year 1579, when one Matthew Falconer, a Brabanter, "did try and draw very good brimstone and copperas out of certain stones gathered in great plenty on the shore near unto Minster, in the Isle of Sheppey." Mr. Thomas Delaval commenced to manufacture copperas at Hartley about the year 1748, but he subsequently sold the manufactury to his brother, Lord Delaval, and by an Act of Parliament, 11th of George III., 1771, power was given to Sir Francis Blake Delaval to grant to Sir John Hussey Delaval, in fee simple, all the copperas works then and there existing, which may enable us to form some idea of the importance then attached to this manufacture. The late Mr. Barnes and Alderman Forster erected the first copperas works on the Tyne, at Walker, in 1798, which are still in operation. The quantity at present manufactured is about 2,000 tons per annum, and the process is still the same, but Mr. Thomas Barnes has applied the refuse crystals to a novel purpose. This refuse was, and is, generally thrown away, but Mr. Barnes uses it as a manure on his farm, on the thin soil which lies on the magnesian limestone. He finds that the depth of the soil is gradually increasing by the disintegration of the rock, and that the more he uses, the more satisfactory are the results. The beneficial effect of the copperas is doubtless partly due to the natural decomposition of the carbonate of lime with the sulphate of iron, and partly to the action of the peroxide of iron on the organic matter of the soil, while, being constantly renovated, a supply of oxygen is provided in a solid form, by this hydrated oxide of iron.

Venetian Red.—The manufacture of this article has long been carried on in this neighbourhood, and is noticed here as it is so closely related to green copperas. It is made by calcining a mixture of copperas and some native hydrated oxide of iron, chalk, and gypsum. The calcined mass is levigated and dried. About 4,000 tons per annum are manufactured on the Tyne, and the price varies from 4*l.* 10s. to 5*l.* per ton.

Sulphate of Copper.—This salt was formerly produced by roasting old copper in a reverberatory furnace, and then dissolving the oxide in sulphuric acid, but it is now obtained in carrying out Longmaid's process for decomposing common salt by means of cupreous pyrites. The quantity made is about 100 tons per annum, which is all produced at the works of Messrs. J. and W. Allen.

Resin Size.—This article is manufactured according to a patent obtained by Mr. W. S. Losh, and is intended to produce a size suitable for paper-makers, and to supersede the old size in ordinary use, which consists of alum, resin, and soda ash. Its manufacture has, however, been only partially developed, and not more than 100 tons yearly is produced; but a new and cheap size, which can be prepared ready for the use of the paper trade is, we think, a step in the right direction, and the theory of the sizing of paper is a field still open to chemists.

Lamp Black.—The manufacture of lamp black, we believe, is peculiar to this locality, and it is produced from bituminous coals. These coals are slowly burnt, at a dull heat, and with as small a supply of air as possible. The smoke is conducted into brick chambers, into which a jet of steam or water is passed to assist in the better formation of the lamp black. The quantity made is about 1,200 tons annually.

Grease.—This product is made to the extent of 2,800 tons annually. It is chiefly produced from the distillation of resin, and in a locality like Newcastle, surrounded by extensive collieries and works, the consumption is considerable. Since the American war the price has been much affected, and, we are told, has advanced from 8*l.* or 9*l.* per ton to 22*l.* per ton.

Chemical Products of Gas Works.—The quantity of coal used in the manufacture of gas on the three northern rivers, the Tyne, Wear, and Tees, amounts to about 100,000 tons.

THE PRODUCTS OBTAINED ARE AS FOLLOWS :—

875,000,000 cubic feet of Gas	£113,000
53,000 tons of Coke	10,000
23,800 gallons of Crude Naptha	2,800
309,000 gallons of Creosote Oil	1,250
3,560 tons of Pitch	3,130
600 tons of Sulphate of Ammonia	9,000
Total	£139,180

The sulphate of ammonia is manufactured direct from the gas water, in the following manner :—A large cylindrical boiler is filled two-thirds full with the gas liquor, and gently boiled. The gaseous products and steam are conducted into a mother liquor, from a previous operation, which is kept slightly acid. When no more ammonia comes over, a quantity of milk of lime is added to the boiler and a strong heat applied, until the colouring matters cease to be disengaged. The gaseous products are collected as before, and the colouring matters are skimmed off the surface of the liquor. The boiling is then moderated, and during the whole operation, a stream of acid is supplied to the cistern. The sulphate of ammonia salts out, and is fished up into baskets to drain, when it is ready for the market.

Cement.—The manufacture of this material, on a large scale in this district, is of comparatively recent origin. A small quantity of cement has long been made on the Yorkshire coast, near Whitby, where a peculiar mineral is found in the alum shale, called the "Cement Stone." This mineral has been analysed by Dr. Richardson, who found it to contain—

Clay insoluble in Acids		18·41
Consisting of Silica	12·24	
,, of Alumina	6·17	
Alumina soluble in Acids		6·89
Oxide of Iron		0·54
Lime		37·68
Magnesia		5·20
Soda and Potash		traces
Organic Matter		1·48
Carbonic Acid and Water		29·62
		99·77

About 20 cwt. of this mineral is found in every 60 tons of shale, and the greater proportion is sent to Hull, where it is manufactured into a cement, sold under the name of Mulgrave Cement.

The mineral is burnt in small open kilns, and afterwards ground to a fine powder.

The production of cement on a large manufacturing scale, dates from the establishment of the works of Messrs. T. C. Johnson and Co., in 1856. This firm manufactures Portland Cement, Roman Cement, Keene's Marble Cement, and Plaster of Paris; and they have recently introduced improved machinery for the more perfect levigation of the raw materials, by which the subsequent chemical action is much facilitated.

Portland cement is very extensively used in this country, in France and Germany, for dock works, basins, fortifications, and for fronting houses in imitation of stone. It is also used for coating the inside of all first-class iron ships. The rivets are carefully coated, and are thus protected from the corrosive action of the bilge water. It has been found of equal service in sugar-carrying vessels, where the leakage of the molasses exercises a very corroding action.

Roman cement is prepared by calcining septaria in open kilns, and afterwards grinding the burnt material in horizontal stoves. It is used either alone or mixed with an equal volume of sharp sand.

Keene's marble cement is made by soaking calcined gypsum in a solution of alum, and then recalcining the mass at a dull red heat. This recalcined material is then ground and sifted. It is only used for internal work, such as floors, skirtings, walls, &c. It is largely employed in London in churches and club-houses; it rapidly dries, after being applied, and may be papered or painted in two days. When dry, it is so hard that a nail cannot be driven into it. Two qualities are made: one of which can be polished in imitation of marble; while the other is used as a ground for painting—when different colours are introduced, a superior scagliola is formed.

The quantities manufactured per annum, are as follows :—

	Tons.	Casks.
Portland Cement	10,000	50,000
Roman ditto	350	2,450
Keene's ditto	50	350
Plaster of Paris	200	2,000

The present prices are—

Portland Cement	8s. 6d.	per cask of	430 lbs.
Roman ditto	7s. 6d.	,,	336 lbs.
Keene's ditto	14s. 0d.	,,	336 lbs.
Plaster of Paris	30s. 0d. per ton.		

Quantities and Prices of Raw Materials Used in Local Chemical Manufactures.

	Tons.	Price. £	s.	d.	Value. £	s.
Sulphur (included as pyrites)	72,800	0	10	0	109,200	0
(Copper value not included.)						
Salt	90,000	0	15	0	67,500	0
Nitrate of Soda . . .	2,500	14	15	0	36,875	0
Chalk	144,000	0	2	6	18,000	0
Coals	323,000	0	3	9	60,562	19
Manganese	11,400	4	0	0	45,600	0
Rough Epsom Salt . .	1,500	2	5	0	3,375	0
Magnesian Limestone .	700	0	3	6	122	10
French Limestone . .	14,000	0	4	6	3,150	0
Resin	—	0	0	0	0	0
Tallow	—	0	0	0	0	0

QUANTITIES AND PRICES OF FINISHED PRODUCTS.

	Tons.	Price. £	s.	d.	Value. £
Alkali	43,500	8	10	0	369,750
Crystals of Soda	51,300	4	15	0	243,675
Bicarbonate of Soda	7,450	12	0	0	89,400
Caustic Soda	580	18	0	0	10,440
Hyposulphite of Soda	400	25	0	0	10,000
Oil of Vitriol	6,440	6	0	0	38,640
Epsom Salts	1,500	7	5	0	10,875
Bleaching Powder	11,200	9	0	0	100,800
Soap	6,000	34	0	0	204,000
Yellow Prussiate of Potash	105	0	1	0 ℔	11,760
Red ditto	40	0	2	6 ℔	11,200
Alum	4,000	7	0	0	28,000
Carbonate of Magnesia	250	30	0	0	7,500
Superphosphate of Lime	15,000	5	0	0	75,000
Pearl Hardener	2,000	10	0	0	20,000
Sulphate of Iron	2,000	3	0	0	6,000
Venetian Red	4,000	5	0	0	20,000
Sulphate of Copper	100	35	0	0	3,500
Resin Size	100	7	0	0	700
Lamp Black	1,200	7	0	0	8,400
Grease	2,800	8	0	0	22,400
Cements	12,000	2	0	0	24,000

ON THE DEFECTS AND WANT OF STRENGTH OF CERTAIN MODERN PAPERS.

BY DR. VAN DEN CORPUT.

Although the papers which are now made are infinitely finer, more beautiful, and above all whiter than those made in former times, it is equally true that, generally, machine-made papers possess less strength than the old hand-made papers. But if it is probable that the rapidity of the mechanical operations, to which paper is subjected under the modern system, and especially the accelerated desiccation which it undergoes, causes it to lose a part of its strength, it is still more certain that other more powerful causes have contributed, in the last few years, to the want of solidity in this article. These causes are principally—1st, the mixture of cotton and of an infinity of other materials of inferior quality with the stuff. 2nd, the too-prolonged immersion in ley of the straw-like substances. 3rd, the destructive effects of an excess of chlorine which ordinary rags require. 4th, the insufficient washing of the pulp, and consequently traces of free chlorine, which the paper retains, and this transformed into hydrochloric acid, slowly corrodes the cellulose. 5th, lastly above all, *the introduction, in too large a proportion* of certain mineral ingredients into the pulp, such as kaolin or china-clay, pipe-clay, plaster, and chalk, substances the admixture of which has for some time become general, and has had the effect, while augmenting the weight of the paper, of diminishing the proportion of fibre, that is, of the rags of which it should consist.

The quality of the paper not only depends upon the character of the raw materials, but also on the mechanical preparation. For this reason strong pulps always furnish a good paper, whereas tough substances, roughly bruised, do not offer the same consistency. In order to obtain strong pulps, they must be subjected a considerable time to the action of the beating-engine, taking care not to destroy their strength by a too rapid or abrupt motion of the beating-roll. The thinner the paper, and therefore the more difficult to pass over the machine, the longer must the pulp be kept in the beating-engine. But this operation must be conducted carefully if a good and solid paper is desired. The bars of the roll should rub the stuff out. If the bars are too sharp, the fibre is cut and the pulp loses its cohesive element.

We have alluded to the alteration which papers undergo from an excess of chlorine, and to the traces of acid which they retain. There is a very simple mode of determining the presence of these bodies in papers, of which the pulp has not been sufficiently washed ; it is, to moisten the sheet with a diluted solution of iodide of potassium. If there are hydrochlorites in the paper, a brown spot is formed more or less dark, by the action of iodine, which produces a blue colour, if the sheet has been sized with starch. Moreover, these papers always give an acid reaction, and an odour more or less sensible of chlorine.

The presence of kaolin is also easily shown. A definite weight of the paper, previously dried, is incinerated and the residue weighed. Paper of good quality ought to leave only 2 per cent. of ash ; French filtering paper leaves only 2 decigrammes of residue to 100 gr. of dried paper, and good Swedish filtering paper (papier Berzelius) used in chemical analysis, leaves, after combustion, only 1-600th of its weight. Nevertheless, it is now very usual to meet with papers which contain 1-6th and even 1-4th of their weight of kaolin. A sample of paper prepared with glycerine, sent to me by M. Bols, a printer at Brussels, gave a residue of near 30 per cent. of mineral substances, consisting chiefly of silica and alumina ; ingredients which, by their excessive quantity, justify the term of mineral paper being applied to this manufacture.

Some idea of the enormous use of kaolin may be formed, when it is known that M. L. Piette, in his talented "Journal des Fabricants de Papier," estimated in 1854, at more than 50,000,000 kilogrammes, the quantity of this substance used in the paper mills of Europe to mix with rags.

This practice, however, is hardly more new in the making of paper than the appreciation of the fraud itself, for Pliny tells us that, in his time, the papyrus, moistened with the muddy water of the Nile, which held in suspension a very fine clay, was frequently spongy and sucked up the ink, by reason of too large an intermixture of this mud ; so much knavery is there, added he (*tantum in est fraudis !*).

Nevertheless, used in moderation, kaolin is not so destructive as might be supposed. When a strong substance is mixed with the pulp, and the whole carefully beaten, it has the advantage of making the paper pure and even, by causing the pores to disappear, which the fibres of the cellulose form in the sheet. The kaolin, which is now made use of by almost all paper-makers, under the specious pretext of giving more colour to the paper, but also undoubtedly with the object of augmenting the weight of their manufacture, gives to the paper, when it is used in too large a proportion, a dull appearance. The sheet is then soft, weak, and without consistency, especially when soft rags are in excess, and the stuff is short. Moreover, by the scratching of pens, particularly those of steel, the interposed aluminous earth is detached from the paper, which very quickly soils and roughens; for this reason care is taken to introduce, relatively, a much less quantity of kaolin into writing paper than into printings.

It is also sought by the addition of a large quantity of starch, to correct the want of strength in paper, arising from the introduction of these pulverulent substances, just as, by glazing, it is sought to modify the downy appearance which the presence of cotton gives to paper.

It is only in an exceptional manner that certain makers have recourse to sulphate of lime (plaster or gypsum), mentioned by Baron Dumas, as being largely consumed for this object. Plaster is far from lending itself equally well to this application as the pure silicate of alumina, which, by reason of its fine grain, unctuousness, and plastic properties, combined with its cheapness, is almost exclusively employed at the present time. If the makers do not employ in preference baryta, and the sulphate, or carbonate of lead, which, equally white as kaolin, have the advantage of being heavier, and consequently should be preferred to effect the proposed object, it is because these substances are dearer than China clay, and, moreover, the salts of lead would have the inconvenience of turning yellow, by contact with the vapours of sulphuretted hydrogen. Besides, the heavy specific weight of these substances causing them to sink to the bottom of the engine, the pulp would not be so homogeneous as kaolin, which remains suspended in the semi-liquid mass of the stuff. It has, however, been found possible to obtain plaster and sulphate of baryta in the required state of tenuity, and free from clots, by precipitating them from solutions of chloride of calcium, or of barium, by means of sulphuric acid or of sulphate of alumina, introduced into the pulp itself. The mixture of zinc white would, perhaps, be a further improvement in this practice, which can be considered as lawful, since it is tolerated, without having been, up to the present time, looked upon, not only, as a positive fraud in the quality of the merchandise, but as possibly having, in many cases, by its abuse, certain inconveniences, of which the disastrous consequences are not sufficiently appreciated.

But these consequences may become, as will be seen, of immense importance. Papers, already weakened by the prolonged bleaching of the raw materials of inferior quality, that are now used, must necessarily suffer still greater injury in the solidity of their texture by the mixture of a pulverulent mineral substance, which intervening between the fibres of the cellulose, necessarily diminishes the closeness of the paper and weakens the sheet so prepared.

If its organic substance undergoes a slight alteration, either from the presence of an excess of chlorine, or from the slowly destructive action of the air, the paper becomes brittle and soon falls to powder, causing the destruction of the ink. Nor is it unusual, as M. Dumas observes, to meet with books, printed within the last ten years, of which the paper crumbles at the least touch.

Assuredly, if this evil is not to be regretted, in respect to the moral value of many modern works, of which the early destruction frees their authors from the severe judgment of posterity, it is no less certain that the introduction of mineral substances into the pulp, ought to be severely repressed, not so much because it is a commercial fraud, as that the process may compromise important interests.

Indeed, setting aside the question of honesty, it may be conceived how important it is not to expose to early destruction public documents, which are at the present time inconsiderately drawn up on papers that contain within themselves the causes of alteration, thereby ensuring their inevitable destruction within a not far distant period. We know from good authority that already, in certain towns, a part of the modern archives have been retranscribed, on account of the extensive deterioration which the paper had undergone, and it is to be feared that this transcription has been made on paper quite as bad in quality as the former. This, of necessity, entails considerable expense uselessly on the corporations or the government.

It consequently behoves all governments, in order to ensure the safe preservation of their archives, to examine carefully the quality of the paper used in the preparation of public registers, and it is the duty of every good administration not to use any official paper liable to change from its faulty composition.

In order to obtain these results, the English government requires that the raw materials of the paper used for the State archives, shall neither be boiled nor bleached. It is, however, but just to acknowledge that many of the faults found in modern papers, can only be applied to the first productions made by machinery, and it is reasonably to be hoped that, in consequence of the improvements in paper-making, the above-mentioned defects will soon entirely disappear.

However, we repeat, repressive measures must be adopted against such a system of manufacture, at least as far as regards papers for public documents, which necessarily require a guarantee of durability, to be secured only by sound paper made of white rags, of hemp, or of flax, tub-sized. After verifying the good quality of the paper by its rattle, rigidity, clearness, and resistance to breakage, the length of the fibre on the torn edge of a sheet must be examined with a glass, and in respect to writing papers, the equality of the sizing should be ascertained by wetting.

As was long ago proved by Baron Liebig, all vegetable substances undergo, when placed in contact with moist air, a true slow combustion or eremacausis. The oxygen of the atmosphere, combining in these circumstances with the carbon that forms the essential constituent element of the vegetable matter, there is formed one volume of carbonic acid gas equal to that of the absorbed oxygen ; at the same time a portion of the latter takes up a part of the hydrogen of the cellulose, to form water. The porous state of the substance, which increases its faulty absorption, favours this decomposition in a high degree.

Substances of animal origin undergo an analogous decomposition ; but here the presence of nitrogen contained therein, gives rise also to the formation of ammoniacal salts, which specially favour microscopic vegetable development of the cryptogamous class. Hence that formation of mouldiness which is ordinarily observed under similar circumstances.

Paper being formed, as we have seen, essentially of vegetable fibres and of the gelatinous substances introduced in the sizing, is subject, like every other organic substance, to decomposition or eremacausis, more or less rapid, according to certain conditions of manufacture. But it is easy to conceive that the presence of earthy matters in the paper pulp, combined with the accelerated desiccation which the paper undergoes, by diminishing its cohesion, can but increase the rapidity of its decomposition.

The first symptom of decay in the paper is generally manifested by inequalities on the surface, which, in some places, become fluffy, at the same time its whiteness is impaired. During this internal decomposition, besides the carbonic acid above mentioned, traces of organic acids, such as humic and crenic, form on its surface reddish spots or holes, when the paper has been blued. In other cases, these spots are yellowish or ochrish ; they sometimes arise from the scum, caused by the imperfect mixture of the size with the pulp. When these alterations are more advanced, a mouldiness is developed in these parts, especially if the paper has been sized with gelatine, of which the most common is a species of *penicillium*. These microscopic vegetations, insinuating themselves between the pores of the paper, lessen its cohesion and accelerate its disintegration.

According to M. Bockramm, a printer in Treptow, these mouldy pots (stock flecke) can be easily effaced from printed paper, without endangering the impression, by passing the sheets through a hydrochloric bath, formed of one part of concentrated acid of commerce, to 18 parts of water.

It is the same expedient which I recommended, many years ago, to M. de Brou, a distinguished artist and conservator of the collections of the Duke d'Arenberg, to remove certain blots which had dimmed, with a cloudy whiteness, the surface of some valuable engravings. This process, which succeeded fully, would have infallibly caused the loss of the print, if it had been printed on modern lime-paper. Damaged sheets, spotted with ink or mouldy stains, may still be whitened, by plunging them for some minutes, into a warm solution of one part of tartaric acid, and 24 parts of water, and then washing plentifully with water. This solution, as well as those of oxalic or citric acid, which may be substituted, has the advantage of being less likely to spoil the paper than mineral acids.

To Baron Thénard is due the application of oxygenated water to spotted papers, or to prints discoloured by metallic sulphates.

I have shown the inconveniences arising from the introduction into paper, of mineral substances foreign to the regular manufacture. There is also another cause that contributes quite as much to the bad quality of modern papers, and which, until now, appears to have escaped the attention of manufacturers ; it is the too rapid desiccation which the sheets undergo in the preparation of machine-sized paper.

Brussels.

GOLD IN WESTERN AFRICA.

BY CAPTAIN F. BURTON.

We find in Leo Africanus, who is supposed to have died about 1526, that the King of Ghana had in his palace " an entire lump of gold "— a monster nugget it would now be called—not cast nor wrought by instruments, but perfectly formed by the Divine Providence only, of thirty pounds weight, which had been bored through and fitted for a seat to the royal throne.* The author most diffuse upon the subject of gold, is Bosman, who treats, however, solely of the Gold Coast.

According to Bosman (Letter vi.) "the illustrious metal " was found in three sites. The first and best was " in or between particular hills :" the negroes sank pits there and separated the soil adhering to it. The second " is in, at, and about some rivers and waterfalls, whose violence

* Similarly, the king of "Buncatoo" had a solid gold stool, which caused his destruction at the hands of his neighbours of Ashanter.

washeth down great quantities of earth, which carry the gold with it. The third is on the sea shore, near the mouths of rivulets, and the favourite time for washing is after violent night rains. The negro women are furnished with large and small troughs or trays, which they first fill full of earth and sand, which they wash with repeated fresh water till they have cleansed it from all its earth; and if there be any gold its ponderosity forces it to the bottom of the trough, which, if they find it, is thrown into the small tray, and so they go on washing it again, which operation generally holds them till noon; some of them not getting above the value of sixpence; some of them pieces of six or seven shillings, though not frequently; and often they entirely lose their labour."

The gold thus dug is of two kinds, dust gold and mountain gold. The former is "fine as flour," and the more esteemed because there is no loss in melting. The latter, corresponding with our modern "nugget," varies in weight from a farthing to 200 guineas; it touches better than gold dust, but it is a loss from the stones adhering to the stone.

The natives, in Bosman's day—and to the present time—were "very subtle artists in the sophisticating of gold." The first sort was the Fetish before alluded to. They also cast pieces so artificially, that whilst outside there was pure gold thick as a knife, the interior was copper, and perhaps iron—then a new trick—and the most dangerous, because difficult to detect. The common "false mountain gold" was a mixture of the precious metal with silver and copper, extremely high coloured, and unless each piece was touched, the fraud passed undetected. Another kind was an artificially cast and tinged powder of coral mixed with copper filings: it became tarnished, however, in a month or two.

With respect to the annual export from the Gold Coast, Bosman reckons it in peaceful times, when trade is prosperous, to be "23 tun." The 7,000 marks are disposed of as below.* Mr. M'Queen estimates the exportation at 3,406,275*l.* The English trade has now fallen to 360,000*l.* to 400,000*l.* per annum.†

* The Dutch West India Company yearly exported,	Marks	1,500
The English African Company	,,	1,200
The Zealand interlopers as much as the Dutch, viz.	,,	1,500
The English interlopers about 1,000, usually, which they have doubled	,,	1,000
The Brandenburghers and Danes together, in times of peace	,,	1,000
The Portuguese and French together	,,	800
Which makes		7,000

For several years before Bosman's time, the Dutch export had been reduced by one-half (750 marks).

† Dr. Clarke ("Remarks, &c.), gives 100,000 ounces This was the calculation of Mr. Swanzy before a parliamentary committee in 1816. Of course it is impossible to arrive at any clear estimate. Allowing the African Steam Ship

In several countries, as Dinkira, Tueful, Wásá, and especially Akim, the hill region lying due north of Accra, the people are still active in digging gold. The pits, varying from two to three feet in diameter, and from twelve to fifty deep, are often so near the roads that loss of life has been the result. "Shoring-up," being little known, the miners are not unfrequently buried alive. The stuff is drawn up by ropes in clay pots, or calabashes, and thus a workman at the bottom widens the pit to a pyriform shape ; tunnelling, however, is unknown. The excavated earth is carried down to be washed. Besides sinking these holes, they pan in the beds of rivers, and in places collect quartz, which is roughly pounded. The yield is very uncertain, and the chief of the district is entitled to one-third of the proceeds. During the busy season, when water is abundant, the scene must resemble that described by Dr. Livingstone near the gold diggings of Tete ; as in California and Australia, prices rise high, and gunpowder, rum, and cotton goods soon carry off the gold-dust. During the repeated earthquakes of July, 1862, which laid waste Accra, the strata of the Akim hills were so much shaken and broken up, that, according to report, all the people flocked to the diggings and dispensed with the shafts generally sunk. There are several parts of the Gold Coast where the precious metal is Fetish, and where the people will not dig themselves, though perhaps they would not object to strangers risking their lives. One of the most remarkable is the Devil's Hill, called by Bosman, Monte de Diablo, near Winnibah, in the Aguna (Agouna) country. In his day, a Mr. Braggs, English agent, was commissioned by the African Company to prospect it. He died at Cape Coast Castle before undertaking a work which, in those days, would have been highly dangerous. Some authorities fix the Seecom river as the easternmost boundary where gold is found. This is so far incorrect that I have panned it from the sands under James Fort. Besides which it is notorious that on the banks of the upper Volta, about the latitude of the Krobo (Croboe) country, there are extensive deposits, regarded by the people as sacred.

The Slave Coast is a low alluvial tract, and appears to be wholly destitute. According to the Rev. Mr. Bowen, a small quantity of gold has been found in the quartz of Yoruba, north of Abeokuta ; but, as in the Brazils, it is probably too much dispersed to be worth working. And the Niger which flows, as will presently be seen, from the true auriferous centre, has at times been found to roll down stream-gold. The soil of Fanti and the seaboard is but slightly auriferous.

As we advance northwards from the Gold Coast the yield becomes richer. In Ashantee the red and loamy soil, scattered with gravel and grey granite, is everywhere impregnated with gold, which the slaves

Company a maximum of 4,000 ounces per month, we obtain from that source 48,000 ounces. But considerable quantities are exported in merchant ships, more especially for the American market. Whilst, therefore, some reduce the total to 60,000 ounces, others raise it to half a million of money.

extract by washing and digging. It is said that in the market-place of Kumasi there are 1,600 ounces worth of gold—a treasure reserved for State purposes. The bracelets of rock-gold, which the caboceers wear on state occasions, are four pounds in weight, and often so heavy that they must rest their arms upon the heads of their slave boys.

In Gaman, the region to the north-west of the capital, the ore is found in large nuggets, sometimes weighing four pounds. The pits are sunk nine feet in the red granite and grey granite, and the gold is highly coloured. From 8,000 to 10,000 slaves work for two months every year in the bed of the Bara river. There, however, as on the Gold Coast, the work is very imperfect, and in some places where the metal is sacred to the Fetish, it is not worked at all. Judging from analogy, we might expect to find the precious metal in the declivities inland and northwards from Cape Palmas, and in that sister formation of the East African ghauts, the "Sierra del Crystal." The late Captain Lawlin, an American trader, settled on an island at the mouth of the Fernan Vaz, carried to his own country, about the year 1843-44, a quantity of granular gold, which had been brought to him by some country people. He brought back all the necessary tools and implements to the Gaboon River, but the natives became alarmed, and he failed to find the spot. Finally, according to the tradition of native travellers, the unexplored region called Rúmá,* and conjecturally placed south of the inhospitably Waday, is a land of goldsmiths, the ore being found in mountainous and well-watered districts. It is becoming evident that Africa will some day equal half-a-dozen Californias.

Mungo Park supplies the amplest notices of gold in the regions visited by him north of the Kong Mountains. The principal places are the head of the Senegal river, and its various influents ; Dindiko, where the shafts are most deep, and notched, like a ladder ; Shronda, which gives two grains from every pound of alluvial matter ;† Bambuk and Bambarra. In Kongkadu, the "mountain land," where the hills are of coarse ruddy granite, composed of red feldspar, white quartz, and black shale, containing orbicular concretions, granular gold is found in the quartz, which is broken with hammers ; the grains, however, are flat. The diggings at present best known are those of Manding. The gold, we are told, is found not in mines or veins, but scattered in sand and clay. They vary from a pin's head to the size of a pea, and are remarkably pure. This is called Sana Manko, or gold-powder, in contradistiuction to Sana birro, or gold stones, nuggets occasionally weighing

* This may be the "Runga," of our maps, with whose position Ruma corresponds. My informant wrote down the name from the mouth of a Waday man at Lagos.

† This would be $\frac{1}{3500}$ (avoirdupois), whereas the cascalhao, or alluvium, of Brazil is $\frac{1}{15000}$, and remarkably rich and pyritical ores in Europe give $\frac{1}{200000}$. Yet M. D'Aubrie estimates the gold in the bed of Father Rhine at six or seven millions of pounds sterling.

five drachms. In December, after the harvest-home, when the gold-bearing Fiumaras from the hills have shrunk, the Mansa or Shaykh appoints a day to begin Sana Ku—gold-washing. Each woman arms herself with a hoe, two or three calabashes, and a few quills. On the morning before departure a bullock is slaughtered for a feast, and prayers and charms are not forgotten. The error made by these people is digging and washing for years in the same spot, which proves comparatively unfruitful unless the torrent shifts its course. They never follow the lead to the hills, but content themselves with exploring the heads of the water-courses, which the rapid stream denudes of sand and clay, leaving a strew of small pebbles that wear the skin off the finger-tips. The richest yield is from pits sunk in the height of the dry season, near some hill in which gold has been found. As the workers dig through the several strata of sand and clay, they send up a few calabashes by way of experiment for the women, whose peculiar duty it is to wash the stuff, and thus they continue till they strike the floor-rock. The most hopeful formation is held to be a bed of reddish sand, with small dark specks, described as " black matter, resembling gun-powder," and called by the people Sana Mira, or gold-rust : it is possibly emery. In Mr. Murray's edition of 1816, there are illustrations of the various positions, and a long description (Vol. I., p. 450, and Vol. II., p. 75) of the style of panning. I will not trouble the reader with it, as it in no way differs from that now practised on the Gold Coast and Kaffir lands. There is art in this apparently simple process. Some women find gold when others cannot discover a particle ; and as quicksilver is not used, at least one-third must be wasted, or rather, I may say, it is preserved for a better day.

The gold dust is stored in quills, stopped with cotton, and the washers are fond of wearing a number of these trophies in their hair. The average of an industrious individual's annual collection may be two slaves. The price of these varies from nine to twelve minkali,* each of 12s. 6d., or its equivalent in goods, viz., eighteen gun-flints, forty-eight leaves of tobacco, twenty charges of gunpowder, a cutlass, and a musket. Part of the gold is converted into massive and cumbrous ornaments, necklaces, and ear-rings, and when a lady of consequence is in full dress, she bears from 50*l.* to 80*l.* A proportion is put by to defray expenses of travelling to and from the coast, and the greater part is then invested in goods, or exchanged with the Moors for salt and merchandise.

The gold is weighed in small balances, which the people always carry about with them, and they make, like the Hindus, but little difference between gold dust and wrought gold. The purchaser always uses his own " tilikissi," beans probably of the *Abrus*, which are sometimes soaked in Shea butter, to increase their weight, or are imi-

* May not this word be an old corruption of the well-known Arabic weight, miskal ?

tated with ground-down pebbles. In smelting gold, the smith uses an alkaline salt, obtained from a ley of burnt corn stalks. He is capable, as even the wildest African tribes are, of drawing fine wire. When rings—the favourite forms in which the precious metal is carried coastward—are to be made, the gold is run without any flux in a crucible of sun-dried red clay, which is covered over with charcoal or braize. The smith pours the fluid into a furrow traced in the ground, by way of mould. When it has cooled, he reheats it, and hammers it into a little square ingot or bar of the size required. After a third exposure to fire, he twists with his pincers the bar into a screw shape, lengthens out the ends, and turns them up to form the circle.

It must now be abundantly evident to the reader that the great centre of West African gold, the source which supplies Manding to the North, and Ashantee to the South, is the equatorial range called the Kong. What the mineral wealth must be there, it is impossible to estimate, when nearly three millions and a half of pounds sterling have annually been drawn from a small parallelogram between its southern slopes and the ocean, whilst the other three-quarters of the land—without alluding to the equally rich declivities of the northern versant—have remained as yet unexplored. Even in northern Liberia colonists have occasionally come upon a pocket of 50 dols., and the natives bring gold in from the banks of streams.

Mr. Wilson ('Western Africa,' chap. x.) remarks upon this subject, "It is best for whites and blacks that these mines should be worked just as they are. The world is not suffering for the want of gold, and the comparative small quantities that are brought to the sea-coast keep the people in continual intercourse with civilised men, and ultimately, no doubt, will be the means of introducing civilisation and Christianity among them."

THE TECHNOLOGIST.

CHEMICAL TECHNOLOGY.

BY PROFESSOR JAMES C. BOOTH.

The arts are those processes by which the products of the mineral, vegetable, and animal kingdoms are modified, in a greater or less degree, in order to adapt them to the wants of man. These processes are based on either mechanical or chemical principles; and while in a large proportion of them mechanics are almost exclusively employed, in an equally large number mechanical operations are merely subservient to chemical action. Hence, a twofold division of the arts is both practicable and convenient. The former is designated as Mechanical Technology, or Practical Mechanics; the latter, Chemical Technology.

Among the chemical arts, many are conducted on a large scale, and are properly termed chemical manufactures; but chemical technology is more comprehensive, embracing less extended processes, and even a few in which chemistry finds a limited application. Thus, the making of alum and glass, the reduction of iron ores, the extraction and refining of sugar, are all manufactures conducted on a vast scale. On the other hand, phosphate of soda and chrome yellow are made on a limited scale; small quantities of nickel, of tannin, and perfuming oils, are extracted and refined; and yet, as their preparation is wholly governed by chemical principles, these processes belong to chemical technology. While some writers incorrectly limit the subject to chemical manufactures, others confine it to the first valuable products obtained. Thus, while the preparation of alum and copperas are acknowledged chemical arts and manufactures, their extensive application to organic fibre to give permanency to dyes, and the whole art of dyeing and calico printing, would be excluded. This is manifestly wrong, if the definition of the arts which we have given be correct; and we cannot exclude those arts of a chemical nature, which more immediately flow from any one branch of manufactures, especially when we consider that such collateral arts are often necessary to the economy of a particular branch of manufacture.

Emanating from chemistry, chemical technology has been usually treated as a branch of that science, and has been correctly designated "applied chemistry." Its recent expansion, however, by the aid of chemistry, allows of its establishment as an independent branch of knowledge,—a science, capable of a classification, not on the principles of chemical science, but evolved from itself, by a comparison of its subjects with each other. The main principle which should govern such classification is the object in view or the product to be made, and, with this, the secondary arts necessarily or usually connected with it. Thus, the making of soap, being an important art, and an extensive mannfacture, necessarily includes the extraction and purification of oils and fats, while perfumery and chandlery seem to follow in its train in a natural order. The following is an attempt at such a classification of the subjects in chemical technology, and is the result of some years' experience in lectures on the chemical arts delivered by the writer before the Franklin Institute of Philadelphia. Doubtless, it will be found imperfect, but it is fair to offer as an apology, the difficulty experienced by the chemist in separating in his mind the composition and properties of bodies from their connection as objects of manufacture, and in breaking down long cherished associations of purely chemical characteristics.

Chemical affinity may be regarded as the force employed in the chemical arts ; fuel and water, as the principal agents used to modify or direct this force ; and the crude productions of the mineral, vegetable, and animal kingdoms, as the materials subjected to action. The air performs less important functions, as a direct agent ; but, in conjunction with fuel, it is indirectly an indispensable agent, in developing heat by the union of its oxygen with the carbon and hydrogen of fuel. Fuel is, however, the true agent in this case, practically considered, because it can be handled, weighed, and measured, by the artisan, and is indispensable in the reduction of metallic ores. We therefore regard fuel as the source of heat in the arts ; and since the larger proportion of the more important technical processes are more or less controlled by heat, it must be viewed as the principal agent or modifier of affinity. Hence the sources and management of heat should be the first subject treated of in a classified narration of technical processes. It may be followed by its application to the warming of buildings, which, in its manifold aspects of economy, convenience, safety, and health of man, embraces the forms of apparatus in which it is employed, and the subject of ventilation.

More naturally connected with fuel than with any other department of the arts are the means of obtaining and of extinguishing fire; the preparation of those mixtures of combustibles with condensed forms of oxygen, such as gunpowder, and other projectile and destructive agents, together with their allied compositions for ornamental displays of fire. These may be embraced under the term Pyrotechny.

The whole of the first subject, included under the term *Calorics*, admits of the three subdivisions or groups: Fuel and Furnaces, Warming and Ventilation, and Pyrotechny.

One of the similar applications of heat to modify mineral substances, is the fusion of sand and alkali to glass, which is highly plastic when sufficiently heated, and in that state receives the form which it retains on cooling. Another application is to the semi-fusion or baking of clay-ware, which, having been previously plastic by admixture with water, and having then received its form, is heated to a point below perfect fusion to give that form permanence. Allied to these is another plastic art; the making and use of cements and mortars, including plaster-casting, and making artificial stone. All these are embraced under the general term of *Plastics*; of which glass-making is Pyroplastics; cements, Hydroplastics; while the art of pottery partakes of the character of each.

Another important but more complex application of fire is to *Metallurgy*, wherein fuel is both the source of heat and the chief means of reducing ores to the metallic state. It will be observed, that while the fluxing of ores naturally connects metallurgy with the pyroplastic arts of glass and pottery, the construction of furnaces and moulds indicates its dependence upon hydroplastics. Modern chemistry has enriched metallurgy with a new department, Galvanoplastics, and with a variety of processes in which the metallurgic treatment of ores is effected by solutions. We may, therefore, conveniently divide the subject into Pyrometallurgy and Hydrometallurgy. For the present, it is proper to regard Photography as a branch of the latter, with which it stands in intimate connection.

Metallurgy and Plastics, having each their branches, in which aqueous action plays a conspicuous part, are thus naturally linked with a long series of arts in which water is the prime agent in modifying and directing the force, affinity; and the connection is still further established by the fact, that the substances acted on are mostly confined to those of the preceding classes, alkali, earth, and metal. The arts in the present class, having for their chief object the preparation of simple chemical compounds, acid, oxide, and salt, and being conducted on purely chemical principles, have received the general term of *Chemics*. Water is the medium of action, the solvent for acid and alkali, in which they exert their powerful and contrary effects; the solvent for salts, in which they are decomposed and resolved into new and useful compounds. The manufacture of sulphuric acid, usually regarded as the keystone of the more purely chemical arts, and its use in transforming common salt into the alkali soda, introduces a series of various connected and derivative arts, conducted on a large scale, whose elements are to be found in plastics, and which may constitute a convenient division of chemics, called Salines, or the saline arts. While we have seen the arts of the preceding class extract the metals from their ores, the next division of chemics subjects them to such treatment in solution, as to convert them into many useful compounds, such as pigments, salts employed in dyeing tissues, &c. This group constitutes the Metallosalines. The making of fine chemicals and pharmaceutic preparations is connected intimately with the preceding saline arts, being conducted in a similar manner but on a smaller scale, and with greater nicety ; it also depends chiefly on the products of those arts as its means of action, and partly on them for materials to be acted on. This forms, therefore, the third group of the chemic arts.

It may have been observed that the arts of the preceding classes are chiefly devoted to the preparation of tools whereby to work upon, vessels wherein to operate upon, or materials wherewith to modify the various crude productions of organic and partly inorganic nature, in order to adapt them to the manifold wants of man, whether to minister to his comfort or luxury. Clothing, food, and the comforts of life are therefore mainly embraced by the following technical processes. The most extended application of the chemical products derived from the preceding class, is to the ornamenting and modification of tissues, which embraces the beautiful and varied arts of dyeing and calico-printing, or ornamenting Textile fabrics. With these are linked the kindred arts of making Sheet-fabrics, paper, leather, &c., as well as working in caoutchouc and gutta percha. To modify and ornament fibrous, sheet, and solid tissues, varnishes and cements are employed, and are classed under the general term Adhesives. The principal subjects of this class being the ornamenting of woven fabrics, it has received the name *Calistics* (*χαλος*, and *ἱστος loom.*)

The use of soap for general purposes of cleansing, and chiefly of cleansing textile fabrics, follows the preceding in a natural sequence, and serves to group a series of arts, rather allied by unity of material on which they operate than by unity of object in view. They include the extraction and purification of oils and fats, the preparation of soap, and the various articles of the perfumer ; and, lastly, Illumination, which includes chandlery, the manufacture of gas, with the various substances and apparatus which afford light, such as burning-fluids, lamps, and jets. *Oleics* is an appropriate term for the class.

After the arts which supply man with clothing and minister to other external wants, those which afford him nourishment follow, and may be conveniently grouped under the term *Sitepsics*, (*σιτος*, food, and *ἑψω*, *cook, prepare.)* The extraction of farinas and sugar, with the refining of the latter, are followed by their modification under the singular process of fermentation and conversion into alcohol, which in its turn, is readily changed into vinegar during the acetous fermentation. The various culinary arts form another convenient group of the domestic arts, embracing the preparation and preservation of food.

The following is a tabular view of the arts, classified in accordance with the principles here laid down.

TABULAR VIEW OF THE CHEMICAL ARTS.

CLASS.	GROUP.	PRINCIPAL SUBJECTS.
I. Calorics.	1. Fuel and Furnaces.	Coal, wood, coke, &c. Reverberatory, blast furnaces &c.
	2. Warming and Ventilation.	Stoves, hot air, steam, water.
	3. Pyrotechny.	Matches, gunpowder, fireworks.
II. Plastics.	1. Pyroplastics.	Glass, enamel.
	2. Pottery.	Brick, earthenware, porcelain.
	3. Hydroplastics.	Lime, mortar, gypsum.
III. Metallurgy.	1. Pyrometallurgy.	Reductions of ores by fire.
	2. Hydrometallurgy.	Galvanoplastics, photography.
IV. Chemics.	1. Salines	Oil of vitrol, soda, nitre, alum.
	2. Metallosalines.	Metallic salts, pigments.
	3. Pharmaceutics.	Inorganic, organic.
V. Calistics.	1. Textile fabrics.	Bleaching, dyeing, calico-printing.
	2. Sheet fabrics.	Paper, leather, caoutchouc, gutta percha.
	3. Adhesives.	Resin, varnish, glue.
VI. Oleics.	1. Oils and Fats.	Extraction and fining, &c.
	2. Saponification.	Soap, essences, perfumery.
	3. Illumination.	Chandlery, gas, burning fluids, lamps, jets.
VII. Sitepsics.	1. Farina, &c.	Starch, flour, sugar.
	2. Fermentation.	Alcohol, wine, beer, vinegar.
	3. Culinary arts.	Preparation and preservation of food.
VIII. Biotechnics.	1. Physiology.	Plants and animals, ashes.
	2. Manures.	Putrefaction, mineral manures.
	3. Products.	Milk, fat, bone, horn.

The whole series of chemical arts may be closed by chemical agriculture, or the art of directing and controlling the growth of plants and animals, whence its name *Biotechnics*, (βιος, *life*, τεχνη, *art*,) in order to render their products, in quantity and quality, most suitable to the demands of the arts or the more immediate wants of man. To effect this, the influence of the air, water, and soil, of mineral substances and manures, on the growth and productions of plants, must be studied ; the composition of their ashes, under different circumstances of growth and product, examined ; the influence of food and other circumstances on the growth of animals and of their parts, such as hair, horn, fat, &c., must be investigated. These important observations on organic life constitute a true art, as yet in its infancy ; and it is of a chemical character, so far as it is pursued with a chemical object in view, (the quantity and quality of organic product,) and by chemical agency, (minute, practical analysis.) We may consider it under the several heads,—of the chemical changes observed in the formation of useful products in plants and animals, including the peculiar chemical character of such products ; of the influence of mineral organic manures on the special products of plants, and various conditions on the products of animals ; and the examination of the ashes of organized bodies, with a view of supplying such as may be required for obtaining special products. These subjects are most conveniently grouped in this manner at the present time ; but as the art becomes more fully developed, the very different nature of plants and animals, and the different influences exerted upon each domain of organic life, will cause their separation.

Philadelphia.

ON THE CHINA-STONE AND CHINA-CLAYS OF CORNWALL.

BY H. M. STOKER.

The China-stone and China-clays of Cornwall, or the disintegrated granites, have, of late years, assumed a no less important than interesting feature in its history ; not only to the capitalist, from the great addition the discovery of their use has made to its commercial importance; to the working classes, from the necessarily co-existant increase of employment ; to the shipping, from the quantity annually exported ; but also to the traveller, from the picturesque scenes, the preparation of these articles have added to the previously existing and unexampled ones offered him for contemplation in the various modes of raising and rendering available the mineral wealth for which we have been so long and so justly famed ; and not only to these, but to the practical chemist as well, does it afford matter for speculation, inasmuch as the supply of the former of these articles is so limited, as to require, in the course of a very few years, some cheap and easily-available substitute, whether to be supplied from this or from some other county, is a question to be determined only by the conjoined efforts of the miner, the geologist, and the analytical chemist.

Attention was first directed to the fact, that the disintegrated granite and clays of Cornwall, as well as those of Devon, when fused or burnt, could be rendered available to the potter, in 1768 by the late Mr. Cookworthy, of Plymouth, who extensively exported them to the potteries of Staffordshire, for that purpose, from Devon ; subsequently to which, large beds of a like description of clays were found in the parish of St. Stephens ; and it having been ascertained that the decomposing granite, from which such beds are formed, was capable, when fused, of forming a suitable glaze for the articles made of the clay, a large trade was at once opened, which has continued progressively to increase till the present time.

The disintegrated granite, under the name of China-stone, from the use to which it was applied, was exported at a later period than the China-clay or kaolin. This article of commerce not having been introduced till the year 1802, when it was first raised from a bed of great purity, containing no iron or manganese, but merely felspar, silica, and mica, in varying proportions ; and this is at present the only source from which it can be obtained of a sufficient degree of purity for ordinary purposes ; though, from its price and the efforts that have been made by chemists both here and in the potteries, to gain a substitute for it, it is very doubtful whether it will long continue so : more especially if the distance we are placed from Stafford be taken into consideration.

Most of the granites from which the China-stone was formed differ from ordinary granite only in the existence in the latter of plates of talc, horneblende, or diallage, the presence of either of which render the China-stone in which they are found, though but in small proportions, of not even the slightest use, from the black or brown-coloured slag of silicate of iron or manganese found on fusion ; some variation, too, may be found in the amount of each of the ingredients which I have named, but this affects neither the clay formed on the continuation of the disintegrating process, nor is it supposed to exert any influence on the glazing properties of the stone.

The places in which a search for this article would be instituted with the greatest probability of success is in the proximity of fissured granite rocks, containing, or supposed to have contained, softened stone ; or in hills with rounded heavy summits, the beds of which are placed horizontally, and felspar (or feldspar) forming its predominating ingredient.

The bed from which it is obtained is about three-fourths of a mile in extent on the contiguous borders of the parishes of St. Dennis and St. Stephens, occupying almost the centre of the central granite district of the county, and is surrounded by other primary rocks of igneous origin, which, as they stretch towards the coast on either side, merge into beds of killas or clay-slate ; on the eastern and northern boundaries the granite is more irregular and abrupt in character than on the other sides, is more porphyritic, and contains a much larger proportion of felspar, in large red or white opaque, cubic, or rhomboidal crystals; while on the south it is separated from the neighbouring granite by a large elvan dyke; and it is worthy of notice, that while on one side of this, you may find China-stone perfectly pure, on the other, only from one to two feet distant, the stone is rendered useless by the presence of small plates of talc embedded in dense grey granite, which also forms a portion of the eastern boundary.

Any one who has carefully studied the porphyry dykes, or the general nature of the primary rocks, of Cornwall, cannot but have noticed the difference in the temperature at which some of them have been upheaved compared to that of others, for while some of our granites are composed of substances which have in their crystals a certain amount of water that has not been lost, others have no trace of it, their felspar having become an amorphous-looking powder (kaolin); and others presenting the same waxy edge on fracture that is noticed in porcelain, particularly the elvan dykes. From this it has been conjectured, though to me it appears doubtful, that as the melting point of other minerals was considerably below that of these rocks, at the time of the extraordinary convulsion to which our country has been subjected, the China-stone was by this means freed from iron, &c.; and that, on its having reached the surface, the water by which it was surrounded at once caused the crystals of felspar to split, lose their outline and character, and become easily acted on by the solvent power of rain-water, which by depriving it of a portion of its potash, leaves the crystals of quartz or silicic acid and plates of mica, glistening with a silvery hue imbedded in a mass of silicate of potash and alumina; which, from the loss of crystallization, cannot be termed felspar, nor is it kaolin, for it has not been subjected sufficiently long to the causes which lead to its formation.

The chief causes which I believe to have led to its disintegration, and not only to the formation of China-stone, or China-clay, but to that of all the land at present in cultivation or capable of being cultivated, are, 1st,—external physical agents, proved by the fact that China-stone is very seldom found at a depth of more than from 20 to 30 feet from the surface; the influence of the seasons; the changes from hot to cold on a body composed of crystals possessing such different expansive powers as those of felspar and quartz; and the solvent power of rain-water: while, as chemical agents, we have, 2ndly,—the influence of the excess of carbonic acid in the air, as well as that from the interior of the earth, of the influence of which we have abundant proof in the excellent crops obtainable near lavas, or wherever this gas can gain access to the compound silicates of which the greatest portion of the Earth's crust consists; and by the influence of respiration in rooms provided with windows, which may have been exposed for a long period to its application.

At present, while there is a great demand for the article, the spot from whence China-stone is procured presents the appearance of a large rabbit burrow, as there are no less than nine setts for the district, the proprietor of each of which has his portion of the hill covered with the mouths of pits, around which are stationed a number of men with their waggons, who, after the China-stone has been raised by quarrying and the employment of powder, carry it to one of the nearest ports to be shipped for the potteries of Staffordshire and Worcestershire. These ports are distant seven or nine miles from the quarries, entailing in this transport a considerable amount of land carriage, and a consequent increase in the price, which of late years has been raised from 12s. to 20s. free on board, at Par, Pentewan, or Charlestown; still the demand has by no means diminished, and the proprietors of these setts have been obliged to fix a certain limit to their annual supply of 18,000 tons, which rate of consumption will have effected the removal of all the China-stone in these beds in rather less than fifty years.

The number of people employed in its preparation are comparatively few, as the operation of blasting requires but two or three persons in each pit; and in loading the waggons the parties employed as carriers are but too eager to fill in order to gain a load. The before-mentioned reasons render the question of supply an important one, and one well worthy the attention of the landowner as to future resources, and the influence the discovery of any large bed of good stone would exert on his pocket; though, while the present setts of the China-stone Company of Cornwall hold out, they not only can but will maintain a monopoly.

China-stone, in its present state, consists of a mixture of quartz, felspar, and mica, blended so as to form an homogenous mass which very much resemble granite, though its texture is not so compact; the quartz exists in small bluish-white and transparent crystals, the edges of which, by the process of disintegration, are rendered more or less indistinct, and they have become more transparent than when in the form of granite. These crystals are imbedded in a mixture of white felspar which has lost a portion of its potash, and small opaque scales of mica having a lustrous silvery aspect and very thin: the granite from which it has been formed is of the simplest kind, the commoner forms containing, in addition to the mica, quartz and felspar, which may be either red or grey, crystals and scales of horneblende, diallage, or talc, with a more or less appreciable amount of iron, indicated by the black spots formed on fusion or calcination; and as the chemical composition of this article, when pure, should indicate an absence of these deteriorating qualities, until some cheap mode of separating these constituents from the otherwise vitrifiable granites of Cornwall be found, the China-stone at present in use must retain its pre-eminence, consisting as it does of a pure double silicate of potash and alumina, which, when fused, forms a pearl-white translucent mass, firm and resonant, consisting of an opaque body of nearly perfectly formed kaolin, surrounded by and diffused through the glaze of silicic acid, to which its transparency is due: and not only does the foregoing deteriorating substances render the article useless, but should there be a very great excess of quartz crystals or silica the article will not from the formation of single silicates be capable of fusion at any temperature; though this fault may be remedied by the addition of either potash or soda, to which the vitrifaction not only of this but of the various kinds of glass, is also due; felspar, according to Liebig, containing 17·75 per cent. of potash.

China-stone is used in the Potteries for a number of purposes, the most important of which are, 1st,—in the formation of clay bodies to form biscuit ware; 2ndly,—to strengthen clays rendered poor by the absence of potash; and, 3rdly,—in the preparation or construction of glazes, for the calcined biscuit ware, when mixed with other ingredients.

The manufactured China-stone and China-clay is termed "pottery," of which there are several varieties, each containing different proportions of China-stone, clay, and other articles. In the porcelain series there is said to be but 3 per cent. of potash, but this I imagine from the transparency and purity of the body, to be inaccurate. The Chinese used to employ the ashes of ferns, which from the amount of carbonate of potash they contain, gave to it that richness and blending of the body with the glaze for which it has been long remarkable: bone ash was also used, both by the Chinese and French, and is now employed by our potters in considerable quantity, for the sake of the phosphate of lime it contains, which, during the process of fusion, adds considerably to the transparency of the ware without rendering the glaze liable to craze or peel off, as would be the case were lime alone employed, in fact at times, during a single firing, more than 5,000*l.* worth of pottery is rendered useless by the admixture of this earth, the surface of the services becoming covered with a congeries of cracks and fissures, hence great care is necessary to prevent its addition.

The terms employed to designate the kinds of calcined and fused wares, are:—Pipe-clay, the least used and least important; Queen's ware; Terra Cotta; Basaltes; and Porcelain biscuit; the whole of which were introduced by Wedgwood, to whose persevering, accurate, and scientific research, we are indebted for the position our pottery now holds; and it should not be forgotten that the rapid strides by which we have gained it, and the discoveries that have of later years been made in this art, have been wholly derived from a good practical acquaintance with chemical analysis, the importance of which cannot be too strongly urged, on both the potter and the producer of the raw material. The other and more common wares are, porclain; pottery, an inferior kind of porcelain; and earthenware; to the description of which I shall for the present confine my attention, that of the before mentioned wares, as well as of Parian, biscuit China, &c., belonging more strictly to the province of the potter than to that of the writer of the present essay.

Until a very late period pottery manufacture was comparatively unknown in England; in the eighteenth century we were indebted entirely to the Chinese for our best, and to the continental potteries for our commoner wares; a century has but elapsed, and to the credit of the industrious, the persevering, the indefatigably speculating, Englishman, be it added, that from pole to pole, under any portion of the Globe's equator, wherever the traveller may roam in search of adventure, no less than through the length and breadth of his happy little island home, he will find, in his cup, his plate, or his dish, a never-dying testimonial to the enterprising character of the Englishman.

In porcelain or China and the coarser variety termed pottery, the ingredients are so combined as to act chemically on each other, the decomposed felspar consisting of a fusible glass of silicate of alumina and potash, more opaque than that formed by the fused silex in which it is disseminated; and when the body is formed of China-clay, infusible at the highest temperature, in the process of vitrifaction, it is so acted on, as to form a substance uniformly opaque, having a vitreous, waxy fracture, and when coloured by some metallic base is termed stone-ware.

There are two kinds of China or porcelain; the one termed the hard China was formerly imported from France, though, of late years, it has been altogether superseded by the second variety, or soft China. The body of hard China may be conveniently formed by a mixture of ingredients in the following proportions:—

Kaolin, or China-clay......	70	parts
Felspar..........................	14	„
Sand..............................	12	„
Selenite..........................	4	„

which calcined, forms the biscuit: this, after being dipped in a mixture of potash and felspar, is again heated, when vitrifaction ensues, the article possessing a homogenous translucent structure and not a mere glaze or coat as found on the common earthenware. In making soft China the English potters fully vitrify the ware by the first application of heat, the shape of the article being kept by ground flint, removable with ease after it is taken from the oven, and the glaze, being subsequently applied, is vitrified at a lower temperature than that used in the formation of the biscuit of soft China, the ingredients used to form which, are,—

Bone............	46	parts
Kaolin..........	31	„
China-stone...	23	„

In making the glaze, a frit is first formed, which renders the glaze more easily applicable to the surface of the biscuit, by calcining a mixture similar to the following:—

China-stone....	25	parts
Soda.............	6	„
Borax............	3	„
Nitre............	1	„

Of this frit, when ground, 26 parts are taken, and added to, or mixed with,—

26 of ground China-stone,
31 „ white lead,
7 „ Flint,
7 „ Carbonate of Lime, &c.,
3 „ Oxide of Tin,

in which the biscuit is dipped prior to the last application of heat. The colours to be laid on the ware are applied and burnt in prior to the formation of the glaze, an article often requiring a separate burning for each different colour, thus, especially in gilded articles, entailing an additional amount of cost and labour.

The China-stone increases the strength and sonorosity of the article, while the ground flint gives whiteness and density to the base of plastic clay: earths are by themselves infusible, but on the addition of silex or silica, another name for quartz, we form a silicate, to which, if we add a third of earth, with an alkaline base, we form a body vitrifiable and uniformly translucent.

I shall briefly describe the mode in which the China-stone and China-clay are treated, prior to their being turned, twisted, and flattened, to form the numberless articles in which they greet the eye.

The China-stone is ground to a fine powder by means of a number of stones which are kept rotating on the bottom of a paved vat, when it, as well as the clay and ground flint, are mixed with a certain quantity of water, by a process termed "blunging," till of the consistence of cream, when it is passed in a state of slop or slip through a series of cambric or lawn sieves kept rapidly revolving by a water-wheel, each pint of the clay slip weighing twenty-four ounces, while that of the flint or China-stone weighs thirty-two ounces. It is then passed through a very fine silk sieve, after which these ingredients are mixed together in variable proportions in a large vat or tub, and as soon as the mixture has attained its requisite consistence, the water is driven off by evaporation, which causing the slip to contain in its interstices an innumerable quantity of air globules, renders it necessary that it should be submitted to the process of kneading or beating, after which it was formerly thought necessary, though now abandoned, that this mass should lie fallow for three or four months, when it is considered to be fit for the lathe.

The proportions of the ingredients used in the different kinds of earthenware are as follow:—

In cream colour or painted ware,—Dorsetshire clay, 56 parts; kaolin or China-clay, 27; flint, 14; and China-stone, 3 parts.

In brown ware,—red clay, 83; Dorset clay, 13; flint, 2; and manganese, 2 parts.

In drab ware,—Caen marl, 32; Dorset clay, 22; China-stone, 45; and nickel, 1 part.

In jasper,—barytes, 32; kaolin, 15; Dorset clay, 15; stone, 33; and of lead, 3 parts.

The glaze commonly used for the cream-coloured ware consists of varying proportions of white lead and China-stone, or, as these may craze, a frit of the following materials is often employed:—

Of China-stone, 30; flint, 16; red lead, 25; soda, 12; and borax, 17 parts; 26 parts of this are then mixed with 15 of China-stone, 10 of flint glass, 9 of flint, and 40 of white lead; which constitutes the fritted glaze.

The composition of most of the bodies and clays now used is a secret confined to the walls of the mixing room, so that it is extremely difficult to ascertain, with any degree of accuracy, the influence of an excess of ingredients; thereby entailing a co-existent difficulty on the part of the producer, in his endeavour to form or prepare a substitute for these articles.

The China-clay or kaolin of Cornwall was first brought into notice at a very late period, though the material itself has been long used; in fact, not only were the Chinese well acquainted with it, both in a raw and a manufactured state, from the most remote ages, but it is also probable, from the interesting evidences brought to light, through the industrious exertions of Mr. Layard, and from other sources, that the Egyptians knew somewhat of its uses.

When obtained by Mr. Cookworthy, in 1768, from the Lescrowse and Trethose clay works, in the parish of St. Stephens a large supply was at once demanded for the Staffordshire potteries, which has gradually increased till the present time.

A considerable amount of crude kaolin has been exported to every pottery on the Continent, and also to those of our inquiring American brethren, while a small portion has been used for bleaching.

Kaolin is found intermixed with quartz and scales of mica, in most valleys contiguous to the decomposing hills of the primary strata of our county, and is not, as far as is at present known with regard to China stone, confined to any particular district, being now obtained or obtainable, though of different qualities, on the south-western sides of either of the granite districts; yet, of course, poorest near those beds of China stone which I before described as free from most deteriorating substances, as in the parish of St. Stephens.

It exists in these beds or stopes, as they are designated, as an amorphous whitish-blue opaque powder; which from the softening influence and rainy character of the south-westerly winds, are most frequent in valleys situated on the same aspect; often lying on the contiguous borders of the granite and killas, clay-slate, grawacke or transition strata, by which this is surrounded; where, being exposed to the action of lodes and co-existing springs, on the occurrence of the slightest convulsion, it has slid to the adjacent valleys, where its presence is indicated by the generally smooth and flattened appearance of the surface; by the vegetation on it, which is often luxuriant, especially if the clay contain an excess of potash; and by the number of springs to which it gives rise in the immediate vicinity, their height above the level of the sea being necessarily limited by that of the valleys in which the clay is deposited.

The character of the clay very much assimilates to that of the granites from which it has been formed by the disintegrating process to which I referred while speaking of the formation of China-stone, not only as to the quantity obtainable from a given amount of clay stope, but also as to the purity of the article and its whiteness, the whitest clay being formed from that granite which has the whitest felspar, and is most free from iron, the presence of this giving the manufactured wares an appearance termed "foxey"; while, lastly, the amount of mica scales, which give to them their tenacity or strength of body, considerably influence the character and value of the clay, so that, as a general rule, we can form a very good diagnosis of the character of the clay by an examination of the granite from which it has been formed; and in doing this, I would advise the use of a good microscope, by which only the clay producer can hope to obtain an accurate knowledge of the value and purity of our clays.

The kaolin of both Devon and Derbyshire is of good working quality but can by no means compare with that of our county, either for whiteness or strength; it contains 60 of alumina, 20 of silica, and 20 of potash (Wedgwood); and to this peculiarity of constitution (excess of silica) is due its property of being infusible, and unchanged, at the highest temperature; it is extremely tenacious of moisture, and hence one great difficulty in its preparation: to be hereafter discussed.

The clay beds, or stopes, are formed by small irregular crystals of quartz, the edges of which are by no means so well marked as in the granite, nor is their opacity so great; the mica is apparently unchanged, consisting of silicic acid, potash, and alumina, in the form of double silicate; while the felspar of the granite or China-stone, by the loss of its potash, has become converted into the amorphous powder I have just described; a singular instance of the effect of slight natural chemical changes giving rise to the formation of two such dissimilar bodies, when fused, as biscuit China, white, glassy, sonorous, and translucent; when, if the disintegrating process have but just overstepped this limit, we find, on fusion, a brick-like mass, white, opaque, adherent to the tongue, tenacious of moisture, and earthy on fracture. There are, however, as I before stated, many and varied intermediate productions from the pasty pipe-clay or tile, to porcelain or glass, which is but another form of a fusible silicate. The clay stopes are oftentimes rendered useless by the presence of some iron lode which causes them to become loosened in texture, and reddened; the stope is then termed "brawny," and this has to be thrown aside as useless.

Having thus briefly given a general outline of the nature, composition, and history of these clays, I shall proceed to the notice of the mode of preparation of them, in this county, which, though simple in theory, requires much care and attention in its execution, and consists essentially in the separation of the quartz from the mica and kaolin, and the subsequent collection of the latter. The execution of this process in any of the extensive works in St. Stephen's parish, one of which would cover from 10 to 13 acres of ground, and from which 2,000 to 3,000 tons are annually raised, and fitted for the market, forms a curious and interesting spectacle of whitewashed happy industry for the contemplation of the traveller during the months of summer.

Distant from five to eight miles from St. Austell, situated in the centre of barren, rugged, heathery wilds, enclosed by stone walls and bounded on every side by cold, bleak, and rugged hills, these works have a picturesque appearance. In one part of them may be seen from 30 to 40 men, boys, and women, who, with their white bonnets, white aprons, and sleeves, carry the still whiter clay, in large junks, to the surrounding hills or drying grounds to be exposed to the warm rays of the sun, the dry winds, and the bleaching power of the air; in another may be seen other parties scraping the clay prior to its being packed in casks, to be sent to various parts of the old and new world; circular or oval pits and square pans are lying in all directions, their continuity here and there disturbed by one or two water-wheels in incessant motion, or piles of dried clay covered with reeders, or lying in sheds; while at one extremity of the work may be seen a number of men and boys employed in excavating the clay stope, removing the overburden, or shearing the stope to wash away its clay; the sand at the same time being removed to the drying ground by means of a tram road, the waggons passing along which are worked by the aid of water power; while overhead launders attached to pumps for various purposes seem to form a skeleton roof to the whole.

The beds of clay stope are exposed by the removal of the overburden which varies in thickness; in some places lying but a few feet from the surface; while in others the only bed fit to be washed is placed at a depth of from 10 to 20 fathoms from the surface; the removal of the superimposed earth is effected by a number of men with their pickaxe and shovels, which, by their barrows, they transport to the adjacent rugged country, so as to render it smooth and level, in order to form drying fields for the summer. While this is in progress, the clay stope, over the top of which flows a small stream of water, is being excavated by another set of men, which, as the water passes through, has the clay suspended in it by the treading action to which the stope is subjected by means of the large boots, often seven pounds weight, with which the clay streamers are supplied; the sand is thus separated from the clay and mica, which are carried on by the water, and the sand is then carried by rail or carted to the top of the work, whence it is taken to be spread over the drying grounds, or is thrown into the pits and pans.

The water to be supplied to the clay stope should consist of two-thirds of spring to one-third of rain-water, this mixture causing a deposit of the suspended clay much more readily than any other. Great attention is often necessary in this part of the process, as from an excess of rain-water it is often requisite that it should be saturated with some earthy base; common alum is at present used for this purpose, though any other cheaper salt would answer the purpose, as it is only necessary to saturate the water fully with earthy bases, when the clay speedily becomes thrown down: a law not generally known.

As a substitute for this, I have at times had recourse to finely-ground peat, or wood charcoal, which, thrown over the surface of a pit, on which it floats, by a process of angular attraction or repulsion, causes the clay to be deposited, even from distilled water, far more readily than by the addition of any soluble earths, as may be demonstrated, with ease, by experiment in two or three tumblers. But as I am rather in advance of the water in which I left the clay and mica suspended at the bottom level of the clay work, I must return thither, till, by the aid of wooden or iron pumps, from 40 to 80 feet deep, worked by a powerful water-wheel, this milky looking fluid is elevated to the level of the large mica launders, where the clay, being lighter than it, leaves it deposited in these inclined pits, which are generally three or four in number, placed in tiers, with a slight elevation at the upper end of each; they vary in length from 10 to 20 feet, are generally 3 feet in breadth, and 6 or 9 inches deep, though both the number, size, and degree of inclination vary with the size and rapidity of flow of the shear of water, though no less than with the amount of mica contained in the stope. In some clay works the shear is so large that most of the mica is carried on with the clay, so that it possesses, when fused, a greater degree of tenacity, though of an inferior quality as to whiteness, plasticity, &c. In the separation of the best clays, these pits require that the motion of the shear through them should be slow and equable; the shear of small size, and the launders should be tapped or cleared out once in every six or seven hours; a careful attention to which well repays any amount of labour in the production of a good article. That portion of the mica collected in the first of these launders often being mixed with its scales and crystals of hornblende, or diallage, is thrown aside as useless, while that collected in the others is generally sold as a second quality clay.

The clay water, having left the mica, now flows on to a large circular or oval collecting pit, 30 or 40 feet in circumference, and from 6 to 10 feet deep, where the clay subsides, forming an under stratum of the consistence of cream, the supernatant water flowing off from the top of the pit, until it is filled. As soon as this happens the clay is allowed to pass out by a trap-hatch to the pans below it; or should there be none at this level, recourse is had to the pumps, by means of which, and attached launders, the clay is passed to the drying pans in any portion of the work. Of these there should be from ten to twelve capable of holding from forty to fifty tons, to each large collecting pit; they have been made, till lately, on any part of the adjacent ground, frequently on that covering the clay bed, where the surface after being levelled and covered with fine loose gravel, is edged in by walls of granite, the joints of which, as well as those of the pits, are rendered impervious by interposed moss; they are generally from 20 to 40 feet square, and 2 deep; the pans, when two-thirds filled with the clay, are thus exposed to the heat of the sun, or the dry winds of March, to the aid of which, alone, the proprietors of the majority of these works have hitherto had recourse.

The kaolin is by this means only partially deprived of moisture, in order to effect the complete removal of which it is taken from the pans, where it has been allowed to remain for from three to four months, to the drying grounds, on the adjoining hills, in summer, in cubic blocks about one foot square. In order to effect its removal from the pans, a number of parallel incisions are made the whole length of the pan, in one direction, by means of a perpendicular knife attached at right angles to a long handle; these long blocks are then divided transversely by men, who, with spades, throw them on a board, on which they are carried by women and boys to the sandy drying yard, where they soon become perfectly dry and white; but as this can only be done in summer, and not even then if a wet season, it has become necessary that recourse should be had to other means; those hitherto employed have all required the use of a fuel obtainable only from Newport or some distant coal tract, and hence requiring considerable outlay, so much so in fact, that but few persons are able or willing to make use of it: the heat in these cases is applied by means of a large kiln, or by passing the clay over a heated drum, neither of which methods could be made available in the return of several thousand tons of clay annually.

The junks of clay, after being again collected, are now piled away in sheds, under a number of thatched gates or reeders; or are placed in some sheltered spot, so that they may, nevertheless, have a constant current of cold dry air surrounding them, and be at the same time kept from rain. When required for exportation, these square blocks are scraped by a number of the clay women, who, armed with their "Dutch hoe"-like instruments, as they surround their scraping tables, present a rather formidable appearance; after this the clay is piled in waggons to be sent from one of the nearest ports, or is packed in a number of small casks, each capable of holding about half-a-ton, in which it is sent off.

The prices of these clays vary much with the quality of the article, though those of a superior stamp seldom alter, as they have held their price for the last ten or fifteen years, and always command an excellent sale in the market at from 36s. to 46s. per ton; while those of an inferior quality may be procured at any price below this down to 17s. per ton; varying with their purity, hardness after calcination, degree of whiteness, both in and out of water, and lastly, the degree of shrinking they undergo on calcination or fusion.

St. Austell, Cornwall.

ON THE UTILITY OF THE NATURAL SCIENCES.

BY W. S. W. RUSCHENBERGER, M.D.

THE proclivities of the present age are eminently utilitarian. Before engaging in any pursuit, men wish to know in what it can profit them. Immediate and direct gain is an object of common desire; hence, those vocations which promise a speedy compensation for labor are most popular, and the paths travelled by those who have been fortunate in pursuit of wealth are most eagerly sought. Agriculture, the mechanic arts, and commerce, which supply the wants, the comforts, and luxuries of man, employ the great masses of society. A love of wealth is a stronger incentive to toil than benevolence; the fame which inures to a labor unproductive of palpable remuneration stimulates but few. Those branches of learning and philosophy which facilitate the acquisition of wealth, attract a larger number of diligent votaries than those which advantageously influence the condition of society, without adding to the pecuniary profit of those who pursue them.

The utility, the beneficial influence, which natural history exercises on the common interests of society, is not commonly understood, and, for this reason, the labors of naturalists are not very generally appreciated. Indeed, a vague meaning seems to be attached to the terms "natural history," and "natural sciences." Unless men comprehend the meaning of these names, they cannot perceive the utility of, or set a value upon, what they are used to designate.

Science and knowledge are not synonymous; there may be knowledge without science. Acquired facts constitute knowledge; but a science consists of any group of congenial truths or facts, arranged according to any rational method, which enables men easily to perceive their general and mutual relations. Science, then, simply means a systematic arrangement of acquired facts. The natural sciences essentially consist in systematic arrangements of the facts and phenomena observed in nature.

In the broad acceptation of the term, natural history includes faithful descriptions of all natural objects. Natural science does not consist merely in making a catalogue of all the plants and animals on the surface of the globe; it embraces a history of the structure, composition, mode of existence, and growth of all natural objects, and seeks to ascertain the laws which determine the innumerable shapes in which matter, both organic and inorganic, presents itself to our senses. All the phenomena observed in the atmosphere above, as well as in the earth beneath, fall within its domain. Chemistry is included among the natural sciences, because the laws which regulate the affinities, the motions ever existing among the molecules or ultimate atoms which constitute matter, are among the subjects pertaining to the researches of naturalists.

A brief allusion to some branches of natural science will enable us to perceive that its influence is advantageously felt in many departments of those arts which contribute largely to the well-being of society.

Botany does not consist exclusively in distinguishing from each other the various forms of vegetation, and recognizing them by names derived from the Greek and Latin languages. It does not teach us simply to divide the world's flora into orders, tribes, families, genera, and species, according to an arbitrary system of arrangement, and to know the peculiarities by which they may be certainly distinguished one from the other. Botany includes a study of the anatomy and physiology of the vegetable kingdom. Through this study, we acquire a knowledge of the structure, mode of growth, and the kind of diet upon which plants depend for sustenance, as well as the appropriate functions of their several parts, and the circumstances which influence vegetable existence. From it we have learned that plants derive nourishment from the earth, through means of roots whose function is to separate from the soil those salts or other materials which enter into the composition of their tissues ; and that, through the medium of leaves, they breathe the air which is essential to their vitality, and, consequently, to the circulation of sap and other liquids.

Such information is of no small value to the science of Agriculture which essentially consists in a knowledge of the most successful means of feeding the various plants cultivated for food, or for materials to be used in the arts and manufactures. When the elementary composition of plants is ascertained through the aid of chemistry, this knowledge of their vital functions enables the agriculturist to select the soil, exposure, and manures best adapted for each variety to obtain a lucrative crop.

But this is not the only manner in which natural history has led to improved and rational modes of cultivation. The labors of botanists have exploded many false notions which prevailed among farmers, calculated to discourage efforts to protect their crops from injurious influences. A power of self-transmutation was once attributed to plants ; ignorant persons believed that some species were capable of metamorphosing themselves into others. It was once asserted, and believed, that "*barley* frequently degenerates into *oats*," and even now some credulous persons contend that "wheat is sometimes transformed into *bromus* or *cheat*."

Even purely descriptive botany may be usefully applied to agriculture. Certain plants, which are injurious to cattle, will be eaten by them when pasture is deficient; and some noxious plants will be eaten when dry and mingled with hay, which animals reject in the green state. A knowledge of descriptive botany would enable the farmer to remove these, as well as profitless weeds, and thus improve his grounds for the advantage of his stock. The wild flora of a country or district affords a valuable indication of the nature of the soil and its subsoil. Thus, the heath on elevations indicates a dry soil ; the fern, that it is deep as well as dry. The deer-hair (*Scirpus cæspitosus*) grows commonly over bogs, resting on clay. In the lower situations, the broom (*Spartium scoparium*) tenants the deep light gravels. The whin, the coarser gravels upon clay subsoil. The rush (*Juncus conglomeratus*,) tells the intelligent farmer that good land is rendered useless for want of drainage. The common sprit (*Juncus articulatus*), that the land is not fertile. Sweet gale (*Myrica Gale*), that it is still worse. The ragweed (*Senecio jacobœa*), in arable land, betrays an ill-cultivated loam. The marsh marigold (*Caltha palustris*), or the wild water-cress, in water meadows, tells the owner that the land is fully irrigated. The common rattle (*Rhinanthus christi*), that the meadow is exhausted. The pry (*Carex dioica*) that water is stagnating beneath its surface ; and these are only a few of the truths which wild flowers teach the intelligent cultivator. Botanists have, indeed, long been at work for the farmer—a fact no one will be willing to dispute who remembers that the sloe, the blackberry, and the crab, are nearly all the fruits indigenous to England ; and that hardly a grass, a flower, or a vegetable, that is now cultivated, is a native of the island.

It is to the study of botany we are indebted for a knowledge of certain vegetable growths which are destructive to timber. "Mr. Schweinitz had in his collection fine specimens of the *Dematium aluta*, taken out of the ships of war built by our government on Lake Erie, where, in a few years, he remarks, 'this little fungulous enemy completely destroyed that fleet which had so signally vanquished the armament of Britain.'"

Linnæus, by his botanical knowledge, detected the cause of a dreadful disease among the horned cattle of the north of Lapland, which had previously been thought equally unaccountable and irremediable.

A large portion of the materials employed in civil and naval architecture, and many of our most valuable medicines, are derived from the vegetable kingdom. It is estimated that at this time there are about 85,000 species of plants which have been distinctly characterised. For the means of distinguishing them from each other, and, consequently, for the ability to recognise, amidst the host, those adapted to the purposes for which we seek them, we are indebted to the labors of botanists.

The department of natural history which relates to insects is less conspicuous than botany; but it is not less important in its bearings on the interests of society. Naturalists have already characterised about 80,000 species of insects, and their continued investigations are still adding to the number. The crustaceans (crabs), arachnidans (spiders), annelidans (worms), &c., &c., in all about 130,000 species, were once included in the department of entomology.

Insects are the scavengers of nature: in pursuit of food, they remove from the surface vast quantities of decaying and putrescent matters, which, if left undisturbed, might so contaminate the air as to render it poisonous to the inhabitants of the earth. Everywhere they constitute a large part of the food of birds and fishes; and in some countries certain species are eaten by man.

Various insects are known to be injurious to the grains and grasses of our fields; to the fruit trees of our orchards, and to plants in conservatories. It is known that some species prey upon others; and that those which feed on the various aphides, or plant-lice, may be employed to relieve us from the ravages of such destroyers.

A knowledge of the habits, mode of life, and of the food of the various kinds, leads to means of escaping the injuries which many of them inflict, and of fostering those which are useful to man. Doubtless there are some persons who are not aware that most insects pass through four stages of existence: 1, the egg; 2, the caterpillar; 3, the chrysalis, and 4, the butterfly, or imago. In order to guard against the ravages of insects, it is necessary to know the stage of existence during which they are most injurious, and also to be able to recognise the different shapes under which they appear. Without a thorough knowledge of the phenomena of insect metamorphosis, it is vain to attempt to control their increase. The information of Linnæus on this point enabled him to teach his countrymen to destroy an insect, the *Cantharis navalis*, which had cost the Swedish Government many thousand pounds a year, by its ravages on the timber of one dock-yard only. After its metamorphosis, and the season when the fly laid its eggs were known, all its ravages were stopped by immersing the timber in water during that period.

In 1817, the late Mr. Thomas Say described the "Hessian Fly" *Cecidomyia destructor*, which commits great ravages on growing wheat; and at the same time pointed out the *Ceraphron destructor*, which probably restrains the increase of the first. It deposits its eggs in the bodies of the larvæ of the Hessian Fly, and the young when they escape from the egg, feed upon the larvæ till it dies.

During the year 1849, Miss Morris, of Germantown, discovered that the *Tomicus liminaris* of Mr. Say, is a destroyer of the peach tree. It bores through the bark and feeds upon the living portion. She has stated also that the *Baris tripunctatus*, of Mr. Say is one of the destroyers of the potato, in the stem of which its larvæ undergo their metamorphosis. And Mr. S. S. Haldeman ascertained that the *Hylesinus* *aculeatus*, of Say, feeds upon the inner bark of the white ash, *Fraxinus acuminata*.

There was a time when a loathsome disease, which Van Helmont tells us he contracted by shaking the gloved hand of a lady friend, was treated by bleeding, purging, and sweating. Since his days, investigations have demonstrated that this malady depends upon the presence of an acarus—the itch-insect—and is to be cured only by destroying the animal. There are several affections attributed to the acarus tribe; the ulcers caused by the chigoe or jigger (*Pulex penetrans*), an insect which is prone to burrow in human flesh, are familiarly spoken of by all who have visited the tropics. The harvest bug (*Leptus autumnalis*) buries itself in the legs of labourers in the harvest field, producing intolerable itching and pain. In cases of *plica polonica*, an affection of the scalp, we are told that millions of lice appear on the third day of the disease. Numerous affections have been traced to the larvæ of flies deposited in the tissues of mammals; a disease familiarly known as the botts, which occurs in horses, sheep, and in man, has this origin. Worms of several kinds are known to thrive in the human body, and to produce disease. Indeed, the affections known to be caused by insects, spiders, worms, &c., are so numerous, that Raspail has ventured to construct a system of medicine based upon the animate origin of diseases. In his work may be found a history of many affections, caused by the presence of minute parasitic insects.

Though many evils arise from insects, they are also the sources of much that is good. The product of the silk-worm, the wax and honey produced by the labour bees, are familiar to all. The gall-nut which forms the basis of one of the most valuable articles known, I mean ink, is due to the labors of an insect on a variety of oak. Gum ammoniac, the varieties of lac (shell-lac, lac-lake, and stick-lac), have a similar origin. To various species of coccus we are indebted for several important dyes, among the most conspicuous of which are the cochineal and kermes. The varieties of cantharides afford blistering materials; and a tea made of bees has been recently found useful in a distressing disease.

Within a short time, the unexpected presence of microscopic insects in certain regions has been supposed to show the course of the winds; when their habits and geographical distribution are fully ascertained, their appearance in any unusual locality may be relied upon as an indication of the direction of atmospheric currents.

A class of animals which exercises an influence of such extent, for good as well as for evil, over the condition of man, is surely worthy of his attentive study.

Conchologists have described about 15,000 species of mollusks. They afford food to man and other animals. The strata of the earth records their antedeluvian existence, hence a knowledge of conchology enables the geologist to recognise fossil shells, the presence of which serves to characterise certain formations.

Herpetologists have made us acquainted with about 2,000 species of reptiles, and established the means of distinguishing those which are harmless and useful from those which are poisonous and fatal.

Naturalists have described about 10,000 species of fishes, a class of animals from which man derives almost incalculable benefits. To be convinced of the truth of this assertion, it is only necessary to glance at the extent and value of the various fisheries in the world.

About 6,000 species of birds have been described. The value of the study of ornithology has been so beautifully stated by one of the earliest members of the Academy of Natural Sciences, that I will quote his language. Alexander Wilson, in the preface to the fifth volume of his "American Ornithology," says:—

"In treating of those birds more generally known, I have endeavoured to do impartial justice to their respective characters. Ignorance and stubborn-rooted opinions, even in this country, have rendered some odious that are eminently useful; and involved the manners of others in fable and mystery, which in themselves are plain and open as day. To remove prejudices, when they oppose themselves to the influence of humanity, is a difficult, and when effected, a most pleasing employment. If, therefore, in divesting this part of the natural history of our country of many of its fables and most forbidding features, and thus enabling our youth to become more intimately acquainted with this charming portion of the feathered creation, I should have succeeded in multiplying their virtuous enjoyments, and in rendering them more humane to those little choristers, how gratifying to my heart would be the reflection! For, to me, it appears that, of all inferior creatures, Heaven seems to have intended birds as the most cheerful associates of man; to soothe and exhilarate him in his labors by their varied melody, of which no other creature but man is capable; to prevent the increase of those inferior hosts of insects that would soon consume the products of his industry; to glean up the refuse of his fields, 'that nothing may be lost,' and, what is of much more interest, to be to him the most endearing examples of the tenderest connubial love and parental affection."

Under the head of mammalogy, naturalists have described about 2,000 species of animals, which, while young, subsist on the milk of their mothers. All known quadrupeds, whales, dolphins, &c., are included in this class. Amongst them are our beasts of burden, the cattle of our fields, and domesticated animals of many kinds. They are familiar to all; but perhaps everyone is not aware that a full knowledge of their nature contributes to the improvement of agricultural stock and affords indications of rational methods of treating the diseases to which domestic animals are obnoxious.

Mineralogy teaches the characters by which simple minerals or stones may be recognised and distinguished from each other. The costly errors into which persons totally ignorant of this science have fallen illustrate its utility. A man in England found upon his farm a great quantity of sulphate of barytes, and, believing from its weight that it must be a rich ore of lead, expended a large sum in building a furnace for smelting it. Another paid a considerable amount of money for a few pieces of white topaz, which he conceived to be diamonds. Men in other respects intelligent, producing iron pyrites, in triumphant proof that they have discovered a mine of gold, is an event of frequent occurrence. About a hundred years ago, a house was built at Baltimore of bricks imported from England; yet beneath the site of the garden, and neatly laid out grounds, once the pride of the owner, was a bed of clay which has afforded and continues to afford material for millions of bricks. A very slight knowledge of mineralogy would have been sufficient to prevent such blunders.

Chemistry is essential to a perfect acquaintance with mineralogy. The utility of chemistry is, perhaps, more generally palpable than any other branch of natural science. To the labors of chemical philosophers society is indebted for many comforts and luxuries. The discovery of a gas adapted to the purposes of illumination has been followed by trades and occupations not previously known or required; gas-fitting, and the manufacture of gas, as well as daguerreotyping, are among the vocations brought into existence exclusively through the study of chemistry. Indeed, the applications of this beautiful science to the practical purposes of mankind are almost innumerable.

Geology cannot be successfully prosecuted without a knowledge of other branches of natural science. Mineralogy is necessary to understand the composition of aggregate rocks; and botany and the different departments of zoology enable us to trace back, through the progress of time, the various steps in the formation of the earth to a period in the creation when no organic form existed, either upon dry land or beneath the waters. The record is indelibly written in the fossil remains of animals and plants; and it cannot be read by one entirely ignorant of osteology and comparative anatomy.

A knowledge of geology is valuable to the engineer in locating roads. The study of geology and mineralogy has developed those principles which facilitate the search for coal beds and veins of metallic ores; clays used in the manufacture of the varieties of porcelain, pottery, and bricks; quarries of marble and stone; and through this study architects may acquire knowledge which will assist them in judging of the strength, durability, and comparative value of the varieties of building stone, and in selecting those best adapted to their purposes. The utility of geology has been publicly acknowledged; many States of the Union have been at the expense of geological surveys, for the purpose of ascertaining their mineral resources.

A knowledge of natural history, generally, facilitates the economic exploration of new countries, and enables the traveller, almost at a glance, to perceive the nature of the soil and climate, as well as the value and qualities of their vegetable and mineral productions. But among the many benefits which the natural sciences confer upon society, there is none more valuable than the assistance they afford to the study of the laws of life, upon an accurate knowledge of which a rational system of medicine, a true medical science, must be based. Physiology is indebted for its present state of advancement, almost exclusively to the assiduous cultivation of the natural sciences.

The rapid sketch above given is sufficient to indicate the usefulness of the natural sciences.

ON CHINESE HOROLOGY, WITH SUGGESTIONS ON THE FORM OF CLOCKS ADAPTED FOR THE CHINESE MARKET.

BY D. J. MACGOWAN, M.D.

The wide-spread territory, the varied productions of her soil, and the high position of China as an agricultural State, lead us to expect that no inconsiderable addition to European and American agriculture would result from a careful survey of the various points accessible to foreigners, and it would doubtless be found that many plants, indigenous to her soil, are capable of being naturalized in one part or another of the American and European continent.

In a manufacturing point of view, although there is much less to repay research, yet there are some branches of industry the investigation of which could not fail to bring valuable facts to light; and, if no more can be done than to point out defects in Chinese labour, which our artisans can supply, that alone would prove mutually advantageous to the two great nations on the opposite shores of the Pacific.

Clock-making, which forms the subject of this paper, is a case in point; and it is believed that, with a modification to be suggested, American clocks can be made an article of extensive import into China. For a long period the importation of clocks and watches, chiefly the former, into China from the continent of Europe, was little short of half a million of dollars annually. This trade has nearly ceased, partly owing, no doubt, to the rapid impoverishment of the country by the opium traffic, and partly to the fact that native manufacturers are able to compete with foreigners. Yet clocks are not often met with in China; they are generally confined to the public offices, where it is common to find half a dozen all in a row. The number annually manufactured cannot be large, for in the richest cities of China clock-makers are not numerous. At Nankin there are 40 shops; at Suchau, 30; Hangchau, 17; and at Ningpo, 7; the average number of men employed in each being less than four, who are mostly occupied in *repairing* watches and clocks. The cheapest clock they make costs 7 dols. Some are worth as much as 100 dols.—the most common price being about 25 dols. each. A manufacturer estimates the number of clocks made at the above places at

1,000 per annum; and probably 500 more would more than cover the whole annual manufacture of the empire. A few watches are made, with the exception of the chain and spring, which are imported. The oil used by Chinese workmen to abate friction appears to be particularly adapted for that purpose, though expensive; it is obtained from the flowers of the *Olea fragrans*.

Before describing the kind of clock which seems adapted for this market, a brief glance at the history of the horological art in China may not be inappropriate. It had its rise, as in the western side of Asia, in the *clepsydra*.

Assuming—what is in the highest degree probable—the authenticity and accuracy of the *Shuking*, we find that, forty-five centuries* ago, the Chinese had occupied themselves with the construction of astronomical instruments somewhat similar to the quadrant and armillary sphere, and the observations they made with them, even at that remote period, are remarkable for their accuracy, enabling them to form a useful calendar. The present cycle of sixty was adopted at that time, by Hwangti, (2697-2597 B. C.) To this emperor is attributed the invention of the clepsydra. The instrument at that period was probably very rude, and not used as a time-piece, but for astronomical purposes, in the same manner as employed by Tycho Brahe, for measuring the motion of stars, and subsequently by Dudber in making maritime observations. It was committed to the care of an officer of rank styled clepsydra adjustor.

The greatest philosopher in Chinese history anterior to Confucius was Duke Chau, the alleged inventor of the compass. He appears, also, to have been the first to employ the clepsydra as a time-piece. He divided the floating index into one hundred equal parts, or "*kih*." In winter, forty kih were allotted to the day, and sixty to the night, and in summer this was reversed. Spring and autumn were equally divided. This instrument was provided with forty-eight indices, two for each of the twenty-four terms of the year. They were consequently changed semi-monthly—one index being employed for the day and another for the night. Two were employed every day, probably, to remedy in a measure the obvious defects of all clepsydras—of varying in the speed of their rise or fall, according to the ever-varying quantity of water in the vessel, which might be done by having the indices differently divided. To keep the water from freezing in winter, the instrument was con-

* Although doubts may exist respecting the absolute accuracy of Chinese chronology, it must, nevertheless, be admitted that it is so far correct as to render arguments founded on the commonly-received chronology altogether untenable; and it is matter of regret, therefore, that the latter has been followed, in their Chinese publications, by all Romish and Protestant missionaries. I cannot too earnestly urge the adoption of Hale's Chronology, and that speedily, lest, in the mean time, some Chinese Celsus or Porphyry should arise, and bring objections against our faith not easily answered to the satisfaction of their countrymen.

nected with a furnace, and surrounded by heated water. Chau flourished eleven centuries before our era. The forms of the apparatus have been various, but they generally consisted of an upper and a lower vessel, always of copper, the former having an aperture in the bottom, through which water percolated into the latter, where floated an index, the gradual rise of which indicated successive periods of time. In some this was reversed, the float being made to mark time by its fall. A portable one was occasionally employed, in ancient times, on horseback, in military tactics. Instruments constructed on the same principles with the above were in use among the Chaldeans and Egyptians at an early period—that of Ctesibus, of Alexandria, being an improvement over those of more ancient times. The invention of Western Asia was doubtless wholly independent of that of the East, both being the result of similar wants. Clepsydras were subsequently formed of a succession of vessels communicating by tubes passing through dragons, birds, &c., which were rendered still more ornamental by the indices being held in the hands of genii.

The earliest application of motion to the clepsydra appears to have been in the reign Shuenti (126-145 A.D.), by Tsianghung, who constructed a sort of orrery representing the apparent motion of the heavenly bodies round the earth, which was kept in motion by dropping water. There is reference, also, to an instrument of this description in the third century.

In the sixth century an instrument was in use which indicated the course of time, by the weight of water, as it gradually came from the beak of a bird, and was received into a vessel on a balance, every pound representing a *kih.* About this time mercury began to be employed instead of water, which rendered the aid of heat in winter unnecessary. Changes were made also in the relative number of *kih* for day and night, so as to vary with the seasons.

As in Europe, monks of the Roman church devoted considerable attention to mechanical inventions, especially in the construction of instruments for measuring time for the regulation of their worship and vigils ; in like manner, also, Buddhist monks, in their silent retreats, but at an earlier period, similarly occupied themselves, and for the same purposes. Several instruments, designed as time-pieces, the invention of priests, are mentioned in Chinese history. They present nothing novel, however, with the exception of one, which is nothing more than a perforated copper vessel, placed in a tube of water, which gradually filled and sunk every hour, requiring, of course, frequent attention. Although their knowledge of hydrodynamics has ever been very limited, the Chinese appear to have been the first to devise that form of clepsydra to which the term water-clock is alone properly applied ; that is to say, composed of apparatus which rendered watching unnecessary by striking the hours. Until the commencement of the eighth century, the persons employed to watch the clepsydra in palaces and public places struck bells or drums every *kih*; but at this period a clock was constructed, consisting of four vessels, with machinery which caused a drum to be struck by day, and a bell by night, to indicate the hours and watches. No description of the works of this interesting invention can be found. It is possible, however, that the Saracens may have anticipated them in this invention of water-clocks.

In the history of the Tong dynasty (620-907), it is stated that in the Fahlin country, (which in this instance, doubtlessly means Persia, though the best living authority amongst the Chinese makes it Judea), there was a clepsydra on a terrace near the palace, formed of a balance, which contained twelve metallic or golden balls, one of which fell every hour on a bell, and thus struck the hours correctly. It is not improbable that this instrument is identical with the celebrated one which the king of Persia sent, in 807, to Charlemagne.

In 980 an astronomer, named Tsiang, made an improvement on all former instruments, and which, considering the period, was a remarkable specimen of art. The machine, which was in a sort of miniature terrace, was ten feet high, divided into three stories, the works being in the middle. Twelve images of men, one for every hour, appeared in turn before an opening in the terrace; another set of automata struck the twelve hours, and the *kih*, or eighths of such hours. These figures occupied the lower storey; the upper was devoted to astronomy, where there was an orrery in motion, which, it is obvious, must have rendered complex machinery necessary. We are only told that it had oblique, perpendicular, and horizontal wheels, and that it was kept in motion by falling water.

As the Saracens had reached China by sea at the close of the eighth century, and by land at an earlier period, some assistance may have been derived from them in the construction of this instrument; but I am disposed to consider it wholly Chinese. Beckman, after much learned research, ascribes the invention of clocks to the Saracens, and the first appearance of these instruments in Europe to the eleventh century. Mention may here be made of other instruments of the same description, also constructed about this period. One (which, like the last, united an orrery and clepsydra) was formed in one part like a water-lily; whilst in another were images of a dragon, a tiger, a bird, and a tortoise, which struck the *kih* on a drum, and a dozen gods, which struck the hours on a bell, with various other motions, besides a representation of the revolution of the heavenly bodies. The machinery of another of these was moved by an under-shot water-wheel; its axis was even with the ground, and consequently the frame containing it was partly below the surface. The motions of the sun and moon, stars and planets, were made to revolve around a figure of the earth, represented as a plain from east to west. Images of men struck the hour, and its parts. In this, however, as in all the aforenamed instruments, the sounds struck were always doubtless the same, as the Chinese do not count their hours.

Another machine was constructed which also represented the motions of the heavenly bodies. It was a huge, hollow globe, containing lights, and perforated on its surface, so as to afford, in the dark, a good representation of the heavens. This, also, was set in motion by falling water. Subsequently to this, various machines are mentioned, but the brief notices given afford nothing of interest, until we approach the close of the Yuen dynasty, the middle of the fourteenth century. Shungtsing, the last of the race of the great Genghis Khan, who is depicted in history as an effeminate prince, and as having the physiognomy of a monkey, was evidently a man of great mechanical skill, and to the last, when his dominions were slipping from him, and confusion reigned everywhere, he amused himself by making models of vessels, automata, and time-pieces. His chief work was a machine contained in a box seven feet high, and half that in width, on the top of which were three small temples. The middle of these temples had fairies holding horary characters, one of which made her appearance every hour. Time was struck by a couple of gods, and it is said they kept it very accurately. In the side temples were representations of the sun and moon, respectively, and from these places genii issued, crossing a bridge to the middle temple, and after ascertaining, as it were, the time of day from the fairies, returning again to their quarters. The motions in this case were, it is thought, effected by springs. An instrument somewhat similar is described as an ornament in the palace of the capital of Corea ; it was a clepsydra, with springs, representing the motions of the celestial orbs, and having automata to strike the hour. Since the introduction of European clocks, clepsydras have fallen into disuse. The only one, perhaps, in the empire, is that in the watch-tower in the city of Canton ; it is of the simplest form, having no movements of any kind, but it is said to keep accurate time.

In dialling, the Chinese have never accomplished anything, being deficient in the requisite knowledge of astronomy and mathematics. It is true, the projection of the shadow of the gnomon was carefully observed at the earliest historic period ; but this was for astronomical purposes only.* Proper sun-dials were unquestionably derived from the West ; but they were not introduced, as Sir J. F. Davis supposes, by the Jesuits. The Chinese are probably indebted to the Mahomedans for this instrument, although we find an astronomer endeavouring to rectify the clepsydra, by means of the sun's shadow, projected by a gnomon, about a century earlier than the Hegira. There is a sun-dial in the Imperial Observatory at Pekin, above four feet in diameter.

* It was by a gnomon that the ancient Chinese endeavoured to ascertain the centre of the earth. A measurement of the length of the solstitial shadow, made at Loyang, on the Yellow river, 1200 B C., was found by Laplace (quoted by Humboldt, in Cosmos, vol. 2, p. 115) to accord perfectly with the theory of the obliquity of the ecliptic, which was only established at the close of the last century.

Smaller ones are sometimes met with in public offices. These were all made under the direction of missionaries of the Roman church, or their pupils. From remote antiquity, a family named Wang, residing in Hiuning, north latitude 29° 53', longitude E.G. 118° 17', in the province of Canhwui, has had the exclusive manufacture of pocket compasses, with which sun-dials are often connected. In most of these, a thread attached to the lid of the instrument serves as a gnomon, without any adaptation for different latitudes, although they are in use in every part of the empire. Another form, rather less rude, is employed by clock-makers for adjusting their time-pieces ; it is marked with notches, one for each month in the year, to give the gnomon a different angle every month. The Chinese instrument exceeds that of Corea in every respect.

Time is not unfrequently kept by igniting incense sticks, the combustion of which proceeds so slowly and regularly as to answer for temporary use tolerably well.

Hour glasses are scarcely known in China, and only mentioned in dictionaries as instruments employed in Western countries to measure time.

A native writer on antiquities says : "The western priest, Limatau (M. Ricci) made a clock which rendered and struck time a whole year without error." The clock brought out by Ricci, if not the first seen in China, is the earliest of which mention is made in Chinese history. They subsequently became an article of import, and, as already mentioned, this branch of trade was at one time of considerable value. Clocks and watches of very antique appearance are often met with—specimens of the original models scarcely to be found in any other country ; some of the latter, by their clumsy figure, remind one of their ancient name, "Nuremberg eggs ;" but their workmanship must have been superior to that of most modern ones, or they would not be found in operation at this late day.

The Chinese must have commenced clock-making at an early period, as none now engaged in the trade can tell when or where it originated ; nor can it be easily ascertained whether their imitative powers alone enabled them to engage in such an undertaking, or whether they are indebted to the Jesuits for what skill they possess. It is certain the disciples of Loyola had for a long time, and until quite recently, in their corps at Pekin, some who were machinists and watchmakers. One of these horologists complains, in "Les Lettres Edifiante et Curieuse," that his time was so occupied with the watches of the grandees that he had never been able to study the language. Doubtless the fashion which Chinese gentlemen have of carrying a couple of watches, which they are anxious should always harmonize, gave the fathers constant employment. A retired statesmen of this province has published a very good account of clocks and watches, accompanied with drawings representing their internal structure, in a manner sufficiently intelligible.

The Chinese divide the day into twelve parts, which are not numbered, but designated by characters termed, rather inaptly, horary. These terms were originally employed in forming the nomenclature of the sexagenary cycle (2657 B C.), which is still in use. It was not until a much later period that the duodecimal division of the civil day came into use, when terms to express them were borrowed from the ancient calendar. The same characters are also applied to the months. The first in the list (meaning son) is employed at the commencement of every cycle, and to the first of every period of twelve years, and also to the commencement of the civil day at 11 p.m., comprising the period between this and 1 a m. The month which is designated by this term, is not the first of the Chinese year, but, singularly enough, it coincides with January. Each of the twelve hours is divided into eight *kih*, corresponding to quarter hours. This diurnal division of time does not appear to have been in use in the time of Confucius, as mention is made in the spring and autumn annals of the *ten* hours of the day, which accords with the decimal divisions so long employed in the clepsydras, the indices of which were uniformly divided into one hundred parts. A commentator of the third century of our era, in explaining the passage relating to the ten hours, adds a couple more ; but even at that time the present horary characters were not employed.

The form I would recommend as suitable for the dial-plates of clocks manufactured for the Chinese market would be as follows :—The small characters on the outer circle are numerals, exactly corresponding to the Roman figures on Western clocks. The inner circle contains the twelve horary characters, and within these are the signs for noon, evening, midnight, and dawn. In the horary circle, the large single characters represent whole hours, and the small double ones half hours, equal to a whole European hour.

Let the minute hand extend to the inner part of the outer circle, and make *twelve* revolutions in a diurnal period. The hour hand should reach to the inner edge of the horary characters, and make one revolution in the same period of time. Let the pendulum vibrate seconds as now, and the minute hand, at the expiration of sixty seconds, make half a revolution. It should strike from 1 to 12 a.m. and p.m., and correspond in this respect to European clocks. It will be understood, then, that at our *even* hours the short hand will point to a large horary character—the middle of a Chinese hour— and the long hand will be *directly upward* ; and at our odd hours the former will be opposite the small characters, which point the commencement of their hour, and the latter will point *directly downward*, or at the 12 p.m. of our clocks. Or to repeat the same in another manner ; at 1 o'clock p.m., our reckoning, the hour hand will be half way between the large characters on the top and the next one to the right, and the minute hand having made a half revolution, will point perpendicularly downwards, and the clock strike one. At the expiration of another of our hours, a whole

Chinese hour will have expired when the former hand will have reached the first large character to the right, and the latter be directed to the zenith, the clock striking two.

After this perhaps unnecessarily minute description of what is wanted in the machinery, a few words remain to be added respecting the instrument as a whole. In the first place, it should be well made. A few worthless ones would damage the business irreparably. They should be of brass, and placed in frames of wood, which will not be easily affected by atmospheric changes. Common pine wood, veneered with mahogany, have answered well. Spring clocks will not succeed. Some of this description, sent from New York, cannot be kept in repair; whilst a quantity of clocks moved by weights, manufactured chiefly in Connecticut, imported into China about seven years ago, have proved good time-pieces, and give no trouble.

With regard to the external appearance, on which so much depends, I would advise that, in every case, there be as much of the works exposed as possible through an opening in the dial plate. A Chinaman not only wishes to see what he is buying, but what is going on in his instruments when bought; and, as his countrymen have the merit of being extreme utilitarians, mirrors in the lower part of the door will be generally preferred to any other ornament. Some, however, should be ornamented at this point for the sake of variety; and perhaps nothing would please more than such a grouping of objects by the artist as would represent a river, bringing into view a steamboat and a sloop, and on the banks a railroad, locomotive, and cars; a steepled church, or a many storied hotel, in the distance; and a stage coach also. Or another interesting device would be afforded by a representation of the solar system; but this would need to be accompanied with several Chinese characters.

It is of primary importance that a particular description of the manner of using the clock, the mode of putting it up, setting it off, winding up, and regulating, should be given. These directions, which should be more minute than if designed for English readers, can be translated and printed very easily in the country. But there would be no difficulty in printing the directions by means of wooden blocks in the manufactory at home. In copying the characters for the dial extreme care is requisite that every stroke and each line should be represented exactly as given in the diagram. Astronomical characters or descriptions of any kind which may be needed by individuals trying the experiment of clock-making for China, I shall furnish most cheerfully, for the privilege of increasing the utility of the instrument by introducing with them a few passages of sacred Scripture.

It may be asked, why, if such a clock be needed by the Chinese, they have never constructed one for themselves? It is certainly marvellous that they should manufacture clocks, including dial-plates, and always employ Roman figures, and follow the reckonings of foreigners, which so few of them are able to comprehend, and which by all are considered mysterious, and outlandish. It is only to be accounted for on the ground of their limited inventive abilities and high powers of imitation. That a time-piece of this description would be in demand in China, I am perfectly satisfied from inquiries made of natives in various quarters. Chinese merchants say that they should be retailed at about 5 or 6 dols. each. If I recollect rightly they can be made in Connecticut at 2 dols. 50, which would afford sufficient profit both for the mechanic and merchant.

THE CULTIVATION OF THE OLIVE.

BY DAVID SHEPHERD.

The olive is supposed to have been originally a native of Asia, and grows abundantly about Aleppo and Lebanon, but it is now naturalized in Greece, Italy, Spain, and the South of France, where it has been extensively cultivated for an unknown length of time, for the oil expressed from its fruit. The wild olive is found indigenous in Syria, Greece, and Africa on the lower slopes of the Atlas. The cultivated one grows spontaneously in Syria, and is easily raised on the shores of the Levant. Much attention has, of late years, been paid to olive culture by the French in Algeria. Tuscany, the South of France, and the plains of Spain, are the parts of Europe in which the olive was first cultivated. The Tuscans were the first who exported olive oil largely, and thus it has obtained the name of Florence oil ; but the purest is said to be obtained from Aix in France.

The olive in the western world followed the progress of peace of which it was considered the symbol. Two centuries after the foundation of Rome, both Italy and Africa were strangers to that useful plant : it was naturalized in those countries, and at length carried into the heart of Spain and Gaul. Its usefulness, the little culture it requires, and the otherwise barren situations which it renders productive, quickly spread it over the western face of the Appenines. According to Humboldt the olive is cultivated with success in every part of the old world, where the mean temperature of the year is between 58 degs. and 66 degs. ; the temperature of the coldest month not being under 42 degs., nor that of summer below 71 degs. These conditions are found in Spain, Portugal, the South of France, Italy, Turkey, and Greece. The olive also flourishes on the north-west of Africa, but is not found south of the Great Desert, except in parts of the Cape Colony where it has been introduced or grafted on indigenous species.

In Europe it extends as far north as latitude 44½ degs., in America scarcely to latitude 34 degs.—so much greater is the severity of the winter on that side of the Atlantic. In the neighbourhood of Quito, situated under the equator, at a height of 8,000 feet above the level of the sea, where the temperature varies even less than in the island climates of the temperate zone, the olive attains the magnitude of the oak, yet never produces fruit.

Olive oil may be said to form the cream and butter of those countries in which it is pressed; the tree has been cultivated in all ages as the bounteous gift of Heaven, and the emblem of peace and plenty. There is a common saying in Italy that "if you want to leave a lasting inheritance to your children's children, plant an olive."

In Italy the young olive bears fruit at two years old; that is in two years after it has been placed in the plantation. In six years it begins to repay the expense of cultivation, if the ground is not otherwise cropped. After that period the produce is the surest source of wealth to the farmer.

Like most other trees that have been cultivated for a length of time, the olive has produced numerous varieties; different countries, or even different districts, cultivating their peculiar favourite. The variety *longifolio* and its many sub-varieties are chiefly cultivated in France and Italy. The variety *latifolia* and its sub-varieties are those chiefly cultivated in Spain. The fruit of the variety *latifolia* is nearly twice the size of the common olive of Provence and Italy, but the oil is greatly inferior.

There are several varieties of olive, differing less in their fruit than in the form of their leaves; two of these have been introduced into the Cape Colony—one of them from England, by Mr. Thomas Berry, in the year 1821, and the other variety I believe from France, since that period.

The European olive may be propagated in various ways. Cuttings of nine inches in length, taken from one year old shoots, may be planted in a rich light soil, and kept moderately moist; the ground ought never to be allowed to become very dry; these will root freely in a few weeks, and be fit for transplanting in twelve months.

In Italy the propagation is conducted in the same manner in which it was during the time of the Romans. "An old tree is hewn down, and the 'ceppo,' or stock (that is, the collar or neck between the root and the trunk, where in all plants the principle of life more eminently resides), is cut into pieces of nearly the size and shape of a mushroom, and which from that circumstance are called novoli; care at the same time is taken that a small portion of bark shall belong to each novolo; these, after having been dipped in manure, are put into the earth, soon throw up shoots, are transplanted at the end of one year, and in three years are fit to form an olive yard."—(Blunt's 'Vestiges,' &c. 216.)

Truncheons, or stakes of the olive, two inches thick and five feet long, may be driven into the ground where they are intended to remain, and root freely. Shoots of one or two years' growth may be laid down, giving them a twist to crack the bark ; or slit them half way through, when they root very readily. These operations should be performed in the month of August.

Grafting on the *Olea Capensis*, and other indigenous species of the Cape olive, should also be performed in the month of August, and there is little doubt of the beneficial result of such practice, in procuring an early return of the green fruit for pickling, and the ripe fruit for oil. The scions or grafts should be placed rather low on the stocks, and the buds on the latter be carefully rubbed off as they make their appearance.

In France and Italy, an uncertainty prevails in the crops of olives ; sometimes one that yields a profit, does not occur for six or eight years together ; and hence it is considered that the culture is less beneficial to the peasants of those countries, than that of corn ; but these circumstances do not appear to apply to the Southern Colonies, especially as the olive may be cultivated on ground which is impenetrable to the plough or spade.

The different kinds of South African olive trees are well known to the peasantry of the colony, by the general appellation of olyrenhout-boom, some of which attain a considerable size, and are useful as furnishing a hard and compact wood for cabinet work, and some more essential purposes of domestic economy. The iron-wood of the colony is in reality a species of olive, viz.—*Olea undulata.*

The Boschjesmen sometimes form their keries and the well-known implement, the graafstock, of the *Olea Capensis*, and for the latter purpose it is peculiarly adapted on account of its hardness. Among those tribes, the nuts are preserved by the mothers, and given occasionally to the children, who appear to devour the kernels with much satisfaction.

The *Olea Capensis* is widely disseminated over the whole Cape colony, and inhabits alike the highest mountains (where they maintain themselves by insinuating their roots into the crevices of the rocks), the strong soil of the *Karoos*, and the purer sands of the downs and sea shores. It is also found in the recesses of the forest, and along the margins of rivers. In the plains neighbouring the Sneeuwberg, the olive sheltered by piles of loose green stones or occasional schistus rocks, attains a larger size than any of the other trees which occur at a distance from rivers. It is common from thence to the Gariep or Orange river. In that country they occasionally shelter the flocks and herds ; and it is the kind so often confounded by botanists with the European species, but which differs in every essential specific character. It is recommended as stocks for grafting upon, until a sufficiency of the European kinds are produced from layers or cuttings to form permanent plantations, as, in strong soils and on the dry declivities of the hills, the trees of the Cape species are observed to shrivel in dry seasons, and remain in a quiescent state like some of the succulent tribes, until refreshed by copious showers of rain. This circumstance might sometimes injure a foreign scion on these stocks, but such remains to be proved.

Choice cuttings of the olive, selected by the agent of the American Patent Office in France, were distributed some few years ago in the Southern States bordering on the Atlantic and Gulf of Mexico. This plant has been cultivated in parts of Florida and California for many years; and, doubtless, there are many other tracts of country uniting the conditions necessary for the growth and perfection of its roots. It may be stated that, while the Floridas were held by the English in 1769, one Dr. Turnbull, a famous adventurer of that nation, brought over from Smyrna, a colony of 1,500 Greeks and Minorcans, and founded the settlement of New Smyrna, on Mosquito river. One of the principal treasures which they brought from their native land, was the olive. Bertram, who visited this colony in 1775, describes that place as a flourishing town. Its prosperity, however, was of momentary duration. Driven to despair by hardship, oppression, and disease, and precluded from escape by land, where they were intercepted by the savages of the wilderness, a part of these unhappy exiles died, while others conceived the hardy enterprise of embarking for Havana in an open boat, and in three years their number was reduced to five hundred. The rest removed to St. Augustine, when the Spaniards resumed possession of the country, and in 1783 a few decaying huts and several large olive trees were the only remains to be seen of their wearied industry. Numerous attempts, at different times, have been made to propagate the olive from seeds, in various parts of the South, which have proved unsuccessful. This want of success may be attributed in part, to the tendency of the olive to sport into inferior varieties when propagated from seeds, but after the experiment has been fairly tested by cuttings of choice and well-proved varieties, it is hoped that this "first among trees" will, sooner or later, become celebrated in the regions of the South.

A dry, calcareous, schistous, sandy, or rocky situation is the most congenial to the growth of the olive. Where soils of this description exist, with a loose and permeable subsoil, and a sloping surface, sheltered from high winds, and a distance not too great from the sea, every natural advantage that can be wished for is obtained. The olive tree, however, will accommodate itself to soils and situations far less favourable. Frequent complaints have been made by persons who have planted olive trees in rich alluvial soils; that although their trees grow most luxuriantly, they scarcely ever produce fruit. The cause of this is evidently to be attributed to the continued and too vigorous growth of the trees, induced by the fertility of the soil. Now, as long as the trees continue in this state, an abundant crop need not be expected;

but when their vital energies become less vigorous, either from age or from artificial treatment, they will be found to produce large quantities of fruit. Depriving the trees of a portion of their roots is probably the simplest and most effectual means by which to induce them to bear quickly and permanently. If the land selected for a plantation be of an open friable nature trenching may be dispensed with, deep ploughing will be sufficient preparation ; on the other hand, if it be of a close and binding nature, it will be useless waste to plant without first trenching the whole to an uniform depth of at least two feet ; In trenching this description of land, where the subsoil is stiff and binding, it will be found of great advantage to future cultivation to keep the original surface soil on the top, care being taken, however, to have the whole broken up to the depth above stated.

After the land has been prepared the intended position of each tree should be staked out, so as to insure uniformity in the plantation ; the proper distance from tree to tree every way is 40 feet, but if it is not intended to cultivate other crops between them, in the first instance, they may be planted at half that distance apart, with the intention of removing every alternate tree to a fresh plantation when they meet together, which, under ordinary circumstances, they will do in about fifteen years.

Planting may be proceeded with at any time between the months of April and September, but May is considered the most favourable if the weather is moist. The plants should not be less than three years old, and if older all the better. In removing strong trees it is advisable to cut them down to within two or three feet of the ground, otherwise their growth will be much retarded. Small trees should not be cut down more than sufficient to prevent strong winds blowing them down.

The olive may be propagated by cuttings, truncheons, suckers, layers, grafts, and seeds, but it is only necessary to mention those methods which are considered the best and most suitable to the circumstances of our Australian colonies and the Cape. Truncheons are large cuttings taken from the branches, of not less than two inches in diameter, and cut in lengths of four feet. They should be planted in trenches, leaving a few inches of the upper end above the surface. The soil for this purpose should be light, friable, and sandy, and so situated that it may be kept moderately moist ; in three years they will be fit for the plantation ; autumn and winter are the proper seasons to operate. This is undoubtedly the quickest method for getting trees into an advanced state, but it retards the trees which furnish the truncheons, whose supply for some time to come will be limited.

In Europe, the general mode of propagation is by suckers, which arise abundantly from the roots of the old trees. The next best and most advisable method is grafting upon the seedlings of the wild olive, which are easily obtained, and are fit for grafting when the stem has attained the thickness of a man's finger. August and September are the proper months to proceed with this operation. Propagation by layers and small cuttings is tedious, and need only be practised when the other methods are impracticable.

Although the propagation of the olive from seed cannot be recommended as a method for staking the plantation, yet it should not be altogether overlooked. If a few trees were occasionally raised in this way it is very probable that a variety might be originated which would suit the situation and the soil better than its parents. But this result is by no means to be depended upon ; indeed the qualities of the seedling tree are oftener found to be inferior rather than superior to those of the parent, hence this method of propagation should only be adopted as an experiment.

After the plantation has been made, it is only requisite to keep down the weeds ; should the land be required for other crops, the tillage for such will be an advantage rather than otherwise. Such crops as do not root deeply, and are calculated not to impoverish the soil to any great extent, are the most suitable.

The proper time for gathering olives for the press is the eve of maturity, which is in April or early in May. If delayed too long the next crop is either wholly prevented or materially lessened, and the tree is then only productive in the alternate years. At Aix, when the olive harvest takes place in November, it is annual. In Languedoc, Spain, and Italy, where it is delayed till December or January, it is in alternate years. The quality of the oil also depends upon the collection of the fruit in the first stage of its maturity.

The fruit should be carefully gathered by the hand, and the whole harvest completed as quickly as possible. The outlay for preparing and planting an acre of land with olive trees will be about 35*l.* The after cultivation will cost no more than from 3*l.* to 4*l.* a year ; but by the economy of labour on a small farm this expense may, of course, be greatly lessened. An acre of land will contain 30 trees, and if on the average each tree produces 20 gallons of oil (in Europe the average is greater) we shall have from this 600 gallons, which at the moderate price of 5s. per gallon (in the colonies it is more than double this price), will be worth 150*l.* Now, the expense of gathering the fruit and preparing the oil must be very great indeed not to leave an ample profit to the cultivator.

THE ICHTHYOLOGY OF NOVA SCOTIA—THE COMMON HERRING.

BY J. MATTHEW JONES, F.L.S. AND J. BERNARD GILPIN, M.D.

Ichthyology has unfortunately been a much neglected branch of zoology, and while we have many works treating upon mammalogy, ornithology, and entomology, there are comparatively few authors who have touched upon the natural history of fish. Perhaps this may in some measure be accounted for by the difficulties attending their study, it falling to the lot of few to be situate in the vicinity of a fishing station; a matter of necessity, when, not only the habits, but the forms of fishes, have to be carefully observed ; as a naturalist, even if placed in the most eligible locality for procuring specimens, can never expect to complete a perfect list of the several species frequenting that locality, without the assistance of fishermen and others, who from daily experience can add so much valuable information, which it would be almost impossible for one individual, by his own exertions, to become possessed of. At the present day, however, the value of fish considered as an article of food for the human race, attaches an importance to this branch of science which is growing every year, and it is to be hoped that ere long, the investigations of naturalists will afford some clue to the occurrence or absence at particular seasons, of those great annual gatherings of fish, which appear on the coast of north-east America and Europe, and which I would venture to suggest are more particularly influenced by the paucity or abundance of the peculiar food preferred by each genus, and the instinctive habit of searching for suitable positions for spawning.

An interesting fact in connection with the habits of fish is that of the extremely local range of some species, shoals being observed in one particular bay or inlet, while in those contiguous, and only distant a short space, not a specimen of that species can be taken. On our own shores here, this local habit in a more distant degree is well known ; the shad, so abundant in the Bay of Fundy, is almost unknown to our eastern coast from Cape Sable to Cape Breton, while looking further north we find the mackerel, which is common on this coast during the season, absent, in a great measure, from the waters of Newfoundland and Labrador. At the Cape of Good Hope, Dr. Pappe, an observant naturalist, resident at Cape Town, states that several South African fishes are possessed of similar habits, but more strictly confined even to bays divided by a small promontory ; and in the Bermudas, where you would imagine, from the small size of the group, that the waters of the shores would be common to all, I find that some species are only taken on the south side of the islands, and others on the north, although these two positions are only divided from each other by a narrow strip of land, in places not much more than a quarter of a mile in width.

Now the solution of this apparent mystery is not so difficult as some persons would imagine. We are all aware that each animal has a partiality for some particular kind of food, and wherever that food is to be found in the greatest abundance, there will be found the animal that feeds upon it. Indeed, so well known is this habit to English entomologists, that, when in search of insects, the sight of a field of thistles, or a patch of nettles at a particular season, proclaims the habitat of certain species which frequent those plants. The buffalo of the west prefers the open prairie, clothed with rich succulent grass; the moose, as Capt. Harley informs us in his widely-known "Sporting Adventures," loves to dwell in forest solitudes, and browse on the leaves and tender branches of deciduous trees; while the tiny mole scoops its tortuous way through the rich mould of the alluvial valley, where it finds an abundant supply of its favourite earthworm. And so it is with the various fishes; the halibut, whose ponderous form we so often see in the Halifax market, resides, as it were, on the sandy slopes of the deep, where it feeds upon the smaller flat fish, mollusks and crustaceans. The cod seeks its prey on the well known "Banks," while the shad delights in the muddy waters of estuaries, where it fattens, according to Perley, on the shrimp and shad worm. In each position these fish find the food they are partial to. But, although I imagine food to be the great inducement for fish inhabiting particular localities, there is yet another reason to be advanced, —search for a suitable position for spawning. These two circumstances, I firmly believe, have more to do with the appearance of vast shoals of fish, visiting, or residing in particular districts, periodically or otherwise, than aught else. In no other way can we account for the vast annual or continual gatherings of certain fishes in the waters of Europe and north-east America, than by presuming that this search for food and suitable positions for spawning are the main motives. Take the cod fishery of the Grand Bank of Newfoundland, that wonder of ichthyology, where, throughout an extent of submarine formation measuring no less than six hundred miles from north to south, and in places two hundred miles from east to west, countless myriads of gadoid fishes have afforded for more than three centuries and-a-half, profitable employment to the fisherman, and wholesome food for tens of thousands of the human race. To account for this, we have in the first place to consider the formation of this vast submarine bank, and the peculiar inducements it presents to the innumerable company congregated there. The Bank lies, as it were, at the point where the Gulf Stream and Arctic Current meet each other, and struggling for the mastery deposit the foreign matter they contain on this spot of contention. The Arctic Current it is which has formed, and is still forming, the bank itself, by bringing down annually, through the medium of icebergs, thousands of tons of earth, rocks, and gravelly matter from the frozen north. These icebergs ground upon the bank, and thawing in that position, deposit their geological burdens, thus year by year adding to the mass. To render this conclusion more satisfactory, it will be well to refer to the hydrographer's chart, by which we ascertain that the ocean bed above the Bank is shelving, while after passing it, the depth suddenly increases by a precipitous descent, of some three thousand feet, thus showing that it is formed from the north, while the current of the Gulf presents a barrier to this deposit, which would otherwise be washed away to the southward, and the great cod fishery of Newfoundland be diminished to a considerable extent.

Now, what an area is here presented for mollusks and crustaceans to inhabit—gravelly beds, sandy slopes, rocky masses, large and small to give them shelter, while those thousands of tons of earthy matter filled with minute organisms are continually being brought down from the northward to afford them food. And as it is such a promising pasture for these smaller residents, which, congregating there in myriads to feed and propagate their species, we may readily conclude that these creatures, which form the principal part of the food of the cod, attract those fishes to the position, and finding there an abundance of prey at all seasons, remain to spawn; as codfish are reproduced by millions annually, we can in a measure account for the immense stock which for hundreds of years has filled every part of that immense ichthyological storehouse, and proved such a blessing to mankind.

These currents have also a great effect upon the migration of fishes, and to prove this I have only to call attention to the following facts. In summer time, when the Gulf Stream extends its northern boundary, which, commencing at Cape Cod runs close to our coast and thence to Newfoundland, several kinds of southern fishes are observed in our waters, one of these, a species of *Monocanthus*, is so truly a southern genus that only one species has been recorded as having been captured so far north as Massachusetts. Another, the albicore, so well known in warmer latitudes, is abundant here during the months of July and August, the Rev. John Ambrose having observed twelve at one time off French Village, St. Margaret's Bay. Then as to northern fishes, when in winter time, particularly during the later months of that season and those of spring, the Arctic current comes pouring down from the north, forcing the waters of the Gulf to the southward, and washing the banks of Newfoundland, exerting a cooling influence even to the latitude of 40 deg., it brings with it many fishes to our shores whose presence during that particular season I have just mentioned could in no other way be satisfactorily accounted for—hence we have the occurrence of the Greenland Shark (*Scymnus borealis*) recently brought to our notice, an inhabitant of the seas of the far north; the Norway Haddock (*Sebastes Norvegicus*), an extreme northern fish—and the Cusk (*Brosmius vulgaris*), another strictly northern form, having its proper habitat between the parallels of 60 deg.

and 73 deg. north latitude, is also found in our waters. I could add other instances in support of my views, but those I have given will, I trust be sufficient to enable you to form some idea of their correctness.

A great question with Naturalists has been as to whether certain fishes inhabiting the seas of Europe and north-east America are identical in regard to species, and if identical how they managed to traverse two or three thousand miles of ocean from their original home. Now, if we can prove the arrival at our shores of fishes from distant latitudes, by means of the great ocean currents, which as highways, or I should say, *seaways,* pass as it were our own doors; may we not conclude that these very currents or seaways are the means of affording a communication from or to either side of the Atlantic. And while some of the Carribean types may be carried by the Gulf Stream to our shores, and on to Europe, the European types can be carried to our shores by the Arctic current, which setting from North Europe to Spitzbergen, washes the east coast of Greenland, and passing Iceland arrives at our position.

Some species are more adapted than others from their *peculiar formation* to wander about the broad expanse of ocean, and like the hawk among birds cleaving the air, propel themselves at a prodigious rate through their watery element. Naturalists are therefore prepared in some measure for the occurrence of such forms in situations where no currents prevail. The most violent storms at sea cannot effect the migration of fishes, even if they blow from a direction contrary to that of the fish's course, for observations prove that the gale which agitates the surface to so great an extent, is not perceptible at a comparatively small depth, and on the principle that migratory birds are generally known to take their course at a great elevation, in order to escape the agitation of the air near the earth's surface, so we may presume that these wandering fishes, gifted with similar instinct, avoid the currents and counter currents of the ocean surface by stemming their way at a depth free from such circumstances. But in case of species known more particularly as inhabitants of the littoral zone, and not endowed with a formation favourable for extensive migration, I may instance the Blennies or *Gobioidæ,* which are chiefly found in shore waters, rock pools, and among sea-weed—we must look to some other agency than the mere motive power of the fish itself. Now, during my investigations in the Bermudian waters, I found that the gulf weed (*Fucus natans*) which is brought to that latitude from the Bahamas, on the eastern current, and being thrown aside, as it were, drifts along from and to all points of the compass as the winds blow, is a perfect preserve for the naturalist, being tenanted by various species of crustaceans, and affording shelter and food to several kinds of fishes. To give an idea of the vast extent of the fields of this gulf weed which float upon the ocean about the latitude of the Bermudas, I may state, that when a southerly gale blows for several days, the whole coast line of the Islands facing that quarter, becomes choked up with this sea-weed, and on gaining an elevated position on land, vast fields are observed still setting in from the ocean. Have we not here again an excellent conveyance for many kinds of fishes, (particularly those unable to take long journeys without assistance) which keeping within the covert of these masses of *fucus* are carried along hundreds of miles, and obtain, the whole voyage, good shelter and abundance of food, which is all a fish requires to bring it safe to other positions, where the temperature of the ocean will not interfere with its constitution. And although the constitutions of fish are in some cases influenced by the temperature of the element they inhabit, and a few degrees above or below a certain temperature will drive them to seek other positions, yet, in many cases, they are not so influenced, and the fact is well authenticated that certain species can bear the test of being frozen in solid ice, and on being gradually thawed, will regain their former signs of vitality, while others have been observed swimming about in hot springs at Manila and in Barbary in water, of a temperature of from 172 deg. to 185 deg., and a species of *Silurus*, according to Humboldt, was observed by him thrown up alive with the heated waters of a South American volcano, which were proved to be of a temperature of 210 deg., *or within two degrees of the boiling point.*

Some marine fish, and certain species of fish-like mammals, appear in some instances to live in fresh water as well as salt. As to the mammals, my friend Captain Blakiston, the celebrated explorer of the Yangste, states in his recent work that porpoises were seen rolling about in the upper waters of that river, 1,000 miles from the sea, and in reply to a question of mine, he states that the water was perfectly fresh far below this point; so that we have here marine mammals, generally supposed to be unable to exist long in fresh water, disporting themselves hundreds of miles from their briny home, in an element very different in its component parts from that to which they are usually accustomed. Again, I have myself observed in the Bermudas a species of *Gobius* existing in a lively and healthy state in rock pools above the highest tidal mark, in which the water, chiefly rain, but partially salt, had become perfectly putrid and offensive.

From five specimens of the common herring (*Clupea elongata*) before me, one taken at Red Bay, Labrador, the second from the "Banks," ten miles seaward; the third from Halifax harbour; the fourth from Annapolis Royal, Bay of Fundy, and the fifth from a cod's stomach, caught upon the Banks, I may say they are identical, except in teeth and size; they all may be called slender. In size the Labrador measures 15 inches; the Bank, 13½; the Shore, 11; the Annapolis or Digby herring 7 to 8, and that taken from the cod about 5 inches. Notwithstanding the difference in size and in teeth, I can only consider them of one species.

Those taken on the Banks ten miles seaward are larger, go in separate runs, are fished for with larger meshes, and are sold as distinct fish in the market from the Shore herring.

They approach the Nova Scotia shore early in March, at first stragglingly and very lean. As the summer advances they become fat. During the latter part of August they are in their prime and are preparing to spawn, which operation takes place in September and October.

The warm sandy coves and still land-locked bays about Sambro, Eastern Passage, Shelburne, and Prospect, are favourite resorts in from 5 to 10 fathoms. Here the fish may be seen lying upon the bottom in thousands. They may be measured by the acre. The sea is white and turbid with the spawn ; and ropes, in passing through it, become as large as small hawsers. The cod and his varieties approach to feed upon it, whilst quantities are cast upon the beach by the sea.

Before the long cold nights and stormy seas of November arrive, the herring have left the surface to re-appear the following Spring. In New Brunswick, according to Perley, the great spawning ground is Southern Head, Grand Manan. Here the herring commence in July and end in October. Along the Bay of Fundy a run of large, thin spawn-bearing herring appear about the middle of May. About the last of June a separate run of small barren herring appear in Digby Basin from the Bay of Fundy. These are fat, and about one in twelve have spawn, and in August immense numbers of fry appear on the shoal bars of the Basin, doubtless the spawn deposited in early spring. Perley reports that spawn is found in the Bay of Fundy in June.

Thus we arrive at a very curious fact, that our herring, though of the same species, spawn some in June, and others in October.

At Labrador, Newfoundland, and the Magdalen Islands, April and May are the spawning months. Allowing from six to ten weeks for the period of hatching, from the analogy of other fish whose periods we do know, the one run must be produced during the stormy months of November and December, after the fish have long left the surface, whilst a second more highly favoured run commences its existence during the warm tranquil season of Midsummer, upon the shallow beaches and warm shoals of the basins emptying into the Bay of Fundy. Thus commencing life under such different auspices, it would seem that each hatching or " run " keep by themselves, at least during their early life, and revisit annually their breeding places.

Self-protection keeps them from the older ones, who prey upon them equally as the cod. The most intelligent observers informed Perley that it takes three years to perfect their growth, and that they spawn the second year.

Thus we have a small run of 7 to 9 inches of the second year, about one in twelve spawning, revisiting the shallow basins of the great Bay of Fundy (which re-appears as the famous Digby herring in all the markets of the world) during July and August, and then retiring from the surface. The shore run of the Atlantic coast of Nova Scotia, about 11 inches in size, appearing in early March, and spawning in September and October ; and the large Labrador, Bank, or Grand Manan run, appearing in March, and spawning in April, May, and June. All seek the deep soundings in winter. At Fortune Bay, Newfoundland, they are taken in nets during mid-winter beneath the ice. Here the soundings are 70 or 80 fathoms, the water land-locked and still.

The fishermen suppose the frozen surface makes the sea dark and apparently more secure for them. The return of Spring warming the water and the summer seas, seems to be the signal for this vast army, each in its separate brigade, to move upward to the surface, and onward along our coasts to fatten in the rolling pastures of the ocean, and prompted by instinct, whose causes are unknown to us, but irresistible to them, to shed their spawn now upon the ice-washed Labrador in early Spring, now upon the warm sand bars of the Digby basin, or lastly upon the shoals of Grand Manan or Prospect Bay, warmed by the summer heats and autumnal sun. The pursuit of food must be another great cause for their annual migrations. A close observation of the food found in the stomachs of herrings at different seasons would do much in discovering a general rule for the proverbial uncertainty and caprice of their movements.

Upon the authority of Yarrell, who quotes Dr. M'Neil, I have stated that the larger ones prey upon the smaller, but our fishermen deny the fact of finding young herrings in the stomach of the larger ones. The surface of the sea about our coasts in Spring and Summer, is fairly alive with the medusæ, and our shores are covered in win-rows with small shrimps called brit and herring bait; one cannot but fancy that these rich gelatinous masses must allure them to the surface.

To sum up all that I have obtained with regard to our herring:

1. It is of one species.

2. With regard to teeth, those upon the tongue and vomer seem constant in all; the larger specimens very rarely upon the lower lip; the smaller usually having them there. Generalising from examining some hundred specimens, I would say the teeth become obliterated by age, and that the more readily as they have no bony origin like the genus *Salmo.*

3. Some spawn in May and June, others as late as October. This very remarkable fact, causing suggestions of how far it modifies the growth and habits of each run, stands so far without any reason.

4. These separate runs, hatched under very different circumstances, and necessarily of different age and size, revisit their old haunts, spawn the second year, and are three years in attaining adult size, and probably by that time become absorbed in the runs of older fish.

5. That great and small of all ages approach the surface and the land in spring, and disappear in autumn. The warm seas and calm weather of the summer being necessary for their spawning and their food,—that as far as regards our coasts their only migration is from the deep soundings of the sea banks to the coasts and back again,—though I by no means assert that in higher latitudes they do not per-

form greater migrations. These migrations must cause a total change in the food, the temperature, respiration, and external pressure during winter and summer.

Following Dekay and Storer, I have considered it a distinct species from the *Harenga*, or English, though Richardson calls his taken at Bathurst inlet, *Harenga* ; and Yarrell's description of the *Harenga* seems to vary but little from ours.

We have seen that our herring passes his existence alternately in a state of rest in deep soundings, (this rest not so deep though, as from recent facts we infer the mackerel does, who, it would appear, becomes torpid and blind during winter, like certain Batrachians whom he resembles in his colour), and of a highly, aërated and lively existence upon the surface. During this state he presents himself as food for man who employs his arts in securing the rich bounty, spread as it were at his door. This brings us insensibly to the history of our Herring Fishery.

As early as March, herrings are taken in nets on our coast, but the fish are so straggling and the seas so boisterous, that, except for bait, fishing does not commence till May. In this month a run of large fat herring are taken in nets upon the Banks, which lie 10 or 15 miles seaward, and carry about 75 fathoms water. A net 30 fathoms long and 3 deep is passed from the stern of a boat at anchor. The free end drifts with the tide, held to the surface by cork floats, sometimes the tides carry the net down 15 fathoms in a slanting direction,—thus drifting from night to morning,—the net is overhauled, and from 20 to 100 dozen is the ordinary catch. It is very evident from the distance from shore, the need of calm weather for the boats and nets, as well as for the fish, who are very susceptible to rough seas, this fishing must be precarious. The boats are stout, weatherly keel boats, with a half deck, from 5 to 15 tons, carrying a gib, fore and mainsail, and usually called second class fishermen, when entered at a regatta.

The " in shore run," a fish of smaller size, are taken in nets set to a buoy, instead of a boat, the free end drifting to the tide. These nets are often moored from one buoy to another to preserve a permanent position across a creek or small bay. In these various ways herring are taken by the shore population of the whole Atlantic and Gulf coast of Nova Scotia, from the Bay of Fundy to Cumberland. The immense tides of the Bay of Fundy, leaving long flats and sand bars at low tide, and the steep trap formation of its southern coast line have singularly altered the character of the fishery. Here the drift-net fishing obtains, boats and nets drifting for miles upon the flow and returning upon the ebb, the nets twisted and coiled into apparently impossible masses. The shores of the trap formation being flat tables of trap reaching plane after plane into the sea, with no crevice to hold a stake or anchor a buoy, the fishermen procure stout spruce fir trees, and lopping off the branches, leave the long lateral roots attached to them. These they place upright in rows upon the bare rock, and pile heavy stones upon the roots as ballast, stretching their nets between them. Entirely submerged at flood, at ebb they are left high and dry, and often loaded down with fish caught by the gills in the meshes of the net. These nets are usually set for a large, lean spring herring, running for the flats in early spring to spawn. This method of fishing obtains throughout the whole trap district of the province bordering upon the Bay of Fundy. With the exception of Briar and Long Islands, about whose coves nestle a hardy race of fishermen, whose red-tan sails are seen from Mount Desert to Cape Sable, and in all weathers, the population of these districts are farmers, rather than fishermen, tilling the southern slopes of the North Mountain, and employing their spare time in procuring their winter supply, or a few boxes of smoked herring for barter. Where unopposed by the stern barrier of trap-rock, the great Bay pours its tide-waters up St. Mary's, or through the Digby Gut, into the Annapolis Basin, or sweeps up the Avon and Horton estuaries, or stays its flood on the Cumberland marshes, Minas Basin, or the Shubenacadie ; there, a rural population, dwelling on the borders of those streams and basins, hail with delight the periodically returning wealth teeming in its muddy waters. Smooth seas, sandy bars, and mud flats, dry at ebb, replace trap-dyke and boisterous waves. The fisheries are curiously modified by these physical changes. Flats and punts take the place of keel-boats and whalers. Young fir-trees are driven into the soft sand dry at ebb. Standing eight feet high, their green branches interlacing, they are formed into circles or L's. The retreating tide, which, in its flow, swept some 30 feet above them, leaves a teeming mass of helpless fish stranded in the shallow pools within their circle. This brush weir-fishing, as it is termed, less rude than the rugged stone-loaded stakes of the trap coast, is yet inartistic enough to provoke criticism in its waste of life, fish too small for use being included in the catch ; yet we must recollect that it requires capital and population to be humane, and that these fir-trees, renewed yearly, are the the cheapest and only material at hand for a population, with no surplus time or capital. In these weirs are taken the Digby or smoked herring, known so well in all markets.

Mr. Benjamin Hardy, speaking of the Digby Herring, says :—

The first herrings that make their appearance in the Basin, come the last of March and first of April ; about the first of May they begin to spawn, and by the 20th of May they have mostly left the harbour. About the time they leave, a small sized run of herrings come in ; they stop but a short time, scarcely two weeks, and then leave. From the middle of June to the first of July the regular school come in—they stop generally about six weeks, sometimes longer, and then leave. There are a very few spawn fish amongst the last-named ; of the second there are none ; the first are nearly all spawn, or what is called melt fish,—which means male and female. The spawn, or young herring, grow rapidly ; I think the first year about four inches, as near as I can ascertain. I think, in about six years they attain to what is called the large Digby herrings. Their food is a small insect, just discernible with the naked eye, which I think generally keeps near the surface of the water. Their manner of taking them is by swimming along with their mouth open, and catching them, and then emitting the water through their gills. They are timorous; thunder drives them into deep water. They follow their prey close in shore in the night, but retire as soon as broad daylight appears, and then return the next night, and so on. I have heard them jumping and skipping about, till about half-an-hour before the weir would show out of the water, and then retire just outside of the weir, and there stay and feed awhile. When they go over the weir, as before named, there would be some three feet of water over the weir. I have seen them, just at night, come within about 300 feet of the weir, and stay there, not coming nearer that night, their line would be in some places straight, and others crooked, just as our weirs were shaped, though there were from six to eight feet of water over the weirs.

The export returns for the year 1861, give 190,000 bbls. of pickled, and 35,000 smoked herring, for the Province; but the number sold as fresh, in the market at Halifax, and those cured by the families living on the seaboard, for their own use, as well as those in the interior, who may be met in strings of 20 or 30 waggons, returning laden with fresh or round fish, as they are technically called, to be cured at home, would, at least, give 50,000 bbls. more.

In this paper I have endeavoured to prove by facts seen myself, by others gleaned from old and experienced fishermen, from the best American writers—DEKAY and STORER,—and from the very able report of the late MOSES PERLEY, Esq., that our common herring makes no long migrations as those of the British Isles are said to; that he passes his winter either in our deep bays, ice-locked, or in deep sea soundings: that the summer heats and smooth seas bring him to the surface and to the land, in separate runs of different aged fish, caused by his spawning in early spring and autumn. I say *endeavoured* to prove, for I am conscious that many of the facts need more proof and closer investigation, and may turn out not facts after all. I have merely hinted at the different existences of winter under deep pressure, half torpid, perhaps beneath 70 fathoms, and his summer life on the surface—of the different times of spawning, as yet without reasons for so singular a fact, modifying, as it must, the early life of the fry. I do not advance any of these facts as new, but rather as newly put together; and I have given a slight sketch how, out at sea, he is waylaid by the fishermen, conducted in shore and beset with drift and set nets, fir-tree stakes and pine brush weirs, by a rural population intent on gathering their rich sea harvest to their homes.

THE TECHNOLOGIST.

NOTES AND QUERIES ON ASIATIC COPALS.

BY M. C. COOKE.

Notwithstanding all the additions which have of late years been made to our knowledge of the sources of economic products, there still remain some to be determined, and many doubts concerning others to be cleared up. Every effort, however small, to clear up mysterious synonymy, or determine the true origin of articles of commerce or consumption, is of interest to the Technologist; and, trivial as may appear, the few notes now hastily collected together, I trust that they will not be found utterly valueless. There are many difficulties in the way of procuring the information we seek, and one of the chief of these is the want of interest in the subject by the majority of those who have really the best opportunity for affording us assistance. Travellers find nothing in such a pursuit to render their narrative more interesting to the public. Merchants consider the fluctuations in the market prices of their commodities of far more importance than their ultimate sources, and Seamen of all ranks study to forget all such commissions, which promise a *certain* trouble, but a very *prospective* profit. We must therefore pick up such small scraps of information as may come to hand in the form of "waifs and strays," and be thankful.

For many years we have received from somewhere in the East Indies, by way of Singapore, and probably other ports, resinous substances called either Copal or Dammar. Animè must be left out of the enquiry altogether, since what is called Bombay Animè, or Indian Animè, is known to be an East-African product, re-shipped from Bombay and other ports.

The commercial resins of these regions of Southern Asia and the Archipelago, according to trade lists, are confined to East Indian Copal, Dammar and Manila mastic. If we are to believe implicitly in what the majority of writers on the subject tell us of the first of these substances, we shall regard it as solely the produce of an East Indian forest tree named, botanically, *Vateria Indica.* Sir W. B. O'Shaughnessy writes—"The substance called East Indian Copal, and sold in England as gum animè, exudes abundantly from this tree." It should be noted that the substance known in the London market as gum animè is a very different resin to that of *Vateria Indica*, and though I have, during the past ten years, carefully watched the market here, especially in so far as Asiatic resins are concerned, I have never met with a fragment of genuine piney resin (*Vateria Indica*), offered for sale. There are several kinds of hard resins produced on the Asiatic continent, and others in the islands of the Archipelago, to which it will be well to devote a few remarks in succession; although of local interest and value, only a few of these reach our shores.

PINEY RESIN (*Vateria Indica*), when recent is soft, and is then called *piney varnish*, but on exposure it becomes hard and brittle, of all shades, from a pale, bright green, to a deep amber. It readily assumes the form of any vessel in which it has been collected, and when hardened is ordinarily broken up into irregularly shaped pieces without any traces of regular "tears." It is remarkably clear and transparent, especially the greenish varieties, and would probably find a ready market. Major Drury says, "It is procured by cutting a notch in the tree, sloping inwards and downwards, from which the resinous juice runs, and is soon hardened by exposure to the air. It is usual, when applying it as a varnish, (in India), to apply the resin before it hardens, otherwise to melt it by a slow heat, and mix it with boiling linseed oil. A spirit-varnish is prepared by reducing to powder about six parts of piney and one of camphor, and then adding hot alcohol sufficient to dissolve the mixed powder. Alcohol will not dissolve piney without the camphor, but, once dissolved, retains it in solution. The varnish thus prepared is good for varnishing pictures, &c., but before being used requires to be gently heated to evaporate the camphor, which would otherwise produce a roughness on the picture, in consequence of its subsequent evaporations. In addition to these uses it is made into candles, on the Malabar coast, diffusing an agreeable fragrance, and giving a clear light and little smoke. A vulnerary balsam is also made of the resin mixed with oil. The tree which produces this resin is a native of Malabar, and is found abundantly in the Coorg forests, and in many other parts of Southern India. Dr. Buchanan mentions the varnish in his "Journey through Mysore, &c.," where he gives a curious account of the method of applying it, as pursued by the natives.—"Some men of the Pauchala tribe, which here is called Peningelan, paint and varnish by the following process: They take buttermilk, and boil it with a small quantity of quick lime until strings form in the decoction, and separate from the watery parts, which they decant. The stringy matter is then mixed with the paint, which has been well powdered ; with these the wooden work is first painted, it is then allowed to dry for one day, and afterwards receives a coat of pundum, which is the fresh juice of a tree called Peini Marum. The pundum must be used while it is fresh, and will not keep for more than two or three days. After the first coat of pundum has dried, another coat of paint is given, and that is followed by another of varnish. In the same manner leather may be painted and varnished. The varnish effectually resists the action of water. All my attempts, however, to find out the varnish tree were vain."

The tree which yields the piney resin, the *Elæocarpus copaliferus* of Retz, *Chloroxylon dupada*, Buchanan, and the *Vateria Indica*, Gaertn., is called *Peini-Marum* in Malabar, *Velli-koondricum* in Tamul, and *Dupada mara* in Telugu, and is the white Dammar tree of English residents. As already stated, this resin forms no portion of the India Copal of English commerce.

Saul Dammar (*Shorea robusta*).—This resin also has such a distinct character that it could not be mixed with or mistaken for any other. It is the produce of a tree still more common on the continent of India than the last, forming immense forests, and yielding a valuable timber, perhaps only second to teak. The tree is confined more to the northern portions of India, along the bases of the Himalayas, where it attains a height of from 100 to 150 feet. Dr. Royle has observed that these trees form extensive forests of themselves, frequently unmixed with any other tree. The resin, when hardened, is of a dull opaque tawny colour with darker streaks. It is met with in irregular flattened masses, from an inch or two in length and width to several inches, flattened, and with the impression or fragments of the bark on the under surface. The upper, or exposed face, is furrowed irregularly by the trickling of the semi-fluid resin, as it issues from the trunk. It is of a dull fracture, brittle, and entirely different from any of the substances known as copal or Dammar in this country. This resin is affirmed to be partially soluble in alcohol, almost entirely in ether, perfectly in oil of turpentine, and sulphuric acid dissolves and gives it a red colour. Equal parts of this Dammar and oil of turpentine make a good varnish for lithographic drawings.

In Southern India the Saul tree is replaced by an allied species (*Vatica Tambugaia*) which yields a similar resin ; but smaller quantities are collected, and it is doubtful whether it forms any proportion of the Saul Dammar of the bazaars.

The true resin of *Shorea Robusta* is also produced in Borneo and Sumatra, and is one of the kinds known to the Malays as Dammar Batu. It is not an article of export to Great Britain.

Black Dammar (*Canarium strictum*).—This is another very characteristic resin, and likely to prove a valuable one, if the prejudice against its colour can be overcome. This also is an Indian product, though not exclusively, for I have reason to believe that it is collected in Assam, Burmah, and the Malay Peninsula. Dr. Wight writes of it thus:—The *Canarium strictum* of Roxburgh is known in Malabar under the name of the "black Dammar tree," in contra-distinction to the *Vateria*, or "white Dammar tree." This tree is rather common in the Alpine forests about Courtalum, in the Tinnevelly district, and is there regularly rented for the sake of the Dammar. This is transparent, and of a deep brownish yellow or amber colour, when held between the eye and the light, but, when adhering to the tree, has a bright shining black appearance."

Notwithstanding this account, a question arose in India some few years since as to the identity of the resin of *Canarium strictum* and the "Black Dammar" of Travancore, but this was finally settled, chiefly through the investigations of Messrs. E. J. Waring and J. Brown, both resident on the spot. The latter gentleman in his report states that, both the black and white Dammar trees grow in the forests of Trevandrum, about 1,800 feet above the level of the sea, but the white Dammar tree seems to be more common than the other, perhaps, because the Hill-men getting more dammar from the latter, destroy it more readily. The best specimens of the black Dammar tree which I examined were about two yards in girth, at the height of four feet above the spread of the roots. The trunk is round, straight, and smooth, rising twenty or thirty feet before branching; the bark generally whitish, dotted with small papillæ, peels off in long flakes. The Hill-men to get the dammar, make a great number of vertical cuts into the bark, all round near the base of the trunk; they then set fire to the tree below the cuts, and, having thus killed it, they leave it for two years before they collect the dammar; they say that, after one year only, the quantity of dammar is much less than after two years. The tree is killed in the hot season, and the dammar is collected in February or March. When on the Ghauts previously, as well as this year, we were struck, on looking towards the forests on both the eastern and western slopes, as high as 3,000 feet above the level of the sea, by numbers of trees, with bright red, often crimson foliage, contrasting strongly with the various greens around. These crimson trees are black Dammar trees; the colour due to the young leaves disappears gradually in April. Lieutenant Hawkes also, in reporting on this resin says, "It occurs in large stalactite-shaped masses, of a bright shining black colour, when viewed from a distance, but translucent, and of a deep reddish brown when held in thin laminæ between the eye and the light. It is perfectly homogeneous, and has a vitreous fracture. Its shape appears to be due to the fact of the balsam having exuded in a very fluid state, and trickled down the trunk of the tree, where it gradually hardened by exposure to the sun; the fresh resin continuing to flow over that already hardened, gives rise to the stalactitic appearance of the huge lumps of resin, the outside of which much resemble the guttering of wax, caused by placing a lighted candle in a draught. It is insoluble in cold, but partially soluble in boiling alcohol, on the addition of camphor; when powdered it is readily soluble in oil of turpentine. Powdered and burnt on the fire, it emits a more resinous smell, and burns with more smoke than white Dammar. This substance also is unknown in our markets.

A curious and interesting substance is known in Burmah under the name of *Poonyet*, which has the appearance of a blackish resin, traversed with cells, excavated by a species of Dammar-bee in the resin, whilst still in a semi-fluid state. Having had occasion to examine a specimen of this substance, I, at once, pronounced it to be the resin of *Canarium strictum*, and not, as some had supposed, a secretion of the insect. This view I have since seen borne out by the remarks of Mr. Brown, of Trevandrum, who states, that the dammar which exudes from the cuts in the trunks of the black dammar tree seems to be a great favourite of several species of insects, especially of one resembling a bee, called by the Hill-men "kulliada," which live in pairs in holes in the ground. A similar substance is known in Malacca, as *Dammar Klootee*, containing larger cells, probably formed by a different species of Dammar-bee in the resin exuded from the same tree, which is not uncommon in that district.

Dammar Daging, or *Rose Dammar*, is the produce of some tree or trees unknown, inhabiting the Malayan Peninsula. This resin occurs in immense masses, of a form very similar to those of the black dammar, but streaked and variegated with dull crimson, alternating with pale ochraceous bands. It is less brittle, harder, and of equally vitreous fracture to black dammar. The extent to which it is found, the uses to which it is specially applied by the natives, and its botanical sources, are still to be determined.

Dammar mata kooching (*Hopea micrantha*). This substance seems to be very common in Borneo, Sumatra, the Malay Peninsula, Assam, and probably, elsewhere. It greatly resembles the ordinary Gum Dammar imported from Singapore; indeed, except in greater hardness, it seems to be undistinguishable. If a quantity of both were intermixed, it would be almost impossible to separate them. I am disposed to believe that the whole of a consignment of East India copal, as it was termed, which was sold in Mincing-lane, about two or three years since, and imported from Singapore, was this resin. Large quantities arrive at Singapore from Borneo and Sumatra, and are dispersed over the world, under the name of Dammar, and, probably, much of this is sold here. It is acknowledged that there is a great difference practically in the quality of Singapore dammar, and this may be due to some consignment being the resin of *Dammara orientalis*, and others of *Hopea micrantha* The latter being doubtless the best.

Singapore Dammar (*Dammara orientalis*), claims but a passing record, and the expression of a doubt whether so much of the white

Dammar from Oriental ports, as many of us have hitherto believed, is really the produce of the above-named coniferous tree.

MANILA COPAL, OR MASTIC. — Occasionally parcels of copal arrive here from the Philippines, sometimes under the name of Mastic, at others as Copal. Excellent specimens of all the varieties produced in Manila are exhibited in the Technological Museum at the Crystal Palace, which were received direct, but no indication is given of their sources, and here again is a fair field for inquiry.

The above "notes," are merely what they profess, and are rather suggestive than exhaustive. Only the most important of the resins of Asia have been alluded to, these being produced in sufficient quantities to supply a large export trade should a demand arise. Other allied substances, unknown to the writer, probably also fulfil the above conditions.* Borneo, or Sumatra, may possess indigenous trees, yielding valuable copals. Other islands of the Archipelago very likely have their dammars yet unknown to Europeans. It is not supposed that the few above enumerated can be accepted as the whole copalline resins of Asia; India alone is known to produce as many others, but these are of secondary importance. The subject thus opened is an interesting, useful, and practical one, and claims further investigation and development.

HISTORY OF THE SODA MANUFACTURE.†

BY WM. GOSSAGE, F.C.S.

Baron Liebig has suggested that the wealth and civilisation of a country may be measured by its consumption of sulphuric acid. I am of opinion that if soda were substituted, in the place of sulphuric acid, for this test, the estimate would be more correct; in fact, the greater part of all the sulphuric acid made is applied to the manufacture of soda, or mineral alkali; and when we refer to the various purposes for which this alkali is essentially necessary, such as the production of glass, of soap, of bleached and printed fabrics, of paper, of glazes for porcelain and earthenware, &c., we see that all its applications are those closely connected with the civilisation and refinement of the human race; to which we may add the fact, that this is the most extensive of all chemical manufactures, both as regards the employment of capital and labour.

Previously to the establishment of the French Republic, in 1793, soda was obtained almost entirely from the ashes of certain plants

* The *Hymenæa Courbaril* which has been introduced into Asia, yields no copal known in local commerce; and none reaches this country even from South America, where the tree is indigenous.

† Read before the British Association.

growing on the sea coast, the chief localities for these being Alicant, in Spain, the islands of Sicily and Teneriffe, and our own coasts of Scotland and Ireland. There was also imported into this country, as well as into France, from Russia and America, a large quantity of potash, and this alkali was then used for many purposes for which soda is now exclusively employed ; and it may be noticed, that such a remarkable change has been effected by the cheap production of soda, that we now export large supplies of this alkali to those countries from which we formerly imported alkali in the form of potash.

One of the first effects of the war, consequent upon the French Revolution, was to cut off all supplies of alkali from other countries into France, and the progress of those important manufactures dependent on the use of alkali having been thus impeded, the Conventional Government of the French Republic issued an appeal to the chemists of their country in the following terms :—

" Considering that the Republic ought to extend the energy of liberty to all the objects which are useful in the arts of first necessity—free itself from all commercial dependence—and draw from its own sources all the materials deposited therein by nature, so as to render vain the efforts and the hatred of despots ; and should place equally in requisition for the general service all industrial inventions aud productions of the soil, it is commanded that all citizens who have commenced establishments, or who have obtained patents for the extraction of soda from common salt, shall make known, to the Convention the locality of these establishments, the quantity of soda now supplied by them, the quantity they can hereafter supply, and the period at which the increased supplies can be rendered."

A commission was appointed in the first year of the French Republic, consisting of Citizens Lelievre, Pelletier D'Arcet, and Giroud, and they made their report in the following year, 1794. This report gave a summary of thirteen different processes, of which particulars had been submitted to the Commission, six of these commencing with the production of sulphate of soda by the decomposition of salt. The preference in the judgment of the Commission was given to the operations devised by "*un Pharmacien*" (a term equivalent to our apothecary or druggist), namely, Le Blanc, who had already erected a soda manufactory near Paris, in conjunction with two of his countrymen, named Dizé and Shée.

It has been thought generally, that, the *invention* of Le Blanc's process was a consequence of the appeal made to their countrymen by the French Convention. It will be seen from the following particulars that this notion is erroneous. The Commissioners say in their report :— " Citizens Le Blanc, Dizé and Shée (co-partners), were the first who submitted to us particulars of their processes ; and this was done with a noble devotion to the public good. Their establishment had been formed some time previously at Frangiade ; but the consequences of the

French Revolution, and of the war which followed it, having deprived them of funds, the works were suspended, and for some months past the manufactory had become a national establishment."

And further, "This establishment had been erected entirely with the private funds of the partners. It would be difficult to collect together, in so moderate a space, more means and conveniences than are met with in this manufactory. Furnaces, mills, apparatus, magazines, are all arranged in the best order for the convenience of the service."

The report then gives a full description of the various processes which constitute Le Blanc's invention, which had evidently been perfected previously to the Revolution. These consist of—

1º—The decomposition of common salt by means of sulphuric acid, and the consequent production of sulphate of soda.

2º—The decomposition of sulphate of soda by means of chalk and carbon, and the consequent production of black ash or rough soda, containing carbonate of soda and sulphide of calcium.

3º—The separation of the two constituents of the last product, by lixiviation with water, and the obtainment of carbonate of soda in a state fit for application in the arts.

These are the processes now used for the manufacture of soda on the largest scale.

In my recent perusal of this report of the Commissioners, I have been much struck with the completeness of Le Blanc's invention as therein described ; in fact, as regards the main principles of the invention, and even the proportions of materials used, these are identically the same as those now in use in this country, as well as in France, after the lapse of seventy years from the date of the invention.

Thus was given to the world, by an humble apothecary, an invention which has done more to promote the civilisation of mankind than any other chemical manufacture, as well as affording employment to a large number of workmen, and yielding wealth to their employers. I regret to add that the poor inventor met with the too common reward for the application of his talents to the public good. After a life of great privation, he ended his days in an asylum for paupers.

The manufacture of soda from common salt having been thus made clear to the chemists of France, the requirements of that country for this alkali were speedily met by the erection of sundry establishments for its preparation. The chief of these were located near the Mediterranean Sea, a few miles from Marseilles, this locality being selected on account of its proximity to Sicily, from whence sulphur was imported for the manufacture of sulphuric acid, and a cheap supply of salt was obtained by solar evaporation of sea-water; limestone was found on the spot. But this situation had the grave disadvantage of being far from a supply of coal, which is now chiefly imported from England. An additional inducement for the manufacture of soda near Marseilles arose from this city being the chief seat of the soap manufacture in France.

The whole art of the extraction of soda from common salt having been made patent to the French community by its publication, in 1797, in the *Annales de Chimie*, it would appear extraordinary that so many years should have elapsed before these processes were adopted in our own country. This was probably occasioned, in the first instance by the war then raging, which cut off nearly all communication between the two countries; but a still greater obstacle existed (also a consequence of the war), namely, the duty of 30*l.* per ton on salt, and this continued to exist until 1823, eight years after the restoration of peace.

In the latter part of the last century—viz., 1774, the Swedish chemist, Scheele, was the discoverer of chlorine (then called oxy-muriatic acid); also of its property to destroy vegetable colours, and this property was studied by the French chemists, Lavoisier and Berthollet, who succeeded in founding upon it a successful process for bleaching linens.

This process was brought over to Scotland in 1787 by Professor Copeland, of Marischal College, Aberdeen, who communicated it to Messrs. Gordon, Barron, & Co., bleachers, of Aberdeen, and these gentlemen applied the process successfully as a practical operation for bleaching calicoes. In the following year, a large bleaching establishment was formed near Bolton, founded upon the employment of this process. Thus was commenced the application of one of the many discoveries contributory to the establishment of the great "Cotton Trade," which has done so much to provide employment and create wealth for the inhabitants of this country.

Previously to the use of chlorine, bleaching was effected by the exposure of fabrics to sunlight and air, and nearly all goods requiring to be bleached for this country were sent to Holland or Germany, where a period of many months was required before the operation was completed, and the goods returned to be finished; whilst the same operation can now be effected in a few hours.

It is obvious that without the discovery of some more rapid method than the former one, we should have been compelled either to do without bleached fabrics, or without the existing and astounding Cotton manufacture.

In the first instance chlorine was used in the state of solution in water, but in this form its use was attended with grave inconvenience to the workmen employed. This was remedied by the addition of potash to the water, producing a solution called "Eau de Javelle" by the first makers of it.

The next step was to substitute lime for potash, thus producing solution of chloride of lime. This was the idea of the late Mr. Charles Tennant, of St. Rollox, who was engaged in business as a bleacher, and a patent was granted to him for the invention in 1798, but this was set aside in 1802. In 1799, Mr. Tennant obtained a patent for the manufacture of chloride of lime in the state of powder.

This manufacture was carried out by Mr. Tennant's then existing firm, and subsequently by himself and sons, to an extent which has surpassed that of all other manufacturers engaged in the same business.

I have already referred to the obstruction to the establishment of the soda manufacture, occasioned by the excise duty on salt. In proof of this I may notice the regulations which at that time prevented the use of bleacher's residua, containing large quantities of sulphate of soda, for any purpose whatever; and, consequently, these were then rejected as useless, although now the same material forms the basis of a most important business. As this affords a very striking example, amongst many others, that manufactures, as well as commerce, must be free from fiscal restrictions, if they are to be carried on for the benefit of the many, as contradistinguished from that of the few, I may give some particulars of the manner in which this obstruction operated.

At the period of the French Revolution, the duty on salt in this country was 10*l.* per ton. This was subsequently raised, as a war tax, to 30*l.* per ton, or thirty times the value of the salt; and this rate was continued during the whole period of the war, and until 1823, when the duty was repealed.

In 1798 an act was passed to allow a drawback of the duty paid on salt used and consumed in making oxy-muriatic acid. This boon was confined to those who used the chlorine produced for bleaching purposes, and did not extend to the manufacturers of chloride of lime for sale. It also required that the residua, containing sulphate of soda, should be thrown away, thus effectually preventing its application to the manufacture of soda. These regulations continued until 1814, when the law was altered, and the manufacturers of chloride of lime were allowed a drawback of the salt duty, and the restriction as to the use of the residua was removed. About this time Mr. Tennant's patent for bleaching powder having expired, other parties began to manufacture this article, and attention was directed to the utilisation of the mixed sulphate of soda and sulphate of manganese resulting from this manufacture; and some quantity of carbonate of soda, in the state of crystals, was gradually introduced into the market, the value at that time being about 30*l.* per ton. The process usually employed consisted in drying down the solution of mixed salts, roasting the product, mixed with small coal, so as to decompose the sulphate of maganese, then dissolving out the sulphate of soda, drying down the solution, and fluxing the sulphate of soda with small coal, adding some iron scales, or scrap iron, near the end of the fluxing. The product contained some quantity of carbonate of soda with sulphide of sodium. It was lixiviated, and carbonate of soda obtained from it by crystallisation.

During this period, the late Mr. W. Losh was making crystals of soda by Le Blanc's process, and this gentleman may be considered as the father of the soda trade in this country, although not the first to introduce the manufacture of soda-ash, on the large scale, by the special decomposition of common salt for that purpose. Mr. Losh was born in 1770, and finished his education on the Continent, where he was a fellow collegian with the renowned Humboldt. He was resident in France when the French Republic was established, and had to fly from thence with others of his countrymen. On his return to this country, he commenced some experiments, at Walker, on the river Tyne, for the manufacture of soda crystals (which were then obtained from kelp, and sold at 60*l.* per ton, the present price being 4*l.* 10s., or about one-fourteenth part); and during the short peace of Amiens, in 1802, he again visited France, and obtained a more complete knowledge of Le Blanc's processes.

After Mr. Losh's return, he applied to Government for permission to avail himself of a spring of weak brine (which he had discovered to exist at Walker) for the manufacture of soda; being permitted to use this, without any payment for salt duty, and having associated himself with Lord Dundonald, Lord Dundas, and some other gentlemen, he proceeded to erect a vitriol chamber and to apply sulphuric acid to the decomposition of salt contained in the weak brine, so as to produce sulphate of soda, and from this to manufacture soda-crystals by Le Blanc's process. The extent of these proceedings were necessarily limited by the use of weak brine in the place of dry salt.

Notwithstanding these previous essays, 1823 may be considered as the NATAL YEAR of the soda-trade, as a special manfacture in Great Britain; and my enquiries lead me to the conclusion, that the county of Lancaster was its birthplace as a special trade. In that year common salt being relieved from fiscal impost, Mr. James Muspratt commenced the erection of works at Liverpool, wherein salt was decomposed by sulphuric acid, specially for the production of sulphate of soda to be used for the manufacture of carbonate of soda. Mr. Muspratt at once adopted Le Blanc's processes in their entirety, and thus led to the establishment of the most important chemical manufacture of the present day. As might be expected, Mr. Muspratt had to contend with many difficulties, but these were overcome by indomitable energy and perseverance, and it is gratifying to know that he has realized a satisfactory reward.

About the same time, and subsequently, other manufacturers, who had been working with mixed sulphates, commenced to make sulphate of soda, by the special decomposition of common salt, for the purpose of making soda; and it has since been found advantageous to adapt this method of working to the production of bleaching powder by using hydro-chloric acid so obtained to generate chlorine by its action on oxide of manganese.

In the early days of the soda-trade, the decomposition of salt was effected in open furnaces, without any attempt to condense the liberated hydro-chloric acid gas; and so long as the extent of manufacture was comparatively small, the inconvenience arising from this was borne by the neighbouring public; but when this noxious gas was evolved from Mr. Muspratt's chimneys in torrents beyond endurance, the Corporation of Liverpool instituted proceedings, by indictment, to suppress the nuisance, which resulted in Mr Muspratt being compelled to remove his works from the town of Liverpool to Newton. This caused the attention of practical men to be directed to the provision of means by which the hydro-chloric acid could be condensed, and obtained in a form to be commercially useful. The difficulty of this arose chiefly from the immense volumes of gaseous matter evolved. The old apparatus of cylinders and Wolfe's bottles were totally inadequate to the purpose. Many plans were suggested, and, amongst others, I devised certain means for effecting this object, for which I obtained a patent in the year 1836. Having demonstrated the practicability of effecting a complete condensation of hydro-chloric acid, by the erection and working of a complete set of apparatus at the soda works with which I was then connected, I introduced the plan to the trade, and it has been subsequently adopted by every manufacturer of soda in the Kingdom.

The principle of this invention consists in causing the acid gas to percolate through a deep bed of coke in small lumps, contained in a high tower, at the same time that a supply of water flows very slowly over the surface of the pieces of coke. By these means an almost unlimited extent of moistened surface may be presented to the gas (the currents of which are being continually changed in their direction) for effecting its absorption; and as the same fluid descends through the tower, it meets with more gas, and gradually becomes charged to saturation; whilst at the upper portion of the tower, any gas, which might otherwise escape, is exposed to the absorbing power of unacidulated water. When this apparatus is used judiciously, a *perfect condensation* of the hydro-chloric acid gas can be effected. This has been proved satisfactorily at the works of Messrs. Crosfield Brothers and Company, at St. Helens, where the acting partner Mr. Shanks, my friend and former pupil (who was the first after myself, to adopt my invention), has effected such complete condensation of the gas proceeding from the decomposition of 25 tons of salt *per diem*, that, the escaping gases passing from the apparatus being caused to bubble through solution of nitrate of silver, contained in a set of Liebig's bulbs, not the slightest turbidness was produced, although the same solution was retained in the apparatus, and used for many trials. By these means was removed one great obstacle to the development of the soda manufacture; and although my reward for this has been the reverse of a pecuniary benefit, it is highly satisfactory to know that all the soda manufacturers are reaping great advantages from my labours.

In the year 1838, a curious episode occurred in the soda manufacture, which again shows that freedom from restrictions is necessary for the existence of a successful trade. In that year a French house, Messrs. Taix and Co. of Marseilles, persuaded the King of Sicily that his miserable revenue would be improved if he granted to them a monopoly of the export of sulphur. The first consequence of this was an advance in the price to 14*l.* per ton, from the previous rate of 5*l.* This insane measure produced its own proper remedy. It was soon found that in our Cornish mines, and more particularly in those of Wicklow, in Ireland, we possessed an inexhaustible supply of sulphur in the form of pyrites, and our practical chemists speedily devised the means to avail themselves of this source for the manufacture of sulphuric acid. In this manner the feeble-minded king bestowed, although unintentionally, a great boon upon this country, as we were relieved from his monopoly, and a large amount of money was beneficially circulated in Ireland.

In working with pyrites, it was found that a great portion of this mineral contained sulphide of copper, as well as of iron; and, at an early period I commenced to extract the copper from the burned residuum by smelting. I was then engaged in the soda manufacture, in Worcestershire. The ordinary pyrites contained only one per cent. of copper, and this being deemed so small a proportion as to be worthless, the residua were thrown away, and accumulated in large heaps in this country, and on the banks of the Tyne. In 1850 I purchased some of these large accumulations of so-called rubbish, and erected works at Widnes for the extraction of copper and silver therefrom. This led to my smelting upwards of fifty thousand tons of this rejected material, affording employment to nearly one hundred workmen. The practicability of such an operation having been thus demonstrated, other manufacturers adopted the same proceeding. Subsequently to the time I have referred to, large importations of copper pyrites for the use of the soda trade have been made from Spain, from which also copper is extracted by smelting.

In giving directions for the decomposition of sulphate of soda, Le Blanc recommends the following proportions of materials to be used:—

1,000 parts of sulphate of soda.
1,000 ,, of chalk.
550 ,, of carbon.

These proportions are in the ratio of about three equivalents of chalk to two equivalents of sulphate of soda. They are the same which are now generally employed by the soda manufacturers of the present day, except that about 750 parts of small bituminous coal are substituted for the 550 parts of carbon.

The mixture is fluxed in reverberatory furnaces, producing black ash containing carbonate of soda and sulphide of calcium, and, according to the skilfulness of the workman in conducting this operation, there remains in the black ash or rough soda obtained, less or more of undecomposed sulphate of soda, and there is produced less or more of soluble sulphide of calcium.

The true composition of black ash or rough soda, also the rationale of its formation, are not settled questions. It has been held by Dumas and other eminent French chemists, when explaining the reactions which occur in Le Blanc's masterly process, that a peculiar compound, insoluble in water, consisting of sulphide and oxide of calcium (called by them oxy-sulphide of calcium), is formed during the decomposition of sulphate of soda by carbon in the presence of lime; also that it is essential that sulphide of calcium should be thus combined with oxide of calcium to destroy the supposed solubility of the former in water, and thus prevent the formation of sulphide of sodium at the expense of carbonate of soda. And they assumed that, in consequence of the necessity to form this supposed compound, it was needful to employ more than one equivalent of lime for each equivalent of sulphate of soda used for the production of rough soda.

According to this theory, it is essential that the supposed insoluble compound should continue to exist in its integrity, so long as it is exposed to the reaction of water or of solution of carbonate of soda. Now I pointed out in the year 1838, in the specification of a patent obtained by me for "Improvements connected with the Soda Manufacture," that the undissolved residuum remaining from the lixiviation of black ash with water consisted almost entirely of mono-sulphide of calcium and carbonate of lime. In fact, when the lixiviation is effected with a large proportion of water so as to produce a weak solution, the oxide of calcium may be converted entirely into carbonate of lime, which is then found *mixed* with the mono-sulphide of calcium; and yet this conversion of oxide of calcium into carbonate of lime, and consequent disintegration of the supposed insoluble compound, is effected, and the supposed soluble sulphide of calcium is set at liberty, in the presence of solution of carbonate of soda; and this takes place without occasioning the production of sulphide of sodium in solution. The fact is, that mono-sulphide of calcium is perfectly insoluble in water; and it is only to the extent to which poly-sulphide of calcium is formed, that solution takes place, and consequent production of sulphide of sodium. The real advantage obtained by the use of an extra proportion of lime arises from this affording a larger amount of surface for re-action, and thus expediting the fluxing operation, and thereby preventing the formation of poly-sulphide of calcium.

In connection with this view of the subject, I pointed out that, when well-made black ash is digested in alcohol, there is no caustic soda dissolved, although the same black ash yields caustic soda abundantly by lixiviation with water. From this I inferred that caustic soda did not exist in the black ash ready formed, and that it was produced, during lixiviation with water, by the re-action of caustic lime on carbonate of soda, which could not have been effected without the disintegration of the supposed insoluble compound.

Assuming these views to be correct, and omitting the minor products of the black ash operation ; also assuming the decomposition of the sulphate of soda and formation of carbonate to be perfect, we may form this diagram as exhibiting the reaction of the materials employed, and of the products obtained :—

MATERIALS EMPLOYED.	EQUIVALENTS.	EQUIVALENTS.		PRODUCT IN EQUIVALENTS.
144 of Sulphate of Soda.	2 Na O S O_3	2 Na 2 S 6 O 2 O	2 Na 2 C 6 O	=2 Na O C O_2 Carbonate of Soda.
150 of Limestone or Chalk.	3 Ca O C O_2	2 Ca 1 Ca	2 Ca 2 S	=2 Ca S Sulphide of Calcium.
		2 C 1 C 2 O	1 Ca 1 O	=1 CaO Oxide of Calcium.
		1 O 6 O	10 C 10 O	=10 C O Carbonic Oxide.
54 Carbon 9 C		9 C		

In this formula I have assumed pure carbon to have been used ; also that the gas evolved is entirely carbonic oxide, whilst, in fact, a large proportion of carbonic acid is produced. Small coal is also used, in practice, instead of pure carbon ; and it is desirable that the finished black ash should contain a considerable proportion of unconsumed pieces of coke ; therefore, a proportion of small coal is used in the mixture, about double the quantity indicated for carbon.

I have already referred to the presence of caustic soda in the liquors obtained by the lixiviation of black ash. In the ordinary course of manufacturing soda ash, as this was formerly effected, these liquors were boiled down in open furnaces, and the salt obtained was roasted, so as to produce a salt consisting mostly of dry carbonate of soda. During these operations much of the caustic soda was converted into carbonate, but the product still retained sufficient caustic to give it the objectionable property of deliquescing when exposed to air. For some years past the evaporation of black ash liquors has been conducted in iron pans, so as to yield crystals of mono-hydrated carbonate of soda, which are transferred to open furnaces to be desiccated ; also yielding residual liquors containing a great part of the caustic soda originally present in the black ash liquors. These residual liquors were the cause of additional expense to the manufacturer, and a course was pursued with them which was very similar to "advancing backwards ;" inasmuch as great labour and expense was applied to convert the ready-made caustic into carbonate, and this product being sold to the soap manufacturer, he incurred much expense to re-convert the carbonate of soda into caustic. In 1853 I obtained a patent for certain modes of working by which this "backward" course was rendered unnecessary, and a large proportion of the caustic soda found ready made in black ash liquors was obtained in a solid state, convenient to be supplied to consumers. This process has been adopted by sundry manufacturers under my patent.

I have endeavoured to define the "rise" of the existing soda manufacture, as consisting in the invention of Le Blanc's process, and the carrying this into practical working by himself and partners, the raw materials consumed being sulphur and nitre (used for the production of sulphuric acid), common salt, chalk, carbon, and fuel, yielding as products hydro-chloric acid, carbonate of soda, and a material containing nearly all the sulphur previously consumed, but in such a state, that it has so far resisted all attempts to make it useful, and it has acquired the expressive designation of "Alkali Waste." At this period the commercial value of carbonate of soda in crystals was about 60*l.* per ton in England.

I have also endeavoured to trace the "progress" of this manufacture in Great Britain to its present state, beginning with the first operation of Mr. Losh, with his weak brine, and those of other manufacturers who were using bleachers' residua, and arriving at the period of the salt duty being remitted, when Mr. Muspratt commenced that development of the manufacture, which has now become one of national importance.

When Mr. Muspratt commenced his operations the value of sulphur was 8*l.* per ton, of common salt 15s. per ton, of lime 15s. per ton, and of fuel about 8s. per ton. When the works arrived at activity, the products obtained were soda ash, of which the value was 24*l.* per ton, and soda crystals worth 18*l.* per ton. At the present time the products obtained by the soda manufacturer are soda ash worth 8*l.* per ton, soda crystals about 4*l.* 10s. per ton, bleaching powder 9*l.* per ton, bi-carbonate of soda 10*l.* per ton; whilst the cost of raw materials now used in Lancashire are, sulphur 8*l.* per ton, for which is substituted pyrites, at a cost equivalent to 5*l.* for sulphur; salt 8s., limestone 6s., and fuel 6s. per ton. It will be thus seen, that with a reduction in the cost of raw materials, not more than equal to 10 per cent., the public is supplied with the products of the soda manufacturer at a reduction of at least 60 per cent. It may, therefore, be fairly assumed that, although the British manufacturers can lay no claim to the invention of the soda process, they are entitled to much credit for having worked this out in the most economical manner. This result has been facilitated by the invention of new apparatus employed, and sundry modifications in the details of working. Amongst the former I may notice the decomposing furnaces of the late Mr. Gamble—the salting pans of Mr. David Gamble—the lixiviating vats of Mr. Shanks, and the sulphuric acid chambers of Mr. Deacon.

As nearly as I can obtain information, there are now fifty establishments in Great Britain in which soda is manufactured by Le Blanc's process, producing

about 3,000 tons	of soda ash..................	per	week.
„ 2,000 „	of soda crystals		„
„ 250 „	of bi-carbonate of soda...		„
„ 400 „	of bleaching powder......		„

The total annual value of these products may be estimated as exceeding Two millions sterling, which is so much entirely added to the annual income of the country, excepting about 100,000*l.* paid for materials obtained from other countries. The number of workmen actually employed in the several manufactories, may be estimated as being at least 10,000, exclusive of those engaged in the manufacture of salt, and in mining for pyrites, limestone, and coal; also exclusive of the men engaged in the transport of raw material and manufactured goods by sea, canals, and railroads.

In reference to this part of the subject, I must not omit to notice the promise of a new market for British-made soda, which has been opened up by the successful labours of Mr. Cobden in the Commercial Treaty with the French Government. Although our manufacturers have to meet an import duty of 15 per cent. on soda ash, or thirty-six shillings per ton (exclusive of the commutation for salt tax), also to provide for cost of transit, the cheap supplies of salt and coal at their command, will enable them to carry on a trade in that country where the soda process was first brought into existence. The import duty will be reduced in 1864 to 10 per cent., or twenty-four shillings per ton.

At the time of this treaty being negociated it was estimated that the consumption of salt in France for the manufacture of soda was 59,000 tons, whilst that in Great Britain was 260,000 tons per annum.

I will now attempt to give a prospective view of the soda manufacture, but which must necessarily be, to a large extent, conjectural. Many attempts have been made to supersede Le Blanc's process, by some more direct means of operating on salt so as to eliminate its soda at once. Up to the present time the result of all these attempts has been the wasteful expenditure of large sums of money; therefore I will confine my further remarks to processes depending on the decomposition of sulphate of soda.

By the existing mode of working, there is required for the production of a ton of soda-ash, the following raw materials :—

	£	s.	d.
1¾ tons of Irish pyrites, costing	1	15	0
1 cwt. nitrate of soda „	0	12	0
1¼ tons of salt „	0	10	0
1½ tons of limestone „	0	10	0
3½ tons of fuel „	1	1	0
	£4	8	0

The other charges consist of interest on capital, wages, repairs, packages, freight, &c. I may remark that, at the present moment, the soda trade is suffering from great depression of demand and price, consequent upon the unfortunate war in the formerly United States.

It will be seen from this table, that two-fifths of the total cost for raw materials is incurred for pyrites, from which to procure a supply of sulphur; and it is a well-known fact, that more than nine-tenths of this sulphur is retained in the material called "Alkali Waste," which is thrown away by the manufacturer. Thus is presented a problem which, if it can be solved, would effect a large reduction in the cost of soda. Many chemists, both scientific and practical, have given a great amount of attention to this subject. I have been so unfortunate as to be among the number, as I have devoted a great portion of my time, during a quarter of a century, and a large amount of both money and labour, to this hitherto delusive subject.

I commenced by demonstrating, in 1838, that one equivalent of carbonic acid would decompose an equivalent of sulphide of calcium, producing mono-carbonate of lime and sulphide of hydrogen in a state of gas. This decomposition was contrary to the received views of scientific chemists of that day, as it was held that an excess of carbonic acid was needful to effect the perfect decomposition of sulphides.

CHRONOLOGY OF THE SODA TRADE.

Period.	Raw Materials and Prices.	Quantity Manufactured.	Prices.
1790	Barilla and Kelp	Not known.	Not known.
1792	Le Blanc's process invented and applied in France ...	"	"
1814	Crystals of soda made from bleacher's residua and by Mr. Losh from brine......	"	Soda Crystals 60*l.* per ton.
1823 & 1824	Mr. Muspratt's works commenced—using Common salt at 15s. per ton. Sulphur at ... 8*l.* " Lime at ...... 15s. " Coal at......... 8s. "	Probably 100 tons per week of crystals and soda-ash.	Soda Crystals 18*l.* per ton. Soda-ash 24*l.* per ton.
1861	50 works in operation in Great Britain using Le Blanc's process. Raw materials in Lancashire costing— Common salt......8s. per ton Sulphur from pyrites, 5*l.* " Limestone.........6s. 8d. " Fuel... ....6s. "	5,000 tons per week.	Soda Crystals 4*l.* 10s. per ton. Soda-ash 8*l.* per ton.

1861—Annual value of produce, two millions sterling. Number of workmen employed in the manufactories, 10,000, exclusive of those engaged in mining for pyrites, limestone, and coal; also those employed in navigation and other means of transport.

I am convinced that, whenever the utilization of the sulphur in alkali waste may be effected, it will be by means of this action of carbonic acid. I demonstrated also, at the same period, that one equivalent of carbonic acid would decompose one equivalent of sulphide of sodium, producing mono-carbonate of soda and sulphide of hydrogen. My present impression is, that Le Blanc's process will be modified by the omission of lime when decomposing sulphate of soda, thus producing sulphide of sodium; and that the carbonic acid evolved by this decomposition will be applied to decompose the sulphide of sodium, producing carbonate of soda and eliminating sulphide of hydrogen, which latter will be absorbed by peroxide of iron, and the product applied in the manufacture of sulphuric acid. I have proved the practicability of all these decompositions and actions, but the ideas have still to be worked out into a practical operation, and I have now left the subject to my juniors as one which presents an object worthy of their attainment.

Widnes, near Warrington.

THE VEGETABLE IVORY OF COMMERCE.

The vegetable ivory, or corozo nuts of commerce, are the fruit of the *Phytelephas macrocarpa*, a South American palm. There is no official record kept of the imports, but large quantities are frequently offered at the public sales. In some years not less than 250 to 300 tons are imported into England, and they have been occasionally sold wholesale at 8s. to 10s. a thousand; but now that there is a more extensive demand for them for buttons and other small fancy articles, 3*l.* 10s. the thousand for small, and 5*l.* to 7*l.* for large, is a more frequent price. In New Granada they sell at about 5*l.* the ton. They are imported from Savanilla, Carthagena, and Zapote.

Dr. Seemann gives the following account of it: "The ivory plant is confined to the continent of South America, where it grows between the ninth degree of north, and the eighth of south latitude, and the seventieth and seventy-ninth of west longitude. It inhabits damp localities, such as confined valleys, banks of rivers, and rivulets, and is found not only on the lower coast region, as in Darien, but also on mountains at an elevation of more than 3,000 feet above the sea, as in Ocana. Amongst the Spaniards, and their descendants, it is known by the name of "Palma de marfil" (ivory palm) whilst its fruit is called by them "Cabeza de Negro" (Negro's head), and its seed "Marfil vegetal" (vegetable ivory). The Indians on the banks of the Magdalena term the plant "Tagua," those on the coast of Darien "Anta," and those in Peru "Pullipunta" and "Homero." It is generally found in separate groves, seldom intermixed with other trees or shrubs, and where even herbs are rarely met with ; the ground appearing as if it had been swept. The trunk is always pulled down, partly by its own weight, partly by its aerial roots ; and thus forms a creeping caudex, which is frequently twenty feet long, but is seldom higher than six feet. The top is crowned with from twelve to twenty pinnatisect leaves, the entire length of which is from eighteen to twenty feet. The segments are towards the base of the leaf alternate, towards the apex opposite ; they are three feet long, two inches broad, and their entire number amounts generally to 160.

The fruit, a collection of from six to seven drupes, forms clusters, which are as large as a man's head ; and stands at first erect, but when approaching maturity, its weight increasing, and the leaf-stalk, which having up to that period supported the bulky mass, having rotted away, it hangs down. A plant bears at one time from six to eight of these heads, each weighing, when ripe, about twenty-five pounds. The drupes are covered outside with hard woody protuberances. Each drupe contains from six to nine seeds, but generally seven. The testa is thick, bony ; the embryo peripherical, and placed near the hilum. The seed at first contains a clear insipid fluid, with which travellers allay their thirst ; afterwards this same liquor becomes milky and sweet, and it changes its taste by degrees as it acquires solidity, until at last it is almost as hard as ivory. The liquor contained in the young fruit turns acid if they are cut from the tree and kept some time. From the kernels (albumen) the American Indians, as well as European turners, fashion the knobs of walking sticks, the reels of spindles, small boxes, and little toys, which are whiter than animal ivory, and equally hard, if they are not put under water ; and if they are they become white and hard when dried again. Bears, hogs, and turkeys devour the young fruit with avidity."*

It is of the same nature, though not of the same consistence as the flour of the cereal grains, the aromatic substance of the nutmeg, and the pulp of the cocoa-nut, which in some palms becomes more hardened. That of the date, and other palms, is quite as hard, if not harder, but it is neither large enough, nor white enough to be of use to the turner.

According to an analysis by Muller, the composition of the seed may be represented by $C_{24} H_{21} O_{22} = 2 C_{12} H_{10} O_{10} + H O$; Baumhauer obtained a precisely similar result some years later.

Dr. Phipson states that he has found that vegetable ivory takes in contact with concentrated sulphuric acid, a splendid red colour, almost equal to magenta. This colour, at first pink, then bright red, becomes much deeper, and more purple when the acid has been allowed to act for about twelve hours. This reaction may sometimes be found useful in order to distinguish small pieces of vegetable ivory from the ivory of the

* Popular History of Palms.

elephant's tusk, or from bone, neither of which take this beautiful red colour in contact with sulphuric acid. The analysis quoted above shows that the greater portion of vegetable ivory is pure cellulose, but the reaction produced by sulphuric acid proves that other substances are present, for cellulose does not become red with sulphuric acid. Mr. Connel found in 1845 that vegetable ivory contained 81.34 per cent. of cellulose, and that the other substances were, gum 6.73, legumine 3.80, albumine 0.42 (that is, 4.22 of albuminous substances) oil 0.73, water 9.37, and ash 0.61 = 100. Filings of vegetable ivory dried at 140° to 150° C. give 1 per cent. of ash.

Payen found that these filings when boiled with caustic soda took a yellow colour, a point confirmed by Baumhauer, who asserts that potash does not produce any colour. The reaction of sulphuric acid on vegetable ivory enables one to distinguish immediately between filings of this substance and bone or ivory filings. It is owing to the well-known action of this acid upon albuminous substances in presence of sugar, and which has been utilized by Raspail in his microscopic researches. But whether the sugar is formed by the action of the acid on the cellulose, or pre-exists already formed in the substance is of little import.

Dr. Phipson, however, inclines to the first opinion, as the colour takes a little time to show itself (five or ten minutes), and as Mr. Connel did not find any sugar ready formed. The white pulp of the cocoa-nut presents a similar reaction with sulphuric acid; the colour produced is first pink, then red, reddish purple, and, finally, in about sixteen hours, a fine violet. The colours thus produced with vegetable ivory and cocoa-nut disappear gradually in contact with water, like the fine reddish-brown colour produced with essence of turpentine and sulphuric acid.

THE TANNING TRADE OF NEWCASTLE AND GATESHEAD.

BY T. C. ANGUS.

The following is the most correct account I have been able to obtain respecting the tanning trade of Newcastle and Gateshead. Some of the persons engaged in the trade have an objection to supply information; but I believe the figures appended to the paper will pretty nearly represent the actual transactions in this branch of local trade.

At present we have only nine tanyards in operation in Newcastle four of some magnitude, the remainder small ones. Thirty years ago, Newcastle was styled the leather metropolis of the north, and buyers came from all parts to purchase. Public fairs were held twice a year, and supplies sent in from all parts of the country by small tanners, who generally had a few pits in a piece of open ground, and about two or three acres of grass land to fill up vacant time, and on these they managed to get wealthy.*

The character of the tanning trade in Newcastle has considerably changed of late years. The goods most in favour formerly were dry Russian hides, imported into this port at a cost of from 7½d. to 8d. per pound. These were eagerly bought up by the tanners, and the price realised left them 25 per cent. for manufacture. This trade continued for some time, but Yorkshire enterprise discovered it, and at Leeds most extensive yards, fitted with every known improvement, were laid down. In this way the Leeds tanners succeeded in securing the trade almost exclusively to themselves ; one tanner there alone producing as many tanned hides in one week as the Newcastle tanners could in one month. Thus, gradually, by improvements and perseverance, they, to a great extent, obtained the bulk of this portion of the trade. Owing to the great demand for these Russian hides, and the home consumption increasing at the same time, prices in Russia ran up to 12d. and 14d. per pound, and thus nearly cut off the importation. At these prices the hides yet continue, and they are now scarcely worth the tanner's notice. The substitute has been East India hides ; but here, again, the Leeds men have taken the lead, surpassing us in the rapidity of manufacture and cheapness of production, and securing the greatest portion of the trade to themselves. Newcastle can boast of being at the head of the trade in the manufacture of seal skins, calf skins, and sheep skins ; and it is gratifying to find that although one branch of our trade has changed hands, another, and one perhaps as profitable, has come to its place. A consumption of 163,000 seal skins, 62,124 calf skins, and 46,452 sheep skins, in one year, shows that the spirit of leather manufacture has not yet left Newcastle. In the production of this kind of goods I believe our tanners cannot be excelled.

The products of leather in Newcastle are a mere item in the consumption. We have to resort to Bristol, London, Liverpool, &c., &c., for our great supplies. In those places so much attention has been devoted to produce work by the use of other tanning materials than oak bark, as to give them a great advantage over Newcastle, enabling them to supply goods thoroughly in accordance with the requirements of this north country trade.

On the whole, I think the tanning trade of Newcastle is in a healthy condition, but few improvements or efforts to increase it have of late been made. One remarkable circumstance should be noted in conclu-

* A singular mode of remitting the proceeds of his leather at Newcastle fair, in 1810, was adopted by a Lancashire man. The amount (200*l.*) was put into the old sheets which had covered his leather. He dare not carry it, nor would he trust any banker with the remittance, but it arrived safe by carriers' wagons after several days' journey. We are in advance of this in these days.

sion: a few years ago we used to import a large portion of raw hides from Denmark, Holland, and Germany; now the tables have turned, and we are weekly sending raw hides from Ireland, for which they will give a higher price than we can afford for manufacture here. The Hollanders and Norwegians who used to wear wooden soles will now have leather boots and shoes, which greatly increases our export of leather.

The following are the statistics of the tanning trade in Newcastle-upon-Tyne and Gateshead, for the year 1862:—

QUANTITIES AND VALUE OF TANNING MATERIALS.

	Tons.	£	
Bark	1,780	9,753	
Valonia	154	2,202	
Gambier	50½	980	
Divi divi	55	772	
Shumac	314	4,315	
Lime and Pigeons' dung	—	324	
Dogs' Manure	—	280	
Oils (Cod and Linseed)	118	5,310	
Tallow	—	100	
Dyes	—	800	
Striping materials	—	100	
Eggs	—	600	
Alum and Soda	—	200	
			£25,736

NUMBER, WEIGHT, AND VALUE OF RAW HIDES AND SKINS.

	No.	Tons.	£	
Butcher Hides	38,020	713	24,908	
Calf Skins	62,124	84	9,320	
Sheep Skins	46,452	—	2,322	
Seal Skins	163,000	873	40,750	
				£77,300
				£103,036

VALUE OF THE ABOVE WHEN MANUFACTURED.

Butcher Hides	£47,500	
Calf Skins	16,373	
Sheep Skins	3,871	
Seal Skins	67,915	
		135,659

NOTES ON SOME OF THE EDIBLE FRUITS OF THE WEST INDIES.

BY J. R. JACKSON.

Amongst the tropical edible fruits brought into this country, none, perhaps, are more universally in favour than the Pine-Apple, though there are many which, if we can rely upon the statements of European travellers, are equal, and even more delicious, than this much prized fruit: take, for instance, the Mangosteen of the Malay Islands, the Cherimoyer of Peru, the Mango of the East, and the Guava of the West Indies. Many of these, as well as others, when once tasted, require no further recommendation to the European; and yet there is an amount of prejudice amongst us which inclines us towards our own fruit produce, or those to which we have been long accustomed, before we can suit our palates to a new production of other lands. There are many imported fruits which, as they form a large portion of our commerce, are as necessary for domestic purposes, and perhaps more so, than those produced in our own island; for Christmas would be wanting in one of its greatest features were there any lack of raisins and currants, which we receive in such large quantities from the Ionian Islands, Greece, Liparis, &c.

It is not my intention in this short paper to speak of the merits or demerits of the fruit produce of all parts of the globe, but briefly to notice those indigenous to the West Indies, where many have been spoken of so highly by travellers. The Cherimoyer (*Anona Cherimolia*, Willd.) attains its greatest perfection in Peru, where it is considered one of the finest fruits known amongst the natives. Its growth extends from Peru up to Mexico, but it has been naturalised in the West Indies, and is also cultivated in some parts of Europe, as in the south of Spain it is sometimes found fruiting, as an orchard tree. It has also been introduced into England, but never cultivated. It is a small tree, attaining about twenty feet in height; the leaves have a very strong and agreeable scent. The fruit, which is by some considered the most delicious fruit grown, is of a soft pulpy nature, with a pleasant sweet taste; its colour, when ripe, is of a darkish purple, the exterior scaly, somewhat resembling a pine-apple, as is the case with most of the Anonas, and of a somewhat conical form with a blunt apex, and about the size of a small melon. The seeds, which are enveloped in the pulp, are covered with a shining brown testa, and like all other species of the genus, when cut in half, exhibit a beautifully ruminated albumen.

Closely allied to this are the Sour Sop (*Anona muricata*, L.), the Sweet Sop (*A. squamosa*, L.), and the Alligator Apple (*A. palustris*, L.). These are all now common in the West Indies. The Sour Sop and Alligator Apple would seem to be indigenous, but the Sweet Sop is probably a native of South America, though now cultivated extensively in the East and West Indies, as well as in Africa and other tropical countries—as, indeed, are all three species. The Sour Sop is a small tree, fifteen to twenty feet high, producing a very hard and dense wood. All parts of the plant have a very sweet scent. The fruit much resembles the Cherimoyer in form, but is of a lighter or greenish colour ; the flesh, or pulp, is also lighter, and is considered of a cooling nature. It is very commonly eaten by the negroes, by whom it is greatly esteemed ; but with the better classes it is seldom sought after, owing, perhaps, in a great measure, to its abundance. The tree was introduced into England so early as 1656, but never established as a fruit tree ; it is, however, very common all over the West Indies, and especially on the savannahs of Jamaica.

The Sweet Sop, as has been said before, is undoubtedly a native of South America, but now cultivated in nearly all tropical countries, where the fruits are always eaten in large quantities, but are said to attain much greater perfection in the Indian Archipelago than anywhere else ; the pulp is said to be very delicious, and has been likened in flavour to clotted cream and sugar. The size of the fruit is about that of an artichoke, and it is covered with tubercular scales. The plant grows to a height of from twelve to twenty feet, and was introduced into this country about the middle of the eighteenth century, but has never been naturalised.

The tree which bears the Alligator Apple is small, not more than twenty feet high, very common in low damp situations and the borders of rivers in Jamaica. This fruit is not so common an article of food as the other species of Anona, owing to a strong narcotic principle contained in it ; but nevertheless it is agreeable to some tastes, having at first a sweet and pleasant flavour. It is somewhat heart-shaped, and smooth on the outside. In Brazil, a wine is sometimes made from the fruits, but is not much esteemed. The wood of this tree is so soft that it is called cork-wood in Jamaica, and is there used for stoppers for bottles, and other purposes to which cork is usually applied.

The tree producing the Mammee Apple (*Mammea Americana*, L.) grows to about sixty or seventy feet in height, with a thick spreading head, forming a beautiful tree. The wood is very much esteemed for various kinds of work, for ornamental purposes, as well as where strength and durability is required ; indeed, it is considered one of the best timber trees in Jamaica. The fruit is round, about the size of a cannon ball ; the outer skin, or covering, is of a brown leathery texture, the inner of a lightish yellow, fibrous nature, so united with the pulp as to be difficult of separation. The seeds which are embedded in this pulp are about four inches long and one broad, of a triangular form, two sides being flat, and one partly rounded. The number of seeds in each fruit is four ; the outer coating is hard, and much reticulated. They have an exceedingly bitter taste, owing to a resinous matter which seems to abound in them ; but the pulp is the part for which the fruit is prized, and for which it is classed amongst the best of the West Indian fruits in the markets, where it is always to be seen in great abundance. This pulp is of a sweet aromatic smell, and of a peculiar yet delicious flavour. It is, however, unsuited to a delicate or weakly constitution, as it is said to leave a cloying bitterness upon the palate, which lasts for a considerable time. It is usually eaten in the same manner as an ordinary pear or apple, but is sometimes sliced, and taken with sugar or wine. It likewise makes a very good jam, by being preserved in sugar. In some parts, the flowers are used for making an intoxicating beverage, by distillation with spirit.

The Avocado Pear (*Persea gratissima*, Gaertn.) is the fruit of a large, straight-growing tree, producing a soft wood, of little or no use. The fruits are, however, eaten both by men, birds, and quadrupeds. It is sometimes called vegetable marrow, and is eaten with salt and pepper. The flavour has been likened to that of a peach, but by some is considered even more delicious. The fruit is very seldom eaten alone, on account of its richness, lime juice, spices, or sugar, being most frequently added. The pulp is firm, of a rich yellow colour. The form of the fruit is very similar to that of the common pear, but somewhat larger. The time of ripening extends over August, September, and October. The seeds are enclosed in a soft rind, and embedded in the pulp. They have a strong astringent property, and it has been said that, by writing with one of them on a whitewashed wall, the letters are immediately changed to a bright red, and are permanently fixed. We have been told, also, that by puncturing them, a bright yellow juice instantly flows from them; some doubt ought probably to be attached to this assertion.

The Guava is a fruit well known in all tropical countries, several species of the genus producing in their respective habitats valuable fruits. The common, or pear-shaped Guava (*Psidium pyriferum*, L.), and the red, or apple-shaped (*P. pomiferum*, L.), are both found in the West Indian Islands, and are very generally cultivated in the East Indies. *P. pyriferum* is a small tree, ten to twenty feet high, flowering in June and July, and producing a fruit in form and size much resembling a pear, and when ripe, of a delicate yellow colour. It has a pleasant aromatic flavour, and is in great favour, as much by Europeans as by the natives, both as a fruit in its crude state, and as a preserve. A delicious jelly is made from it, which is well known in this country, and which is in every way suited to the refined palate of an Englishman. It is considered one of the best conserves imported from the West Indies. The fruit, like the mango and several other tropical fruits, soon deteriorate, and is consequently almost unknown in England, except as a conserve. The plant in its wild state is short and shrubby, but by careful cultivation, it may be changed to a large and beautiful tree. It was introduced into this country about the middle of the seventeenth century, and occasionally fruits in our stoves, but is not cultivated with us as a fruit tree. The fruit of *P. pomiferum* is said to be of no great value, on account of its astringency, but it has a pleasant, agreeable odour, and by careful cultivation would, no doubt, prove a good, wholesome, and pleasant fruit. All parts of the plant have a strong astringent taste, the root and young leaves being considered stomachic. This species is only a shrub, growing about twelve to sixteen feet high.

The Anchovy Pear, the fruit of *Grias cauliflora*, L., is another of the many esteemed fruits of these islands. The tree producing it is straight and handsome, growing from 30 to 50 feet high. It has lanceolate acuminate leaves, from two to three feet long, and large whitish blossoms. The fruits are about the size of a large pear, and of a russet-brown colour. The seeds are embedded in a firm, fleshy pulp, which is commonly eaten amongst the natives. In flavour it somewhat resembles the mango, and is frequently pickled in like manner. The tree is common in all parts of the West Indies, and very abundant in thickets and damp situations in Jamaica. It can be easily raised from seeds in a moist stove. It was introduced in the middle of the eighteenth century.

The Star Apple (*Chrysophyllum Cainito*, L.) is a beautiful tree, growing from thirty to fifty feet in height, with a spreading head, composed of very flexible branches. The leaves are from two to three inches long, of an oblong form, acute at the apex, the under side covered with a deep yellow or golden down—hence the name *Chrysophyllum*, composed of two Greek words meaning golden-leaved. There are several species or varieties of this genus, all furnishing fruits much resembling *C. Cainito*. The variety *Jamaicense* would appear to produce the best fruit, or that which is most esteemed by the natives. The fruit is large, of a globose form, with small black seeds arranged in the cells, radiating from the centre in the form of a star, each cell containing one seed. The pulp, or flesh, is soft, of a sweetish, insipid taste, not much in favour with Europeans, but esteemed by the natives. All parts of the tree are said to be highly astringent, as well as the unripe fruit, but upon becoming ripe it loses this property. It was introduced into this country early in the eighteenth century, and is frequently found in stoves as an ornamental plant. The trees seldom bear fruit till they attain a considerable height. The Damson Plum of Jamaica is supposed to be a species or a variety of this genus—viz., *C. oliviforme*, Lam., var. *monopyreum*. This is a smaller tree, producing a close-grained wood, somewhat resembling box. The fruit is not much sought after as an article of food. Both plants grow abundantly in all the West Indian Islands. The former species is also common in South America, within the tropics.

Lucuma mammosa, Gaertn. — A large Sapotaceous tree, sometimes growing one hundred feet high, with large shining leaves and small whitish flowers, furnishes a fruit known as the "Mammee Sapota," or American Marmalade, from the similarity of the flavour of the pulp to the marmalade made from quinces. The fruit is large, of an oval shape, with a rough brown skin. The seeds are large, of a somewhat oval form, with a shining brown testa. The pulp of the fruit is much esteemed, both by the natives and by Europeans. This tree is cultivated in many parts of the West Indies on account of its fruit. It is found growing spontaneously in South America, and other parts within the tropics.

The Grenadilla (*Passiflora quadrangularis*, L.) is a large fruit, somewhat resembling a melon, but rather more oblong ; its size is frequently fifteen or sixteen inches long, with a diameter of five or six inches. This fruit is much valued for its soft and delicate pulp, which is very cooling and refreshing in hot climates. It has a sweetish, acid taste, and when ripe is of a purplish colour. It is often eaten alone, but wine and sugar are frequently added. The external colour of the rind is of a greenish yellow. The flowers are very fragrant, blossoming fully in August and September. A strong, healthy plant, is very prolific in fruit bearing, producing fine fruits unceasingly up to the end of December. It is a small, shrubby plant, with a quadrangular stem, hence its specific name, and is a native both of Jamaica and South America. It has been introduced into this country, and has borne fruit at Kew, in the Horticultural Society's and other gardens.

The Papaw (*Carica papaya*, L.) is a peculiar plant, both as to its manner of growth, and the properties which different parts are said to possess. Some doubts exist as to its native habitat, but it is now found in both the East and West Indies, many parts of South America, Africa, and other tropical climes. It is a tree rising some twenty feet high, with a soft, slender, hollow stem ; it has no lower branches—indeed, it may be said to have no branches at all, the leaves being borne upon long slender stalks diverging from the top of the trunk or main stem ; the leaves themselves are very deeply seven-lobed, the lobes pinnatifid and pointed. The plants are diœcious, the flowers of the female being much larger than those of the male ; they are bell-shaped,and of a yellow colour. The fruit which succeeds the flowers is about the size of a melon, but of a more oval form. The fleshy pulp is covered with a thin, smooth skin. The fruit, when ripe is greatly esteemed by the natives in some parts, being eaten either sweetened with sugar or flavoured with pepper to take away the strong acrid taste which prevails, owing to the presence of a milky juice. The immature fruits, when pickled, much resemble the East Indian mango. The milky juice from the unripe fruits is used medicinally, as is also the powdered seeds, both being considered a powerful vermifuge ; another peculiarity of this juice is its effect upon the flesh of animals, for by steeping meat in it, even for a few minutes, it becomes tender, and it is even asserted that meat hung in the tree is operated upon in a singular manner.* The leaves have the power of creating a lather, and,

* An article "On the Supposed Influence of the Papaw on Meat" will be found in the TECHNOLOGIST, vol. ii., p. 15.—EDITOR.

for this reason, are used as a substitute for soap by the natives of the West Indies.

The foregoing is a brief description of the most common edible fruits of these islands. In a climate like that of the West Indies, many fruits are brought to greater perfection than they would be in a more temperate clime, and this is the cause of so great a variety of fruits being in repute amongst the natives, which, not being suited to the palate of Europeans, are not included in this paper.

THE COLLECTION AND MANUFACTURE OF LAC IN THE NAGPORE TERRITORY.

BY RAMASAWMY MOODLIAR.

The Koosumb tree (*Schleichera trijuga*), from which stick lac is procurable, is generally found located on hills; but it flourishes also along the banks, and in the neighbourhood of nullahs, and in itself presents the appearance of a jungle. It attains both a great height and diameter, the first varying from thirty to seventy feet, and the latter from one to four feet; its branches are wide spreading, and the wood is strong and pliable. The tree blossoms in February, and the fruit is ripe in April and May; from the seeds of which an oil is procured, and used for the lamp, and considered a good cure for poora. In the Nagpore territory, the tree (called by the natives Koosumbia) is found in the districts of Lanjee, Comtah, Roypore, Joucknuddee, Chandah, Bundara Buster, and Ranjem; but most abundant in this last-named district.

The lac insect is produced inside the bark of the tree, and may be observed on removing a portion of it early in the month of August; and during the prevalence of heavy fogs the insect perforates the bark and forms the lac, the insect itself forming the colouring matter. The first crop is picked in November, December, and January. If allowed to remain on the tree for a month or so longer, a whitish insect or maggot is generated, which consumes the lac insect. Should fogs not prevail in August, as is usual, there would be a failure in the lac crop: there is a second crop of lac procurable in July, but its quality is very inferior to the first.

The Goands collect the crude stick lac, and bring it to the village bazaars, where it is sold for tobacco and salt, and sometimes cash; but merchants generally make a contract with the Goands for it, and an advance is made by merchants to them. They furnish it at the rate of four to six coodoos, equal to from thirty-two to forty-eight pounds weight per rupee. When the lac is kept for a few months, after it is collected,' it is reduced to half its original weight.

After the lac is brought from the jungle, it is converted into dye in this country for leather, tusser, or common silk, and good silk at Nagpore; but the Nagpore country people do not understand the use of it for dyeing cotton cloth and thread, and it is only used in a rough way.

The process of making lac-dye is as follows: the lac having been carefully picked from the branches is reduced to a powder in a stone hand-mill, then thrown into a cistern, covered with two inches of water, and allowed to soak for sixteen hours, or say, from four p.m. to six a.m. It is then trampled by men for four hours or so, until the water appears well coloured, each person having a portion of about ten pounds weight of lac to operate upon. The whole is then strained through a cloth, boiling alum-water being poured on it during the process, and the coloured water run off into another cistern, where it remains for one day to settle. The water is then run into a second cistern, and the day following into a third, and the water is then allowed to run off as waste; the colouring matter is then taken up in tin vessels from the three cisterns and placed in a canvas strainer, where it is allowed to remain from two to three days, or until such time as all the water has been strained off. It is then placed in a pressing machine, and all remaining moisture squeezed out. The square cakes of dye are then made according to the mark of the manufacturer. The shell lac is made from the lac which remains in the cloth after the first straining.

The branches contain the insects under the bark; a removal of which will exhibit them to the naked eye (red). To promote their increase, all that is necessary is, to attach or bind a branch containing the insect to the ordinary berry fruit (or Ellenda) tree; but the Koosumba tree yields the best lac.

The Moorka tree yields lac largely, but very inferior in quality.

THE COMMERCIAL PRODUCTS OF THE FISHERIES IN THE INDIAN OCEAN AND THE EASTERN SEAS.

BY THE EDITOR.

Although the products obtained from the sea in the East are very extensive, yet no collective estimate or description has ever been given of them. Some of these have incidentally been noticed in our pages,* and we now proceed to describe others. The Pearl oyster fishery, Tortoiseshell and Mother of Pearl, the Chank fishery, Trepang, or Beche de Mer, and Cowries, are some of the many articles which commerce largely

* Beche de Mer, TECHNOLOGIST, vol. 1, p. 40; Mother of Pearl and its uses, TECHNOLOGIST, vol. 1, p. 219; The Tortoiseshell of Commerce, TECHNOLOGIST, vol. 1, p. 375; Chanks and Bangles, TECHNOLOGIST, vol. 2, p. 185.

developes in India and the far East, but the fishes sought for food are equally important.

Firstly, we have the products of that sea monster, the shark, in its edible fins and oil.

There are shark fisheries on the eastern coast of Africa, and in several parts of the Indian Ocean, chiefly for the sake of the fins which are exported to China. About 7,000 cwt. were imported into Canton alone in 1850, chiefly from India and the Eastern Archipelago. From 7,000 to 10,000 cwt. of sharks' fins are exported annually from Bombay. In 1853, 7,373 cwt. of these valued at 14,748*l.*, were imported into Bombay from the Arabian and Persian Gulfs, Sonmeannee and Mukran. About 1,400 cwt. of these fins are sent from the Madras territories to China. Sumatra, Manila, Malacca, Arracan, and the Tenasserim Provinces, also send large quantities. There are two kinds recognised, the white and the black shark fins, which are eaten by Chinamen. The species from which they are chiefly obtained are *Rhynocobatus pectinata* and *R. laevis* and *Galiocerda tigrina.*

The late Dr. Buist, of Bombay, in a communication to the Zoological Society in 1851, stated that there were thirteen large boats, with twelve men in each, constantly employed in the shark fishery at Kurrachee.

The value of the fins sent to market varies from 15,000 to 18,000 rupees (1,500*l.* to 1,800*l.*), or 1,000 to 1,200 rupees for each boat, after allowing the Banian or factor his profit. One boat will sometimes capture at a draught as many as 100 sharks of different sizes. The average capture of each boat probably amounts to about 3,000, so as to give the whole sharks captured at not less than 40,000 a year. The great basking shark, or mhor (*Salachus maximus*), is always harpooned ; it is found floating or asleep near the surface of the water. The liver of a large fish of this species will yield eight barrels of oil. The oil is of a very low specific gravity.

The fish, once struck, is allowed to run till tired ; it is then pulled in, and beaten with clubs till stunned. A large hook is now hooked into its eyes or nostrils, or wherever it can be got most easily attached, and by this the shark is towed on shore ; several boats are requisite for towing. The mhor is often 40, sometimes 60, feet in length ; the mouth is occasionally 4 feet wide. All other varieties of shark are caught in nets, somewhat like the way in which herrings are caught at home. The net is made of strong English whip-cord ; the meshes about 6 inches ; they are generally 6 feet wide, and from 600 to 800 fathoms, or from three-quarters to nearly a mile, in length. On the one side are floats of wood about 4 feet in length, at intervals of 6 feet ; on the other, pieces of stone. The nets are sunk in deep water, from 80 to 150 feet, well out at sea.

They are put in one day and taken out the next ; so that they are down two or three times a week, according to the state of the weather, and success of the fishing. The lesser sharks are commonly found dead, the larger ones much exhausted. On being taken home, the back fins, the only ones used, are cut off, and dried on the sands in the sun ; the flesh is cut off in long strips, and salted for food ; the liver is taken out and boiled down for oil ; the head, bones, and intestines left on the shore to rot, or thrown into the sea, where numberless little sharks are generally on the watch to eat up the remains of their kindred. The fishermen themselves are only concerned in the capture of the sharks. So soon as they are landed they are purchased up by Banians, on whose account all the other operations are performed. The Banians collect them in quantities, and transmit them to agents in Bombay, by whom they are sold for shipment to China.

In Akyab harbour, about 200 maunds of black fins are collected annually, worth 9 rupees per maund, and 150 maunds of white fins. White fins fetch the higher price of 30 rupees per maund. The local name for them is Gua-maget. They are exported to China and the Straits. Shark skin is used by the native workmen for polishing wood and ivory, and is also made into shagreen.

Another important marine product is the fish-glue, or isinglass, obtained from various fisheries of the Indian Ocean.

The solid dried sounds or swimming bladders of many fishes, are largely shipped to China and other parts under the name of "fish maws."

The *Polynemus plebeius* and *indicus* seem to furnish the largest portion. These fish are caught of a great size, and sold in the Calcutta bazaar during the cold season. This isinglass is also said to be produced of good quality by Indian species of *Silurus* and *Pimelodus.* Isinglass, the produce of Bengal, has been celebrated in China from the earliest times ; it is called there *Fish sago.* About 2,500 cwts. of fish maws are exported from Bombay, and smaller quantities from Madras and Bengal. At Akyab, fish maws, known locally as "Zeebaeing," are produced to the extent of 30 or 40 maunds per annum, the price being 35 rupees per maund. They are exported to China and the Straits.

Among the fish and other oils locally obtained or met with in commerce in the East, are at Madras, karahmanoo fish oil (from *Polynemus plebeius* and *P. uronemus*), seri-nei (shark-liver) oil, and Bochet-fish liver oil, Cooawanoo oil from the loggerhead turtle (*Caouana divacea*, Esch.), Amaci nai (turtle oil), shark oil, Bombay and Tellichery ; fish oil, Malabar; porpoise oil, Patna ; fish maw oil, Joree oil, and Seephoo oil, Calcutta ; muria ekam fish oil, Indian Archipelago ; fish oil, Japan.

Fish-liver oil is now prepared in large quantities on the Western and Malabar coasts for exportation. That supplied to hospitals for the use of the troops, is obtained from the liver of the skate, seer, and white shark indiscriminately. From analysis and experiments made in England, it has been found to equal in its medicinal properties the best cod-liver oil, but from its disagreeable taste and odour, it can never supersede the oil of Newfoundland. A more agreeable kind of oil may be prepared from the livers of the skate or seer fish, but when the liver of the shark is also used with the livers of the other fish, the oil so obtained has a very offensive odour and unpleasant taste, which cannot by any mechanical or chemical process be removed, however carefully it may be prepared.

At Moutrah, a town situated in a deep bay not far from Muscat, they dry and export large quantities of a diminutive fish, about two inches long, which are packed in bales. This species of fish literally fills the waters of Oman. Dr. Ruschenberger (' Voyage Round the World,' vol. i., p. 121), says,—" They sometimes appeared in dense strata about the ship, so thick as completely to hide the cable from view, which was distinctly seen when they were not present."

The *Lates nobilis*, different species of *Polynemus* and the *Mugil Corsula*, daily cover the tables of Europeans in Calcutta, who will more readily recognise these fishes under the names of the Begti or Cockup, Sudjeh, Tupsi (Mango fish), and the Indian mullet. The mango fish is so named from its visiting the Indian rivers annually to spawn, during the mango season. It arrives as soon as the mango is formed on the tree, and disappears at the close of the season, or about the middle of July. This fish has, perhaps, the most agreeable flavour of any in the world, and is so much sought after by natives as well as Europeans, that although not so large as a middling-sized whiting, they are sold at the beginning of April, at from 2 to 4 rupees (4s. to 8s.) per score. Before the end of May, as they become plentiful, they are sold at 2s. per score, and later from two to three score may be had for a rupee.

Hilsa or sabti, the Indian mackerel, makes its appearance in July. The fish is delicious either boiled, baked, or fried, but it is generally considered very unwholesome. The natives devour it in such quantities as to occasion great mortality among them. The fish, on being cured with tamarinds, forms a good substitute for herrings. It is then known by the appellation of the tamarind fish.

Burtah, the salted and spiced flesh of the suleah fish, is a piquant relish well known at the breakfast-tables of Bengal; other delicious fishes are the Indian soles, the roll fish, and above all, the black and white pomfrets, and the Bummaloh, which latter in a dried state, is known by the name of the " Bombay duck." The bazaars in Calcutta are always stocked with an ample supply of dried fish, which is consumed partly by the Europeans and native shipping of that port, partly by the poorer classes of Bengal and the Upper Provinces. Cargoes of this article are annually imported by the Burmese and Arabs.

In the Maldive Islands the bonita is thus prepared :—The back bone is removed, and the fish laid in the shade, and occasionally sprinkled with sea water. After a certain period has elapsed, the fish is wrapped up in cocoa-nut leaves and buried in sand, when it becomes hard. Fish thus prepared is known in Ceylon, and perhaps over all India by the name of *cummelmums*. The pieces of this fish brought to the market have a horny hardness. It is rasped upon rice to render it savoury.

The Terussan, a large fish like a salmon in shape, and of a reddish colour, caught off Sumatra, is delicious eating. The air-bladder, called by the natives lupa lupa, is a great article of trade, and sells for 30 dols. per picul at Penang. It is dried in the sun, and the Chinese make great use of it.

The Malays strike the porpoise or *loma*, and the *paree*, ray or skate, with an iron harpoon, to which a long coil of rope is attached. The porpoise is chased during the day, but the skate is harpooned at night, being attracted to the boats by the light of torches. The skate sometimes attains to the size of six feet in diameter ; those of three or four feet in diameter are common. As they come close up to the surface, they are easily struck. When the barb has been driven into the fish, and the shaft has separated from it, the skate dives with considerable velocity ; and if large, it may be secured after about an hour's labour.

Dried fish of three kinds, under the native names of Plaheng, Plasalit, and Platu (some of them are flounders) to the extent of 79,000 piculs of 133lb., and dried shrimps to the extent of 1,000 piculs are annually exported from Siam to the Eastern ports. There is an extensive trade carried on in China, and the other Eastern nations in crustacea and molluscs. Dried shrimps and prawns form a large article of commerce. All sorts of oysters, mussels, and other shell-fish, of which there is a great plenty and surprising variety in the Japanese and other seas, are eaten, none excepted—raw, pickled, salted, boiled, or fried. The ear-shell (*Haliotis*), called Awabi, is sought for generally for the fish. The flesh is cut into slices or strings, which are extended on a board and dried. As this shell-fish was the common food of their necessitous ancestors, when the Japanese entertain company at dinner, they always provide a dish of it. Kœmpfer states that it has hence become a custom among all classes, when they forward one another presents of any kind, to send along with it a string or piece of this dried flesh, as a good omen, and as a reminder of the indigency of their forefathers. Several species of cuttle fish dried, dried oysters, mussels, cockles, and clams, and the dried ink fish (called Zekat), are largely exported from Japan for Chinese consumption.

Kœmpfer, in his "Account of Japan," thus speaks of the latter :

"Ika is a common sea-qualm. Both the Chinese and Japanese esteem it as a scarce and delicate bit. Fish are easier caught with the flesh of this qualm than with any other bait. Jako, or sepia, is another sea-qualm, with long tails or feet, at the end whereof are, as it were, small hooks, wherewith the creature fastens itself to the rocks, or the bottom of the sea ; it is a common soccano, or side dish, and eaten either fresh, boiled, or pickled. There are two sorts of kurrage, which is also of the sea-qualm kind. One is called midsukurage—that is, the white qualm. This is common in all seas, whitish, transparent, watery, and not fit to eat. The other is scarcer, fleshy, and eatable, after it has been prepared, and deprived of its sharpness. It is prepared after the following manner:—They first macerate them in a solution of alum for three days together; then they rub, wash, and clean it till it grows transparent, which done, it is pickled and preserved for use. Before the infusion, the skin is taken off, washed, pickled, and kept by itself. Some of these sea-qualms are so large that two men can scarcely lift them up. Pickled, as they are brought upon the table, they are of the same substance, colour, and taste as the edible birds'-nests brought from China; and I have been credibly informed by Chinese fishermen that these birds'-nests are made of the very flesh of this animal."

Gnapee or Nga-pee is made of prawns, shrimps, or any cheap fish, pounded into a consistent mass, and frequently allowed to become partially putrid. It is known in commerce by the name of Balachong, and largely consumed as a condiment to rice in all the countries to the east of Bengal, including the southern part of China and the islands of the Eastern Archipelago. Its distribution gives rise to an extensive internal trade, and like the herrings and salt fish with the negro population of the West Indies, it forms to the natives a palatable addition to their ordinary food. To show its importance to Pegu, gnapee to the value of 142,000*l.* was exported across the frontier into Burmah Proper in the year 1861. The best balachong is said to be made in Siam, being compounded of dried shrimps, pepper, salt, and seaweed beaten into the consistence of a tough paste, and then packed in jars for use and exportation. It is also made and exported in large quantities from Sumatra. The shrimps (udang) of which they make it are very plentiful, and there are very many varieties as udang mangkara (large lobster shrimp), udang gala (long-legged shrimp), udang sumut, and udang pasang, &c.

It has been supposed that nearly a tenth of the population of China derive their means of support from the fisheries. Hundreds and thousands of boats crowd the whole coasts, sometimes acting in communities, sometimes independent and isolated. There is no species of craft by which a fish can be inveigled which is not practised with success in China. Every variety of net from vast seines, embracing miles, to the smallest hand-filet in the care of a child. Fishing by night and fishing by day; fishing in moonlight, by torchlight, and in utter darkness; fishing in boats of all sizes; fishing by those who are stationary on the rock by the sea-side, and by those who are absent for weeks on the wildest of seas; fishing by cormorants; fishing by divers; fishing with lines, with baskets—by every imaginable decoy and device. There is no river which is not staked to assist the fisherman in his craft. There is no lake, no pond, which is not crowded with fish. A piece of water is nearly as valuable as a field of fertile land. At daybreak every city is crowded with sellers of live fish, who carry their commodity in buckets of water, saving all they do not sell to be returned to the pond or kept for another day's service.

A gentleman sent to China on an agricultural mission by the French Government, M. Eugène Simon, has made a valuable report on the fish and fisheries of that country, and has also despatched specimens of several kinds which he thinks capable of being bred in Europe. He speaks of these in the highest terms, and says that it would not be difficult to select 40 or 50 species worthy of observation. Amongst others he reports is the Lo-in or king of fish, classed as Crenilabrus by Dr. Bridgman, measuring sometimes six or seven feet in length, weighing from 50lbs. to 200lbs., or more, and said to be equal to the famous salmon of the Rhine. Then come the Lein-in-wang and the Kan-in, almost as good and even larger than the other; the Lin-in, finer than any carp in Europe, and weighing sometimes 30lbs.; and the Kin-in, or Tsi-in, which does not weigh more than from 10lbs. to 12lbs., and is the finest and most delicate of all in flavour, partaking at once of the characteristics of the trout and sole.

Whale-fishing in the Indian Ocean constitutes a large and profitable trade. In this pursuit, however, Great Britain has no share. From Java Head to Cape Leeuwin the distance is about 1,600 miles. Far and wide along this whole line of sea, ships of the United States are constantly cruising about in search of whales, and occasionally meet with immense prizes, even within sight of the colony which Great Britain has planted on the Western coast of the Australian continent. England in her own waters is, in this respect, England no longer, and while ships of foreign nations making light of a voyage of 13,000 miles, traverse the ocean to fish on British coasts, carrying away annual prizes of industry to the value of 1,000,000*l.* sterling, Great Britain looks on unheedingly.

An American whaler is usually about 450 tons burthen, and it is supposed that, in all parts of the Indian Ocean, there are not less than eighty always cruising about at one time. This gives an aggregate tonnage of 36,000 tons. Dutch and French whalers are also occasionally to be met with in this region; and although, in point of number, they perhaps do not constitute above a tenth of the number of American vessels, yet the quantities of oil which they, too, succeed in taking, sometimes in British waters, illustrate still further the apathy of the English in regard to this source of wealth.

In 1838, American and French whalers cruising in the vicinity of Cape Leeuwin captured, at one onslaught, a school of whales which yielded about 10,000 barrels of oil estimated in value at 25,000*l.*; not a single British or colonial craft being present to share in the gains. In February, 1845, several American vessels encountered and captured a considerable number of whales at Champion Bay in the 27th degree of S. lat., about ten miles from the shore—their operations being distinctly seen by some colonists from land. The yield of oil was on this occasion upwards of 6,000 barrels, estimated in value at about 16,000*l.*

In October, 1857, American, Dutch, and French whalers cruising off King George's Sound took prizes of oil amounting to 12,000 barrels—in value about 28,000*l.* These various captures were exclusive of extensive ones made by the same vessels in their cruises further out at sea, and being only isolated occurrences amongst many of a similar kind that might be named, they forcibly illustrate the anomaly that British enterprise, hitherto so active and vigilant, should permit foreigners to approach the very threshold of British territory, and carry away wealth which is so easily within their own grasp.

The whales on the coasts of Japan not only afford oil in great abundance, but their flesh, considered wholesome and nutritious by the Japanese, is largely consumed. No part of the animal indeed is thrown away; all is made available to some useful purpose or another. The skin, which is generally black; the flesh, which is red and looks like coarse beef; the intestines and all the inward parts, besides the fat or blubber, which is boiled into oil, and the bone, which is converted into innumerable uses; all is made available to purposes of profit.

CHINA GREEN.

BY PROFESSOR H. DUSSAUCE.

Mr. Charvin has extracted from the *Rhamnus catharticus* a green colouring matter similar to the Chinese green (green indigo), but less costly. This product is in irregular plates with a variable aspect, according to the thickness of the plate.

Like the Chinese *Lo-Kav*, this product seems to be a lake—that is, a combination of an organic substance with an earthy matter. Gradually heated, it lost first water without any sublimate product; in burning, it left an inconsiderable quantity of ashes.

The following is the result of a comparative experiment done at the same time with that product and the *lo-Kav*, with the analysis of Mr. Persoz:

	Green Charvin.	Chinese.	Chinese by Persoz.
Water . .	13.5	9.5	9.3
Ashes . .	33.	28.5	28.8
Colouring matter	53.5	62.	61.9
	100.0	100.0	100.0

Mr. Persoz defines the *lo-Kav* "a lake formed by cyanine, having for base phosphated magnesia, alumina, and oxide of iron." In Mr. Charvin's process lime is only found, mixed with a little alumina and silica without phosphoric acid, but the colouring matter is the same in the two products. The chemical reactions of Mr. Charvin's green are similar to the Chinese *lo-Kav*.

Preparation.—In a kettle containing boiling water he puts two pounds of *Rhammus catharticus* bark; a few minutes a pink skim is produced. He then puts the whole into an earthen jar, well covered, and then allows it to rest till next day. The liquid is yellowish; it is decanted and lime water added to it, which produces a change of colour; it turns reddish-brown, the liquid is put in jars—very little in each one—and the whole is exposed to air and light. The reddish-yellow colour is modified and takes a green shade; little by little the green colour becomes more general, and is then deposited in plates. All the liquids are mixed together and carbonate of potash is added; or green precipitate is produced; he leaves it in deposit, decants the liquid and collects the precipitate and dries it.

The experiments of Mr. Charwin prove,

1st. That his green colouring matter is of the same nature as the Chinese *lo-Kav*, and will dye silk in as beautiful a green as the *lo-Kav*.

2nd. This matter is extracted from an indigenous plant, the *Rhammus catharticus*.

3rd. That the process will permit its manufacture for dyers at the price of 37s. per pound.

ON JAPANESE PAPER.

BY P. L. SIMMONDS.

Extensively as paper is employed in Japan, we are not yet thoroughly informed as to the materials of which it is manufactured. A large portion is, we know, made from a species of mulberry, to which Von Siebold has given the name of *Broussoneti Kaminoki*. Whether this is a distinct species from the *Broussonetia papyrifera*, the bark of which is used for making paper in China, or only a variety, is not yet clear. Some young trees of the Japan mulberry are, however, said to have been introduced recently into the gardens of the Acclimatisation Society of Paris. The tree might be grown in various parts of Europe and America, if the culture were remunerative enough in the yield of bark. It prefers a strong soil, especially of a calcareous nature, and should be planted at intervals not exceeding three feet; otherwise the branches would extend, whereby the bark would become full of knots, causing much loss of substance in the manufacture. The soil is not manured until the second year; in the autumn of that year the plant is lopped close to the root; and this operation, as well as that of manuring slightly, is repeated every second year. 100 lb. of branches thus obtained, stripped of their leaves, yield 10 lb. of bark. The branches, on arriving at the manufactory, are put into hot water for half an hour; the bark can then be easily stripped off by the hands, and is afterwards left in the sun to dry. It is next macerated for three days in river water and bleached in the sun. These operations having been several times repeated, the bark is at last boiled in a lye of ashes for the space of three hours, then manipulated for some time to separate any epidermis that may have remained ; and lastly, when dry, the mass is pounded fine and made into a pulp with water, to which a glutinous liquid extracted from a shrub called Nebooicko—probably the *Acacia Nemu*—is added in the proportion of about two pints per cwt. of pulp. The latter is then made into sheets much in the usual way. Sir Rutherford Alcock states that the barks of different shrubs are used, and his collection in the International Exhibition of 1862 contained some 60 or 70 kinds of paper, with the various applications for pocket-handkerchiefs, bank-notes, printing and room-paper, waterproof clothing, imitation leather, &c.

In Kœmpfer's "Amænitates exoticæ," there is an account of the mode of preparing Japanese paper, which very much resembles the Chinese. The plants used for the purpose are there called *Kaadsi.* The botanical description of Kœmpfer is *Papyrus fructi mori celsæ, sive morus sativa, folis urticæ mortuæ, cortice papyrifera.* According to this description, the plant cannot be other than the paper mulberry tree, which, as already remarked, is very like the *ku-chu* of the Chinese.

Every year, after the fall of the leaves, the young shoots, already rather thick, are cut off in lengths of three to four feet, and made up into bundles in order to be boiled in soda ash. They are tied together and placed upright in a very large and closely covered vessel. The boiling is carried on until the bark loosens and the wood is left bare. It is then allowed to cool, and the wood split, in order to remove the whole of the bark, which is then put into water from three to four hours. When the bark is sufficiently tender, the black skin is scraped off, and at the same time the annual bark is separated from the bark of those branches which are not yet so old. The youngest bark gives the finest and best paper. That made from the older bark is blackish, but not unpleasant. Bark more than a year old must be thrown aside, as it yields a very coarse paper. Parts which are knotty, thick and otherwise faulty, are also picked out, and very ordinary paper made therefrom.

When the bark is duly arranged according to its different qualities, it is boiled in ley, and during the boiling is stirred with a thick rod, occasionally adding fresh ley to prevent its boiling over, and to replace the loss by evaporation. The bark is allowed to boil until it can be rubbed to pieces between the fingers, and forms a paste. To make the ley, two pieces of timber are set crosswise on a tub, and covered with straw, upon which are placed wood ashes, over which boiling water is poured.

The bark, after boiling, is taken out of the vessel and washed. This washing is a delicate operation, as it must not be carried too far. If the stuff is only slightly washed, the paper is strong and firm, but coarse, and of little value ; if it be too much washed, the paper is beautifully white, but weak, runs, and is useless for writing. Experience only teaches how the washing is to be done, which must be in running water. The stuff is thrown into a strong basket, through which the water only can pass, and continually agitated until it is sufficiently pure.

To make fine paper, the stuff is washed twice, but in a cloth instead of a basket; for the more it is washed, the more the bark disunites, and the greater the loss. In the process of washing, the knots and other extraneous substances are, as much as possible, removed.

When the stuff is sufficiently washed it is thrown on a strong, smooth wooden table, and beaten by two or three men with sticks, and a hard wooden implement called "kusnocki," until it is as clean as paper. It is now put in water and stirred until it forms a paste. The paste is washed in a tub, into which is then poured a slimy and glutinous fluid, prepared by steeping rice and the root *Oreni* (*alhea radice viscosa, Flore ephemero magno puniceo*) in water. The mixture is stirred with a rod until the three substances are well mixed, and form a liquid and uniform paste. The sheets are then made on forms, which consist of rushes. Nothing now remains but to dry the paper. The sheets are laid on a table covered with a mat, and between each sheet there is placed a board called kama-kura, that is, cushion. This board, somewhat larger than the sheet, is of use to remove the sheet subsequently. Each heap is also covered with a mat, upon which a board is laid, and gradually a heavier weight, in order to press out the water. The next day the weight is removed, and one sheet after another lifted with a rod and placed on a thin board, to which it is made to adhere by hand, and then placed in the sun. The thoroughly dried sheets are collected, cut, and taken to the warehouse.

The steeping in rice water makes the paper white and strong. This size is prepared in a glazed earthen pot, in which the grains of rice are soaked in water. The pot is at first slowly shaken, afterwards more quickly, then cold water is added, and the whole strained through a cloth. The remaining rice is put in fresh water, and the process repeated so long as the rice gives a glutinous matter. Japan rice is excellent for this purpose, as it is the whitest and most glutinous of Asia.

The liquid from *Oreni* is prepared by putting the cut and bruised root in water. In twelve hours the water is glutinous. According to the season of the year more or less of this liquid is used, and the whole art of making good paper depends upon the quantity of *Oreni* used.

The coarse paper for packing purposes is prepared in the same way from the bark of the shrub *Kadse-kadsura*, which Kœmpfer calls, "*papyrus procumbens, lactescens folio longe-lanceato, cortice cartaceo.*"

Japan paper is strong, made in large sheets, and so much like linen that it may be mistaken for it.

Dr. Hawk describes the process much in the same manner. In December, he says, after the tree has shed its leaves, they cut off the branches about three feet in length, and tie them in bundles. They are then boiled in a lye of ashes in a covered kettle, till the bark is so shrunk that half an inch of the wood may be seen projecting at either end of the branch. When they have become cool, the bark is stripped and soaked in water three or four times, until it is soft, when the fine black skin is scraped off with a knife. The coarse bark is then separated from the fine; that from the young branches make the finest paper. The bark is boiled again in fresh ley, continually stirred with a stick, and fiesh water from time to time added. It is then put in a sieve and taken to a brook, and here the bark is incessantly stirred till it becomes a pure pulp. It is now thrown into water and separates in the form of meal. This is put into a small vessel with a decoction of rice and a species of *Hibiseus*, and stirred until it has attained a tolerable consistence. It is then poured into a large vessel from whence it is taken out and put in the form of sheets on mats or layers of grass straw; these sheets are laid one upon another with straw between, and pressed to force the water out. After this they are spread upon boards in the sun, dried, cut, and gathered into bundles for sale. This paper will better endure folding and last longer than ours.

THE ECONOMIC PRODUCTS OF THE PALMYRA PALM.

BY WILLIAM FERGUSON.

The *Borassus flabelliformis* is one of those palms enjoying the widest geographical distribution. A glance at one of the maps in Berghaus's or Johnston's Physical Atlas, showing the range of the most remarkable plants, will help to illustrate this fact.

The number of uses for which the Palmyra is employed may be said to be almost infinite; indeed one of the Eastern languages, the Tamil spoken in a portion of the region which the tree acknowledges as its native country, possesses a poem entitled "Tala Vilásam," enumerating no fewer than 800 different purposes to which the Palmyra may be applied, and this poem by no means exhausts the catalogue.

Fruit.—The spadix bearing the fruits is generally simple, and covered with a single sheath or spathe as in the *Areca Catechu* and cocoanut palms, but it is sometimes compound and bearing two bunches of fruit in a compound spathe. The fruits are with beautiful regularity, arranged round the spadix in three rows, and whichever way examined, are found in nearly opposite pairs. Each spadix bears from ten to twenty fruits, and one of these spadices, with the fruits ripe, would be nearly as much as a man could carry. Each palm bears seven or eight of these spadices, so that a tree often bears about 150 fruits in one season; each fruit is about the size of a young child s head. The fruits, when young, are pretty distinctly three cornered, but when old, the pulp round the nuts so swells as to give the fruit the appearance of a perfect globe.

The ripe fruits or drupes contain two or three nuts embedded in a mass of soft yellow pulp, intermixed with dark straw-coloured fibre or coir. These nuts are oblong, and a good deal flattened, and covered with a mass of short fibre which adheres to them. Besides this fibre they are covered with a thick shell, so difficult of fracture that the Tamils say an elephant cannot break them.

Leaves or Fronds.—The fronds are fan-leaved, armed with spines radiating from a common centre, and the stipes serrated at their edges. The fan part is about four feet in diameter. It answers as a kind of umbrella when held by the stem over one's head. The spines are cut off and the middle is formed into large fans called vissaries and punkahs. These are lacquered for sale, or used plain as may suit the taste of the purchaser, but one never sees a Budhist priest without one of the smaller sort, or a fan of some kind or other; of which some are heart-shaped, others circular with handles of carved ivory.

The leaves of this tree as well as those of the talapat tree are used instead of paper by the natives. They write letters upon them, which neatly rolled up, and sometimes sealed with a little gum lac, pass through the post office. During the operation of writing, the leaf is supported by the left hand, and the letters scratched upon the surface with the stylus. Instead of moving towards the right hand which performs the writing, the leaf is moved in a contrary direction by means of the thumb.

All their olas or books treating of religions and the healing art, &c., are transcribed on them, but in a language elevated above the common idiom. The leaves of both these palm trees lie in folds like a fan, and the slips stand in need of no other preparation than merely to be separated and cut smooth and even with a knife, after having been slowly dried in the shade and rubbed with oil. Their mode of writing upon them consists in carving the letters with a fine pointed style, and in order that the characters may be the better seen and read, they rub them over with an ink made of lamp black, or some other substance, and a solution of gum, so that the letters have altogether the appearance of being engraved.

The iron point made use of on these occasions, is either set in a brass handle, which the Moormen and others carry about them in a wooden case, and which is sometimes six inches in length, or else it is formed entirely of iron, and together with the blade of a knife designed for the purpose of cutting the leaves and making them even, set in a knife handle common to them both, into which handle it shuts up, so that it may be carried by the owner about with him, and be always ready at hand.

On such slips all the letters and edicts of the Dutch Government used to be written, and sent round open and unsealed. When a single slip was not sufficient, several were bound together by means of a hole made at one end, and a thread on which they were strung. If a book had to be made for the use of the Wihares or any other purpose, they sought for broad and handsome slips of talapat leaves, upon which they engraved the characters very elegantly and accurately, with the addition of various figures delineated upon them by way of ornament. All the slips had then two holes made in them, and were strung upon an elegantly twisted silken cord, and covered with two thin wooden boards. By means of the cord, the leaves are held even together, and by being drawn out when required for use, they are separated from each other at pleasure.

In the finer binding of these kind of books, the boards are lacquered, the edges of the leaves cut smooth and gilded, and the title is written on the upper board ; the two cords are by a knot or jewel, secured at a little distance from the boards, so as to prevent the book from falling to pieces, but sufficiently distant to admit of the upper leaves being turned back while the lower ones are read. The more elegant books are in general wrapped up in silk cloth, and bound round by a riband in which the Burmese have the art to weave the title of the book. The palmyra books are never much beyond two feet in length and two inches in breadth, as the parchment-like ribs between the little ribs will not admit of their increase in size.

Narrow strips of the leaf are braided into winnows, hats, and caps, baskets, mats, and bags ; the baskets are used for drawing water as well as other purposes, and the bags not only for carrying rice, salt, &c., in small quantities, but for storing grain, being made very large and strong, while the mats are necessary for the natives, not only to sit, eat, and sleep on, but for drying various kinds of fruit, treading out this grain and many other purposes. On the stem of the leaf is a very hard and strong covering like that on the bamboo or rattan, which slit off is formed into coarse strong ropes.

Each tree has from twenty-five to forty fresh green leaves upon it at a time, and of these the natives frequently cut off twelve or fifteen annually, or a greater number once in two years, to be devoted to various purposes, as well as with the view to enable the fruit to ripen and increase in size. When the leaves are intended for thatch, or for making fences, they are placed flat on the ground in layers over each other, and often with weights upon them to assist in the process of flattening them. The thatch formed of these does not last longer than two years, nor is it so handsome as that made from the plaited cocoa-nut leaves. The leaves make very close and elegant fences.

Toddy.—At the season when the inflorescence begins to appear, when the spathes have had time to burst, the "toddy-drawer" is at work in the palmyra groves. His practised eye soon fixes on those trees fit for the "scalping knife," and if they have not dropped the foot stalk of the leaves, the first operation, if the trees are valuable, is to wrench them off. This done, the toddy-drawer, armed with his leathern protector for his breast, his raceme-batten of wood, his small thongs, straight and crooked knives, with the side leather pouch to contain them, procures a piece of tough jungle vine, or a strip of the stalk of a young palmyra or cocoa-nut tree, which he converts into a sort of loop, of such dimensions as to admit of his feet getting through to a space large enough to allow them to clasp the tree. This done he puts his feet in this thong, stands close to the tree, stretches himself at full length, clasps it with his hands, and pulls his feet up as close to his arms as possible; again he slides up his hands, and repeats the process, until by a species of screw process, he ascends to the summit of the tree.

An expert climber can draw toddy from about forty trees in a few hours. In Jaffna a distinction is made between toddy and sweet toddy, the former called by the Tamils "culloo" is the fermented, the latter the unfermented juice.

Toddy serves extensively as yeast, and throughout Ceylon no other is employed by the bakers; large quantities of it are also converted into vinegar, used for pickling gherkins, limes, the undeveloped leaves of the cocoa-nut, and palmyra trees, and other substances; but by far the greatest quantity is boiled down for jaggery or sugar. About 1,000 tons are said to be manufactured of it in Ceylon.

According to Forbes three quarts of toddy will make 1 lb. of jaggery. Malcolm remarks that jaggery resembles maple sugar, and that in the neighbourhood of Ava, one pound sells for the third of a penny. In Jaffna 3 lbs. are sold for 2d. The usual process of making jaggery, as pursued at Jaffna is exceedingly simple. The sweet toddy is boiled until it becomes a thick syrup, a small quantity of scraped cocoa-nut kernel is thrown in that it may be ascertained by the feel if the syrup has reached the proper consistency, and then it is poured into small baskets of palmyra leaf, where it cools and hardens into jaggery. In these small plaited palmyra baskets it is kept for home consumption; sent coastwise, chiefly to Colombo, or exported beyond seas to be refined. To make vellum or crystallised jaggery, which is extensively used as a medicine, the process is nearly the same as for the common sugar, only the syrup is not boiled for so long a period.

The pot which contains it is covered and put aside for some months, at the end of which period the crystals are formed in abundance. The juice of the palmyra is richer in saccharine matter than that of most other palms, in consequence, perhaps, of the tree more generally growing in dry sandy soil and in a dry climate. The great fault of the jaggery made at Jaffna seems to arise from the too free application of lime, a small quantity of which is absolutely necessary to prevent fermentation. Jaggery forms an article of commerce from the upper to the lower provinces of Burmah, and is also of importance in some of the islands of the Indian Archipelago. Besides being exported in large quantities from Ceylon forms a considerable portion of the food of the Tamil people of Jaffna. Amongst a variety of purposes to which it is put, is that of being mixed with the white of eggs and with lime from burnt coral or shells. The result is a tenacious mortar, capable of receiving so beautiful a polish that it can with difficulty be distinguished from the finest white marble.

Timber.—A full grown palmyra is from sixty to seventy feet high; its trunk at the bottom is about five and a half feet, at the top two and a half feet in circumference. Its wood is generally known in Ceylon and the maritime ports of India. Large quantities of it are exported from Point Pedro and other ports of Jaffna to Madras and Colombo. At certain seasons of the year, the felling, splitting, dressing, and exporting of it give work to thousands of the Tamil people of the northern peninsula of Ceylon. The trees have to arrive at a considerable age before they are of use for timber; when a hundred years old they are excellent. The wood of this palm near the circumference, when of sufficient age, is remarkably hard, black, heavy, and durable, and universally used for rafters in pent-roofed houses, for which purpose Roxburgh states it is the best wood in India. The centre is soft and spongy, containing little else than a coarse kind of farinaceous matter, intermixed with some soft, white woody fibres and is cut out, as the black exterior hard part only is employed. The wood is capable of taking a fine polish. Its specific gravity is, according to Mr. Mendis, sixty-five pounds per solid foot. For house building and various domestic purposes, the timber is the most generally used of the palm tribe. Pillars and posts for the verandahs of houses, well-sweeps, joists, and reepers or laths, &c., are made from it. The trunk is split into four for rafters, into eight for reepers, and these are dressed with an adze. From the structure of the fibres, it splits easily in the direction of its length, but supports a greater cross strain, than any other wood; iron nails, however, will rust rapidly in it.

Palmyra trunks split into halves, with the heart scooped out, are used as spouts for various purposes, but more especially for carrying away the water from the eaves of houses. The dark outside wood of very old trees is used to some extent in Europe for umbrella handles, walking canes, paper rulers, fancy boxes, wafer stamps, and other articles.

Kelingoes.—The nuts are collected and buried in heaps in the ground. When dug up after the space of three months, the young shoots called kelingo supply the inhabitants with a nourishing aliment. In size, colour, and shape they resemble a parsnip, and look like a cold potato. In its fresh state it will keep good for a couple of months, and when well dried in the sun, for a whole year. In this state they are called odials. When reduced to flour or meal, the favourite *cool* or gruel is made of it.

Punatoo.—The pulp of the fruit is preserved for use in the following manner. The ripe fruits are put into old baskets containing water, and are then squeezed by the hand till the pulp forms a jelly. Layers of this jelly are spread on palmyra leaf mats to dry on stages. Layer after layer is deposited to the number of about fifteen. These are left in the sun about a fortnight or three weeks, only covered at night, and protected from the dew and rain. The best sort is called Pimatos, and the tough withery kind made from the remaining fruits gathered at the end of the season, which is much in favour, *Tot Punatoo.* Punatoo is sold by the mat at 3s. to 6s. each (about 1,000 pints of three nuts each being sufficient for a mat), and is the chief food of the islanders of Ceylon, and of the poorer classes of the Peninsula, for several months of the year.

Reviews.

A Treatise on Sugar Machinery, &c. By N. P. Burgh, Engineer. E. and F. N. Spon.

This is a most valuable work on a subject on which but little has hitherto been published. The manufacture of sugar machinery in this country rests in very few hands, and there has been a disposition to withhold rather than to furnish any information to the public, unless it were some specific inquiry as to the cost of parts of machinery. Mr. Burgh's work comes, therefore, most opportunely, looking at the high prices of sugar, and the steady extension of cultivation in the East and West Indies, the Mauritius, Natal, Brazil, and other quarters. It treats of the processes of producing sugar from the cane, and refining moist and loaf sugar, home and colonial, as well as the practical mode of designing, manufacturing, and erecting the machinery, together with rules for the proportions and estimates. The estimates given are very full, clear, and explicit on all points of cost for the minutest article. Crushing mills, boilers, clarifiers, heaters, pumps, tanks, vacuum pumps, receivers, centrifugal machines, charcoal-burning furnaces, and retorts, are all figured and described in four single and twelve folding plates.

Mr. Burgh's work will be equally valuable to the producers and refiners on the Continent, as to the sugar planters of the two Indies, Natal, and Louisiana, and the refiners of New South Wales, Victoria, and America. The whole getting up of the work is admirable, and will command for it a ready sale in all quarters interested in sugar production.

PETROLEUM AND ITS PRODUCTS. By A. Norman Tate, F.C.S. London: J. W. Davies.

The trade in petroleum has already attained to such a magnitude, that Mr. Tate has done good service to the public in issuing this treatise, which gives an account of its history, origin, composition, uses, and commercial value, the methods employed in refining it, and the properties, uses, &c., of its products. Mr. Tate has dealt with the subject thoroughly and exhaustively in all its branches, and his little work may be recommended as a reliable hand-book for all interested in this substance.

THE GHOST AS PRODUCED IN THE SPECTRE DRAMA, &c. By H. Dircks, C.E. E. and F. Spon.

Mr. Dircks has, we think, been ill-advised in thrusting so much of his private quarrels in the matter of the ghost apparatus before the public. More than one-half of this little book of 100 pages is taken up with details and extracts from correspondence, and remarks upon the manner in which he has been treated. It would seem that the right of representing his phantasmagoria inventions was freely presented by him to the Polytechnic Institution, and what Mr. Dircks complains of is, that his name as the inventor has been almost generally withheld, and that having been thus liberal to the Institution, common justice demanded, that at least the honour, when honour was due, should have been awarded. This appears to be the sore point. The book before us, divested of this personal discussion, would have been interesting enough; for Mr. Dircks not only gives us the benefit of all his progressive discoveries in the matter, from the paper first read at the British Association Meeting at Leeds, in 1858, to the more recent improvements, with full explanations of the machinery, apparatus, and processes adopted in these ghost dramas, and further favours the public with a number of new adaptations. As a curious description of these spectral illustrations, the book is most interesting.

THE COLOURING MATTERS DERIVED FROM COAL TAR. By Prof. H. Dussauce. Philadelphia; Baird.

A useful compilation of the most important and recent information relative to the coal dyes now so extensively used. The several colours, and the practical mode of employing them, are specifically given, and the theory of the fixation of colours and mordants popularly explained.

An Inquiry into the Nature of Heat, &c. By Zerah Colburn. London: E. and F. Spon.

The author considers that the prevalent hypotheses respecting the nature and precise mode of action of heat are unsatisfactory, and, therefore, advances opinions and theories of his own. The subject is one of great interest to all who have to do with the question of steam, the preparation of metals, or any of the other various and important industrial applications of heat. We quote the following extract:—

"Heat is supposed to be extruded from irom by hammering it, until it is red-hot, upon an anvil; thus (bearing in mind that we are all along dealing with a supposition) savages obtain fire by rubbing sticks of dry wood together; thus Desaigues, by subjecting fluids to strong pressure, rendered them luminous; thus compressed air inflames tinder; thus the heads of wooden piles sometimes burst into a blaze under the heavy and rapid blows of a steam pile-driving engine; thus a cannon-shot, striking an iron armour plate, often throws off a flash of fire, and is afterwards found to be too hot to be handled; thus the turning, boring, drilling, planning, and polishing of metals are attended with the development of heat; thus the agitation of the sea in a storm is found to have warmed the water. The same effect being produced also by the compression of water in an hydraulic press; and thus, in short, heat is supposed to be extruded wherever friction or compression takes place; and, indeed, wherever atoms of ordinary matter of any kind approach each other.

"The separation of material atoms cannot, upon the same supposition, be effected except through the agency of heat or electricity, which latter appears to be a linear form of heat, acting in definite directions only, and not in the contagious and diffusive manner of so-called "solar" heat and the ordinary heat of combustion."

PUBLICATIONS RECEIVED.

Enquete sur le Commerce et la Navigation de l' Algerie (Alger Bastide).—A familiar Epistle to Robert J. Walter (Saunders, Otley, and Co.)—Skin Diseases and their Cure, by a Diathetical Treatment. By Edwin Payne, M.D. Renshaw.

THE TECHNOLOGIST.

THE TECHNOLOGY OF SOME OF THE PRODUCTS OF THE DISTILLATION OF COAL.

BY WILLIAM PROCTER, M.D., F.C.S.

Some years ago Dr. Ure wrote thus :—"There is not, perhaps, any waste article of our manufacturing industry which has been so singularly neglected as coal-tar, and yet there can be but very few which offer anything like so fair a field for the exercise of skill and ingenuity." At the present time what a different state of things exists ; for there is perhaps no substance which has been, and is being, so fully investigated as Coal-tar, or which has produced results so serviceable to the arts, manufactures, and domestic comfort, or which has shown more fully the value of science in suggesting plans for the utilization of waste substances. We have now large manufactories established solely for the production of Coal-tar, and substances capable of affording it are brought from most distant lands. It is a singular fact that every substance produced by the distillation of these coals, shales, bitumens, &c., has some valuable economic application. Although the illuminating oil is frequently the primary object of the manufacturer, the advance of Science has enabled him to utilize a large number of secondary products which would otherwise have been waste. It is to the consideration of these secondary products that this paper is to be devoted.

When coal-tar is submitted to distillation, a light oil or naphtha in the first instance passes over, then a heavy or dead oil, and, lastly, pitch remains behind in the retort. By distilling in this way there is obtained from 100 parts of coal-tar, about 9 parts of naphtha, 60 parts of dead oil, and 31 parts of pitch.

In a large number of places in various parts of the world, an inflammable liquid exudes, to which the term naphtha is applied, such as

Persian naphtha, Burmese naphtha, &c., but it is now more exactly applied to the light oil, which is the result of the action of heat in organic matter. NAPHTHA, and its chief constituent Benzole, has, on account of its numerous applications, become an important commercial article and one of special manufacture from coal, shales, or some of the natural tars or naphthas. The process by which it is procured from coal is of this kind. Tar obtained from coal at a comparatively low temperature, is placed in large iron stills and distilled by direct steam. The distillate constitutes "rough naphtha," is very impure and has a foul odour due to the presence of a large number of organic impurities; it contains basic and acid oils and neutral hydro-carbons. To remove these and purify it, the naphtha is transferred to large cylindrical vessels lined with lead; through them passes a vertical shaft capable of being rotated, furnished with blades pierced with holes. Sulphuric acid is now run into the vessel and mixed with the naphtha by rotation of the shaft. Most of the basic oils, &c., are absorbed, and the acid of a tarry consistence subsides to the bottom of the vessel and is drawn off. When the naphtha is required to be highly rectified, it is a second time treated with the acid. The naphtha still retains in solution the acid oils, some sulphuric acid as well as sulphurous acid produced by deoxidation. To remove these substances and effect further purity, the naphtha is treated with caustic soda in an apparatus similar to that used for the acid. The liquid is then distilled and constitutes the *Coal Naphtha* of commerce, and is mainly composed of a series of hydro-carbons, of which Benzole constitutes the larger part. *Benzole* or *Benzene* (C_{12} H_6 or C_{12} H_5, H Hydride of Phenyl) is at ordinary temperatures a clear colourless liquid with a somewhat fragrant odour, and at 32° freezes to a white substance like camphor. Its sp. gr. is 0.85, if it is lower, impurity or adulteration is indicated. Benzole was discovered in 1828 by Prof. Faraday during some investigations into the nature of oil gas, and was prepared artificially by Mitscherlisch, by the distillation of Benzoic acid with lime. It boils at 177°, and this being a lower temperature than the hydro-carbons with which it is associated in naphtha, pass into vapour, affords a ready method of separation by fractional distillation On these principles the benzole is separated from the naphtha in an ingenious apparatus devised by Mr. Mansfield; it consists of a metal still of about two gallons capacity. A worm passes from the top of the still through a closed cistern full of water, and communicates with a discharge pipe connected with a condensing apparatus. Naphtha being placed in the vessel and heat applied, nothing comes over until the water in the cistern reaches 177°, Benzole is then condensed. The pipe being surrounded with water can never attain a temperature higher than 212°, the result is that all the hydro-carbons as toluol, cumol, cymol, &c., which are not volatile at 212° are condensed and fall back into the still, a second distillation keeping the head at 180° or 190° produces an extremely pure article. The residue which is left in the still is by no means valueless, and is adapted for nearly all the purposes for which ordinary coal naphtha is applicable. If Benzole is required free from all admixture, it must be frozen and placed in a funnel that the impurities may drain away.

Although equally well adapted for many of the economic purposes for which they are used, Benzole has these advantages over Naphtha, the odour is less unpleasant and, being more volatile, it is more rapidly and effectually removed by evaporation. Under the name of Benzine Collas, Sherwoodole, &c., Benzole has been extensively used to remove grease and fatty matters from all textile fabrics, and Mr. Calvert has made such application the subject of a patent, and cites a large number of purposes for which it is adapted. In order to remove grease, etc., from these articles, if small they are simply rubbed with it ; but on a large scale, they are put into a suitable vessel and the naphtha is run in ; after a time it is drawn off and the fabrics are submitted to pressure to remove as much as possible of the adhering liquid. After being used in this manner the naphtha or benzole is not wasted, but is freed by distillation from the greasy matters which it has dissolved, and which may be utilized as a lubricant for machinery, etc. The powerful solvent properties which Benzole possesses over a large class of resinous substances has given to it an extensive economical application. It is one of the materials used for the solution of caoutchouc in the manufacture of Macintosh waterproof articles. One method of making vulcanised India-rubber consists in rubbing caoutchouc softened by naphtha with sulphur and heating to 320°. It dissolves gum mastic, etc., camphor, wax and essential oils with great facility, and for some of these purposes is becoming an important agent in the researches of organic chemistry. Some resins such as copal, etc., which are only slightly acted upon by the liquid, dissolve readily in the vapour at its point of condensation, hence its probable utility for varnish purposes. A cheap polish and furniture paste have long been made with naphtha, and also a cheap varnish with gum dammar. But in this direction the light spirit procured during the distillation of petroleum, etc., for illuminating oils, promises to be of great service. The presence of these light oils is detrimental to the goodness of the heavier oils used for illumination, inasmuch as the presence of the former is the cause of the explosibility often possessed by the latter. Obtained during rectification they were at first looked upon as little more than waste products, but lately have been introduced into commerce under the name of turpentine substitute, turpentole, etc. The recent high price of turpentine has caused a great demand for the article as a substitute in preparing paints, common varnishes, etc.

Benzole is one interesting point in the passage of coal to colour, and is dependent upon the peculiar action which nitric acid exercises upon it, having as its result the production of Nitro-Benzole ; other chemical agents convert this fluid into Aniline, the basis of the larger part of the beautiful coal-tar dyes (TECHNOLOGIST, vol. ii. p. 428). Having the peculiar odour as well as flavour of oil of bitter almonds, nitro-benzole forms an efficient substitute for that substance both as a flavouring and perfume, and is often sold for such purposes under the name of essence of mirbane. For culinary uses nitro-benzole has the great advantage of being innocuous whilst the oil of bitter almonds is a deadly poison.* Its chief application as a perfume is in soap-making, and for this purpose it is found to be better adapted than the true oil.

Both Benzole and Naphtha are highly inflammable, burn with a dull, smoky flame, but in a properly constructed lamp they yield on combustion a cheap and brilliant light. Some years ago naphtha was extensively used, being burnt in a lamp of similar construction to the paraffine lamps, or in a state of vapour as Holliday's lamp. But on account of the extreme volatility of naphtha, and the property which the vapour has of forming an explosive mixture with atmospheric air, leading to serious accidents, the use of this substance is completely superseded by the various paraffine oils, except in the instance of the flaming and smoky light used at our markets and fairs: mixed with alcohol, naphtha constitutes an efficient burning fluid, and is largely used on the Continent where spirit is cheap. Some such compound has, I believe, lately been proposed to take the place of oil for lighting railway carriages, the liquid being burnt in a state of vapour by an appropriate arrangement.

Ordinary coal gas when transmitted through naphtha or benzole receives a considerable addition to its illuminating powers. Mr. Lowe upwards of twenty years ago first suggested and patented this method. He passed coal gas through a rectangular box containing trays of naphtha; in passing over it the gas became impregnated with the hydrocarbon. He calculated that 1,000 cubic feet of naphthalised gas were equal in illuminating power to 2,000 cubic feet of ordinary gas, and that the saving to the consumer by adopting his process was twenty-five per cent. Within the last year or two this plan has been adapted to many of the London street lamps, and has been made a subject of special investigation by Dr. Letheby. He says, for this purpose the naphtha must be colourless and of a sp. gr. not less than 0·830, and not more than 0·860, and should yield 70 per cent. of volatile naphtha at 266°, and 20 per cent. at 302°. This gives continuously eight grains of hydro-carbon to each cubic foot of gas, and raises the illuminating power 60 per cent. over the unnaphthalised. A company has lately been established in this country to carry on the naphthalising of gas as well as to burn it in a state of vapour mixed with air, under the name of the atmospheric light. The latter plan of lighting was tried some years ago in America and abandoned, I believe, on account of its impracticability. The plan is to drive a current of air by

* That nitro-benzole in food is innocuous is questionable from several recent cases that have come before the public.--EDITOR.

means of machinery (that used in America was the motive-power of a descending weight) through a vessel of the hydro-carbon, kept slightly warm to assist evaporation; the air saturated with the vapour is then burnt as gas. It is by no means probable that this light will, as it is stated, supersede coal gas, for below a certain temperature the air will not carry sufficient vapour to furnish a good light, and in cold weather the benzole condenses in the pipes, and the liquid itself requires the application of heat.

Inspired in a state of vapour benzole possesses anæsthetic properties, and, like chloroform, produces insensibility to pain; but it has not come into general use for this purpose, unpleasant symptoms having displayed themselves on several occasions in those who have taken it. It has been employed medically with success as an external application in some affections of the skin; for itch I have found benzole an effectual and speedy remedy.

On many occasions and for many reasons the detection of benzole is frequently a matter of importance. Dr. Hofmann has furnished us with a ready method of detecting it. The liquid to be examined is warmed in a test-tube with fuming nitric acid, it is then diluted with water, and shaken up with ether, which dissolves the nitro-benzole formed. The ethereal solution is separated by a pipette and mixed with an equal volume of alcohol and hydrochloric acid, and granulated zinc is then added. After five minutes the mixture is saturated with potass and shaken up with ether and the ethereal solution being evaporated on a watch-glass, the addition of a drop of a solution of chloride of lime strikes the purple colour indicative of aniline.

Carbolic Acid ($C^{12} H^5 O, H O$), called also Phenol and Phenylic acid is another important product of the distillation of coal. When those portions of the acid of coal-tar which distil between 300° and 400° are mixed with a hot solution of potash, a crystalline mass results, which is resolved by water into a light oil and heavy alkaline liquid, when the latter is neutralized by hydrochloric acid, the impure carbolic acid separates as a light oil. This is purified by the action of chloride of calcium and distillation, exposed to a low temperature, and the crystals formed drained from the mother liquor and carefully preserved from air. The crystals are colourless and deliquescent, fuse at 95° and pass into vapour at 370°. Carbolic acid has an odour of creosote, in fact a great deal of the creosote met with in commerce is only carbolic acid more or less impure. It is one great cause of the offensive odour of some coal oils.

The disinfecting power of coal-tar has long been known, a property which is due to the carbolic acid. It belongs to that class of colytics known as antiseptics, whose action is to prevent putrefaction by arresting it in a singular way, without destroying the organic matter, but at the same time do not allow decay to go on. Injected into the bodies of animals, it preserves them unaltered in contact with the air, and

M. Lemaire says that a human body can be preserved with less than fifty centimes of it. The best mode of using it as a disinfectant is a mixture of sulphite of lime and carbolate of lime; this constitutes "M'Dougall's disinfecting powder." In such a combination the carbolic acid prevents putrefaction, and the sulphurous acid acts as an ordinary disinfectant, according to Schonbein, in the act of taking one part of oxygen to itself converts another portion into ozone, which produces the disinfecting result. The manufacture of disinfectants has now become a regular and large one, and is carried on by Mr. M'Dougall, near Oldham. He uses the powder to prevent decomposition in stables, cow-houses, or in any accumulations of putrescible matter, and generally for the prevention of decomposition in manures. The solution is employed in dissecting-rooms for the destruction of the noxious smell. A liquid is also prepared with carbolic acid and lime water, which is applied to destroy the bad effects of sewers, and acts by stopping the generation of gases in sewer water, or in any accumulation of animal refuse. The liquid is likewise adapted to prevent the decomposition of meat brought to market, or of dead animals.

Carbolic acid has considerable power of producing colour, and by the action of various chemical agents upon it, valuable blue, red, and yellow dyes have been made. This property may be shown by dipping a piece of deal wood in carbolic acid and then into nitric acid, when it acquires a blue colour; mixed with ammonia and chloride of lime carbolic acid becomes blue, whilst if mixed with sulphuric acid and added to perchloride of iron, the liquid assumes a purple hue. Mixed with lime and exposed to the air, it yields rosolic acid, and a rich red colour is produced. An interesting circumstance connected with this fact was mentioned by Mr. Calvert at the Meeting of the British Association at Aberdeen, showing the value of science to commerce. It was noticed that large quantities of the calico sent to India became of a rose colour, and therefore unmarketable, thereby both in the cost of shipping and injury of the article entailing a heavy loss to the manufacturer. Mr. Calvert investigated the matter, and found that the staining was due to rosolate of lime, the formation of which he traced to the following cause. The bales of cotton were protected from wet by a waterproof felt, in the manufacture of which a solution of gutta percha in impure coal naphtha had been used. Under the influence of the warm and damp atmosphere of India, the carbolic acid became volatilized, and coming into contact with the lime in the calico, was converted into rosolate of lime. The discovery of the cause in this manner prevented any similar accident again happening. Rosolic acid is produced by the action of oxalic and sulphuric acids on carbolic acid, and constitutes one of the dyes mentioned as attainable from the latter substance. This action gives rise to the production of a beautiful red solution, but by reason of the alteration which light produced upon it could not for a long time be made available as a dye; another obstacle was the impossibility of fixing it to constitute a fast colour. Lately these difficulties have been overcome by Guinon, who by combining this substance with ammonia, has produced a beautiful permanent dye, used largely for printing muslins, and known under the name of peonine. That the introduction of nitrogen in this manner endows non-azotised vegetable substances with a power of fixation, and likens them in this respect to animal substances, is a highly interesting scientific fact. The yellow dye afforded by carbolic acid is the result of the action of nitric acid upon it, and its conversion into Picric acid, which is deposited in yellow crystals. Picric acid is also known under the names of Carbazotic acid and Nitrophenic acid, and was introduced for dyeing purposes about six years ago by Messrs. Guinon, Marnas, and Bonny, of Lyons. The colouring property is very considerable, one part of the acid in 300,000 parts of water communicates a yellow tinge to the liquid. All animal fabrics are dyed with facility of a brilliant yellow and fast colour, one part of picric acid in water with a little sulphuric acid gives 1,000 times its weight of silk a moderate yellow colour. Acted upon by the protoxide of iron, a red dye (picramic acid) is the result, whilst with oxide of copper it gives a yellow green dye. The blue dye, Azuline, is prepared by the action of Aniline on Peonine. On account of the property which picric acid has, of forming sparingly soluble salts with potash, it is used as a test with that alkali. Its well marked colour and bitter taste has caused it to be employed for mixing with some poisonous substances for the purpose of preventing accidents. Picric acid has medicinal properties, having anti-periodic powers similar to quinine. One great impediment to its administration exists in the fact that a yellow colour of the skin is produced in those to whom it is administered.

Mr. Bethell has proposed with great advantage the employment of oil of tar as a method of preserving wood and preventing decay in timber ; this power is in a great measure due to the carbolic acid of the oil. The protection is due to the prevention of absorption of moisture, to the coagulation of the albumen, to the general prevention of decomposition, and is at the same time so noxious to animal and vegetable life, that the attacks of insects are repelled, and the growth and propagation of fungi prevented. The mode of application consists in placing the timber in strong closed cylinders under pressure, similar to a steam boiler ; a vacuum is produced by an air-pump, and the hydrocarbon forced into the wood by a pressure of 150lbs. on the square inch. As much as 18lb. have been forced into a cubic foot. When a quantity equal to 10lb. to each cubic foot has been forced in, the process is complete. Railway sleepers prepared in this manner have been in use for twenty years, and at the end of that time found comparatively sound. It is said that by this process the common and softer woods, such as Scotch fir, are rendered as durable and firm as the best oak. The general use of this method of preserving wood on a large scale resolves itself into a question of cost.

Dr. Ashby, in the 'Mechanics' Magazine,' gives an entirely new application for carbolic acid, and thinks that it would be found useful in grinding, filing, boring, or sawing in metal work, on account of possessing that which he calls "pro-frictional powers," as opposed to the "anti-frictional powers" of oil, which keeps surfaces asunder by the interposition of a thin fine film, whilst carbolic acid seems to bring them together. The medicinal properties of carbolic acid have been lately highly spoken of in diarrhœa, and in obstinate vomiting, and in the proportion of one part to seven of water, has been used with great success as a local application to fetid, ill-conditioned ulcers, and speedily cures some skin diseases. It is said to be an effectual remedy for the foot-rot in sheep.

NAPHTHALINE ($C^{20} H^{8}$) is another product of the distillation of coal, and in cold weather condenses in the pipes in such quantities, that it has been called the gas-maker's nuisance. When pure it is a beautiful white crystalline substance, insoluble in water, but soluble in alcohol and ether. By the action of the strong acids, especially the nitric, a large number of substances of the highest interest to the chemist are produced. At present no economic application has been found for naphthaline, which the large quantity capable of being procured with facility renders very desirable, it is true that by the action of various reagents, purple, violet, yellow, shades of red and blue can be produced, yet on account of their fugitive nature and incapability of being fixed so far, they are not commercially successful for dyeing purposes.

PARAFFINE ($C^{20} H^{20}$) is a solid crystalline substance existing in small quantity in coal tar, but obtained for commercial purposes from the residuum of the distillations carried on for the manufacture of illuminating oils. After the lamp oil is separated, a heavy oil is left; this being submitted to a temperature of 30°, the paraffine solidifies, and is removed by pressure, the liquid oil being used for lubricating machinery, &c. After this separation the crude paraffine is purified by being submitted to the action of sulphuric acid and soda alternately, and then appears like spermaceti, being both tasteless and inodorous. The striking chemical character of paraffine is the indisposition it possesses to combine with other substances, and a power of resisting the action of the most powerful reagents. Nitric and sulphuric acids do not affect it at ordinary temperatures; the same is the case with the alkalies, chlorine, &c. The fat oils, the essential oils, and ether dissolve it readily, alcohol sparingly. Chemically it is solid olefiant gas, a fact which causes it to burn with a most brilliant, white, and clear flame. This latter property, coupled with a beautiful appearance and remarkable transparency, constitutes it a formidable opponent to wax and spermaceti in the manufacture of candles, over both of which it possesses considerable advantages in regard to transparency, high temperature of fusion, great illuminating power and freedom from grease. The transparency enables the manufacturer to produce coloured candles of paraffine with a quantity of colouring matter so small, that the burning properties are not interfered with by the introduction of a large quantity of incombustible materials found to be required with wax, &c. The coloured candles tinted, red, mauve, violet, crimson, &c., by the coal-tar dyes, and produced by the Messrs. Field in various designs, are really beautiful objects. The temperature at which this substance becomes fluid varies with the source from which it is obtained; that from Boghead coal fuses at 114°, that from Bitumen at 110°, whilst the paraffine from Rangoon tar requires a heat of 140° before it melts. A high melting point is an important matter in candle making; for under such circumstances the *well* which is formed at the base of the wick during burning, containing a supply of liquid matter ready to be drawn up by the wick for combustion, is preserved intact, and "guttering" obviated. Paraffine candles burn with a clear, white, smokeless flame. According to Dr. Letheby, weight for weight, the illuminating power is 22 per cent. greater than sperm, 40 per cent. greater than wax, 46 per cent. greater than stearine, and 58 per cent. greater than composite; or to estimate it in another way, the light produced by 98lb. of paraffine is equal to that of 120lb. of sperm, or 138lb. of wax, or 144lb. of stearine, or 155lb. of composite candles. According to Dr. Frankland, the cost of light in relation to other candles is, paraffine, 3s. 10d.; sperm, 6s.8d.; wax, 7s. 2d. Paraffine is now extensively used to supply the place of sulphur in dipping matches, thus remedying the suffocating odour produced by the formation of sulphurous acid when a lucifer is ignited. After the separation of these important substances with such manifold applications and uses, PITCH is left as a residuum, but not as a waste product. A comparatively recent application of it is, the conversion of small, almost valueless, coal into an excellent kind of coke. The pitch is ground and mixed with seven or eight parts of coal, and put into a cokeing oven, the vapour of the pitch becoming decomposed, deposits its carbon on the coke in the process of burning, which increases greatly the product from a given quantity of coal. A manufacture of patent fuel from pitch is also carried on largely near the coal beds of Wales, by grinding and mixing it with small coal, heating together, and then by great pressure moulding it into bricks, when a compact mass is formed in some respects superior to coal. The other applications of pitch consist in its use for asphalting roads and roofs; it is also employed in ship-building and in the preparation of lamp-black.

Such, then, are the most important points in the technology of the destructive distillation of coal, and few subjects are more extensive or more interesting. Abstruse scientific researches have given these valuable products to us, and made known and developed their wide application. The labours of Dr. Faraday into the nature of benzole may be looked upon as the starting point, and the further development is due to the industry of chemists of our own time. There is doubtless yet a mine of wealth to be explored, both in a scientific and commercial sense, capable of producing results probably as little expected, as at first was the appearance of our brilliant but well-known tar dyes.

OILS AND FATS.

BY CAMPBELL MORFIT.

Although some fatty bodies are very different from others in their chemical nature, and all of them differ from the essential oils, yet being often used in the same branch of manufacture indiscriminately, they may be embraced together as a class under the term *Oleics*.

By far the larger proportion of oils and fats agree in being composed of a fat acid, united to a base called glycerine. The three principal acids are stearic, margaric, and oleic; when stearate or margarate of glycerine predominate (the compound being called stearin or margarin), the fat is more solid, as tallow, suet, &c.; when oleate of glycerine (called also olein) is in sufficient quantity, the fat is fluid or oily, as olive oil. The chemical connection between margaric acid, which is a solid crystalline fat, and vinegar or acetic acid, and the connection between acetic acid and common alcohol, are pointed out in an essay published in the 'Journal of the Franklin Institute,' 1848. Now since formic, acetic, and valeric acids can be shown to be derived from wood-spirit, common alcohol, and fusel oil, which are their respective alcohols, we may infer that the higher fat acids have also their alcohols. The investigations of Brodie in wax seems to point out such alcohols and their acids. The general formula for this fat acid series, the most extended series yet developed in organic chemistry, is $C_n\ H_n\ O_4$, n being an even number. No well-defined connection has yet been established between other fat acids not belonging to this group.

According to Georgey ('Ann. der Chem. und Pharm.' lxvi.), the butter of cocoa contains the following acids:

Caproic	$C_{12}H_{12}O_4$
Caprylic	$C_{16}H_{16}O_4$
Capric	$C_{20}H_{20}O_4$
Pichuric (lauric, laurostearic)	$C_{24}H_{24}O_4$
Myristic (probably)	$C_{28}H_{28}O_4$
Palmitic	$C_{32}H_{32}O_4$

The *cocinic* acid of St. Evre is a mixture of capric and pichuric acids.

Gerhardt and Laurent have endeavoured to prove ('Comptes Rendus,' 1849) that the formula for stearic acid is $C_{34}H_{34}O_4$; that margaric acid is an isomeric modification of it, and should be called metastearic acid.

The train-oil of the Beaked Whale (*Balæna rostrata*) has recently been examined by Scharling ('Journ. of Prac. Chem.' xliii.), who gives it the formula $C_{62}H_{60}O^4$. It consists principally of a liquid fat, free from glycerine, a minute portion of spermaceti, and traces of other fats. Its specific gravity is ·8807 at 52°. It burns with a bright flame, and its illuminating power is in the ratio of 1.57 : 1 of common whale oil. It also burns slower and emits less smoke than the latter oil.

Mr. C. Watt, Sr. ('Newton's Journ.' 1848, and 'Ch. Gaz.' vi.), uses the following method for bleaching dark oils or tallow. To every half ton of oil, take ten pounds of bichromate of potassa. Powder the salt, dissolve it in four pints of hot water, stir, and carefully add fifteen pounds of sulphuric acid, and continue the stirring until complete solution. This mixture is then thoroughly incorporated with the melted fat, previously separated from foreign matters by repose and decantation. The containing vessels should be of wood, and the temperature about 130° F. When, after much agitation, the liquid fat assumes a light green colour, the bleaching is completed, four buckets of boiling water are then to be added, the whole stirred for five minutes, and left to repose for several hours, when it will be white and ready for use.

Mr. Watts, Jr., proposes to recover the chromic acid *ad infinitum*, and thus render the process very economical, in manner as follows. Transfer the green chrome liquor, after the separation of the fat, to a tub, dilute it with water, and then add thick milk of lime until the sulphuric acid is nearly saturated ; leave to repose, decant the liquor from the sulphate of lime, and carefully add to it another portion of the cream of lime, until the precipitation of all the green oxide and the supernatant liquor is clear and colourless. Drain off this liquor, add fresh water, and, after settling, again decant. Repeat this washing, then transfer the precipitate to a red-hot iron slab, and keep it constantly stirred until it changes to a yellow powder. The chromate of lime thus formed, if decomposed by sulphuric acid in slight excess, yields chromic acid as well suited for bleaching purposes as that from bichromate of potassa.

A good oil-filter is said to be made of fine sand, charcoal, and gypsum ; the sand to retain substances suspended in it, charcoal to decolourize it, and plaster to remove water. ('Journ. de Chim Med.' 1846.)

To decolourize raw linseed oil, a solution of two pounds of copperas in two and a half pounds of water is poured into a flask containing two pounds of linseed oil, and exposed to the sun for several weeks, during which it is frequently shaken. The oil is said to be rendered limpid and colourless, and may be drawn off by a siphon, or stoppered funnel.

Many substitutes have been proposed for the more costly oil for lubricating machinery, but hitherto with only partial success. Munkittrick's patent ('Lond Journ.' xxxvi. 98) consists mainly in the addition of caoutchouc to common grease, the former being softened by spirit of turpentine ; but he also uses other ingredients. For example : ten gallons of water being heated, one pound of glue and ten pounds of carbonate of soda are stirred in ; ten gallons of oil or grease are next added, whereby a quasi-soap is formed ; and lastly, four pounds of caoutchouc, softened by turpentine, are incorporated.

Boudet ('Journ de Pharm.' and 'Lond. Pharm. Journ.' 1850), gives the following as the process by which the French *liard*, or lubricating fluid is made. Add one pint of finely minced caoutchouc to fifty pints of rape oil, and heat until the mixture is complete. A very unctuous oil is thus formed, which remains fluid at freezing temperature, and does not clog the machines, but facilitates the motion of their parts.

Heydenreich proposes ('Journ. de Connais. Utiles,' 1849) to distinguish fat oils from each other by their odour when warmed, their colour by contact with oil of vitriol, and their specific gravities. By the first process the oil is heated in a porcelain capsule over a spirit-lamp, when the peculiar volatile odour of fish, linseed, and other oils may be detected, especially if compared in the same way with the unadulterated oils. For the acid test, from ten to fifteen drops of the oil are dropped upon a piece of glass, underlaid by white paper, and a drop of oil of vitriol is brought in contact with it by a glass rod. If it be rape-oil, a greenish-blue circle is formed around and at a short distance from the drop, while light yellowish-brown striæ form towards the centre. The same takes place with oil of black mustard, but from twenty-five to thirty drops of the oil are required. With whale oil, the colour is reddish, after twelve to fifteen minutes violet on the edge, and in two hours violet throughout. Olive oil gives a pale-yellow, passing into greenish-yellow. Linseed oil is at first dark reddish brown, and then black.

The more solid fat, stearin, is separated from the more fluid olein by pressure, to make stearin-candles, or, the fats being decomposed, the more solid stearic acid is separated from buttery or fluid acids, to make stearic acid lights. Under this head we may embrace spermaceti and wax. There is but little novelty offered on any of these points.

To separate the solid from the more fluid fat in palm oil, lard, &c., the fats are granulated and pressed cold in bags by a powerful hydraulic press, the olein which flows out being used for soap. The contents of the bags being again granulated, and pressed between warm plates of iron, the balance of the olein, with some margarin and stearin, is then removed. To remove colour from the stearin thus obtained, it is fused with a very little nitric acid. To remove still further all the olein, Morfit proposed mixing it with a little oil of turpentine, and then pressing. See Morfit's 'Chemistry Applied to the Manufacture of Soap and Candles.' According to Heintz (Ber. d. Berl. Acad.), stearin from mutton suet becomes transparent at 124° to 126°, but does not fuse before 144°.

A process is described in the 'Rep. Pat. Inv.' Oct. 1850, for mixing some twenty to thirty per cent. of rosin with fatty bodies in the melted state, by adding sulphuric acid gradually, heating it from twelve to eighteen hours, so as to evolve sulphurous acid, and then submitting the dark-brown crystalline solid to distillation by heated steam. The solid and oily portions are then separated by pressure.

To test for the presence of stearic acid, Geith pours over two drachms of wax, one ounce of lime-water, diluted with one ounce of water. If the acid be present, the liquid loses its alkalinity, and remains clear.

Buchner proposes fusibility and specific gravity as an approximate test of the presence of stearic acid, or tallow. Tallow fuses at 108°, yellow wax at 142°. ('Buchner's Rep.' xliv.)

Our knowledge of the composition and alliances of the waxes has been much enlarged by Brodie's investigations of common beeswax and Chinese wax. He found common wax to consist of *cerotic acid* (formerly *cerin*), soluble in hot alcohol, of the composition $C_{54}H_{54}O_4$, therefore of the fat acid series $C_nH_nO_4$; and of *palmitate of meliss-ether* (formerly *myricin*). By saponifying myricin he obtained palmitic acid and melissin, which last has the formula $C_{60}H_{62}O_2$ ($=C_nH_{n+2}O_2$), or that of an alcohol. By the action of lime and potassa on melissin, he obtained the corresponding acid, melissic acid, $C_{60}H_{60}O_4$. Upon examining Chinese wax, he found it to consist chiefly of cerotate of cerote-ether, $=C_{54}H_{55}O,C_{54}H_{53}O_3$, for by saponification he obtained cerotic acid, $C_{54}H_{54}O_4$, and cerotin (the alcohol) $C_{54}H_{56}O_2$ ($C_nH_{n+2}O_3$).—('Phil. Mag.' Sept. 1848, 'Amer. Journ.' (2) vii. 427.)

CINCHONA CULTURE, AND BOTANICAL OPERATIONS IN JAMAICA.

BY NATHANIEL WILSON, ISLAND BOTANIST.

The usual routine operations connected with the increase and dispersion of plants have been successfully carried on, and a wide dissemination of plants and seeds made during the past year.

The public demand for useful plants continues to increase in proportion as their utility and suitability to the climate become known.

Of this class I may specially mention spices and dyewoods, of which description I have distributed one thousand and fifty-two plants, well established in bamboo baskets previous to leaving the garden, so that no loss may or can occur but by careless attention of recipients; and, I am happy to say, that in most instances the plants have been successfully established, and one of these, a nutmeg-tree, bore two thousand fruit during the current year, proving most incontestably that the plant is quite at home in this island.

The product of these plants, in common with that of many others introduced from time to time, and but partially known, constitute valuable staples of other countries, and are no less eligible as articles of export from this colony, more particularly so when managed with that industry and skill bestowed on other and older staples. And if there is one class of plants better suited than another in this respect, for field culture, and for the habits and physical capacities of the peasantry, it is that of fibrous plants, for which too, with regard to the number of species, strength, and quality of fibre, we stand unrivalled, as illustrated at the Great Exhibitions of London and Paris. Foremost among these, as herbaceous perennials, for colour, strength, and fineness of fibre, I may instance the genera *Sanseviera* and *Bœhmeria*, the former is known in India as bow-string hemp, and the latter as the far-famed Chinese grass cloth, or Rhea fibre of India. The finest samples of the latter, cleaned and prepared, are worth 100*l.* per ton in British markets. This plant was introduced here in 1854, and found to thrive in warm moist localities, with the vigour of our rankest weeds, spreading most rapidly; still fibrous plants (I regret to say) are not yet recognised in field industry, and only serve as botanical novelties in gardens. This branch of agriculture is peculiarly suited for industrial and reformatory schools, and, in conjunction with other practical pursuits, might soon become self-supporting, while a knowledge of new staples, the plants producing them and mode of treatment, would rapidly diffuse itself over the island.

The most important event in the history of this botanic garden for many years past, has been the introduction by seeds of the quinine-yielding Cinchona in the autumn of 1860. By the month of October in the following year I succeeded in rearing over four hundred healthy plants, quite ready for planting out; but, unfortunately, the selection of a proper site for their final establishment was overlooked, and the consequences of subsequent treatment the plants had to undergo, proved the destruction of one half their number. However, being wishful to prove by every means in my power the result of the experiment of testing the adaptability of the plant (constitutional and climatic) for cultivation in the higher altitudes of this island,—finding the climate of Bath as the summer approached by far too warm,—I had the whole of them removed in small pots to Cold Spring coffee plantation, the elevation being about four thousand feet, and placed under artificial treatment. I soon found the climate and soil of that locality to be all I could desire for the plants; and as it afforded every facility for carrying out so valuable an experiment, I at once availed myself of it, and planted out in the coffee fields on the 16th November, 1861, several plants of each species, then about two or two-and-a-half inches in height. In twelve months after, a plant of the red bark (*Cinchona succirubra*) had attained to the height of forty-four inches, with leaves measuring thirteen and a half inches long, by eight and three quarter inches broad. The same plant, now two years old, measures six feet in height, with ten branches, having a circumference of stem at base of four and a half inches. The *Cinchona nitida* and *Cinchona micrantha* (gray barks) being of more slender habit of growth, have not made such rapid progress; the highest has attained to five feet, with three branches. The leaves, however, are larger, and measure fourteen inches by ten.

So far the experiment has proved eminently successful, and is placed beyond the shadow of a doubt by the most sceptical. Indeed it would be difficult to find more healthy trees in the forests of that neighbourhood; in about three or four years hence they may produce seeds. In the meantime they can be largely increased by cuttings and layers in the hands of a skilful propagator. During the months of August and September, 1862, the collection was again removed to Bath.

The plants were at this time eighteen to twenty months old, a critical period for forest trees in flower-pots under artificial treatment, and in a climate, too, so uncongenial for them as that of Bath, which would have soon terminated their lives had they not soon afterwards (13th October) been planted out at Mount Essex, near Bath, at an altitude of two thousand feet, or little more. This site, as a temporary one, was had recourse to to save the plants alive, until a better one could be obtained; and so far it has answered the purpose, for a majority of the plants are healthy, but have not made so fast progress as could have been desired. The soil is too loamy, and by far too stiff to admit of a free and rapid escape of the heavy rains which fall here in torrents during the greater part of the year; the altitude is also too low for the Peruvian barks, and a few of the trees have died since they were planted. The red bark thrives at a much lower altitude, and being a more hardy tree, the plants are more healthy; but as they are not yet too large for removal, I would strongly recommend its being done during the cool months, or as speedily as found to be practicable, to the site (if obtainable) which I had the honour of recently selecting and reporting upon to government. The entire eligibility of this site has been fully proved by the success attending the interesting experiment above-mentioned, being in the same neighbourhood, with the advantage of virgin soil, which the other had not.

A very important fact has now been established, viz. that the climate of our higher, and many of our intermediate mountains, is suited for the growth of the most valuable species of quinine-yielding plant, the *Cinchona succirubra*, and also a knowledge of the method of increasing the plants, and the soil best adapted for their full development, has been obtained. Another valuable discovery has lately been made in India respecting the febrifugal virtues of the leaves of the red-bark, as they fall from the tree; an infusion of the leaves, in the dose of one fluid ounce, was administered to the first four cases of intermittent fever that occurred in the civil hospital of Darjeeling; and in every case, the patients were cured without any other medicine whatever.

The barks of Cinchona yield as large a per centage of quinine in India as they do in their native forests. These facts being established by practical experiment, and brought to the knowledge of the world, cannot do otherwise than influence the cultivation of the plants immensely, conferring benefits in a domestic and commercial point of view of no ordinary importance; and, whatever may be its destiny in this island, the experiment has arrived at that stage which will admit of no further delay of justice, in placing the plants in a proper clime, and under a system of management that will secure success in all practical operations connected with the plantation; so that the plants may, in a short period, extend over the length and breadth of the island, and secure those advantages to the country which they are capable of conferring, when the experiment and energies of this institution shall have arrived at a happy result.

Botanic Garden, Bath, Jamaica, Dec. 1863.

INDUSTRIAL MUSEUMS IN THEIR RELATION TO COMMERCIAL ENTERPRISE.

BY THE LATE PROFESSOR GEORGE WILSON.

The industrial museums of the country have not risen in obedience to any sudden romantic impulse of educational enthusiasts or hypothetical philosophers, but have slowly grown into a visible reality, and forced themselves on the notice of the practical intellects of the country. How this has been, a few words will explain.

The long peace which followed Waterloo gave us leisure to neglect war; to apply the sciences to the useful arts; and to interchange with our brethren of mankind on all sides, the important discoveries and inventions which they and we had severally achieved. When the French Revolution awoke Europe from its perilous slumber, it awoke the philosopher as well as the soldier and statesman, and Watt's steam engines and Davy's voltaic batteries were fruits of the same energy which dethroned the Bourbons, and won Waterloo. When peace at length came, discovery followed discovery, and invention invention, with a rapidity such as the world never witnessed before. Four of those, partly discoveries, partly inventions—namely, steamships, railroads, locomotives, and electric telegraphs—the beginnings of which were long before the peace, but their practical evolution not till long after it, were of themselves sufficient to have necessitated industrial museums, by their effect in abridging space and time. Keats, the poet, in his Eve of St. Agnes, imagines with exquisite fancy the possibility of a full-blown rose becoming "a bud again." We have seen something of the kind happen. The great globe has seemed before our eyes to contract into smaller dimensions, and all the cities on its surface to come closer together, and almost to look in at each other's windows. When such things have occurred as the simultaneous announcement to every capital of Europe that Czar Nicholas was dead, who has not felt as if the cities of the globe were visibly separated by no other barrier than the almost imperceptible wire-fence of the electric telegraph?

The feeling of increased neighbourhood with the whole earth, which has thus been startlingly brought before us, grows familiar and even pleasant with every excursion we make. What a strange difference has come over the meaning of the words, "a day's journey," as signifying so much space traversed ! Think of the difference between even the shortest "sabbath day's journey," as measured across the Egyptian desert from the back of a camel, and the platform of a locomotive engine ; or across the Atlantic from the deck of a packet, and the paddle-box of an ocean steamer. We scarcely seem seated in our express trains, for what by miles is a long journey, when we are called on to surrender our tickets ; and before we have time to forget the song to which the sailors hove the anchor on one side of the world, the outlook gazing on the other is heard shouting, "Land in sight."

Our children may tire of swift progression, and cut the telegraph wires and cables, that they may meditate in peace, and undisturbed by news, realise the poet's "lodge in some vast wilderness." But for us in our present eager mood, express trains are but lagging steeds, and the failure of the Atlantic cable a bitter calamity. The seven league boots, the shoes of swiftness, and Fortunatus' wishing cap, which, under the names of steam-engine and telegraph, modern science has bestowed upon practical art, must, although they had been but solitary gifts, have altered all our commercial relations. The entire globe is now an open market-place and bazaar for every nation, and trading must proceed in a very different fashion from before. The great races of men will, doubtless, continue to work at different rates and in different ways, and we shall always probably be able to say of them, what Shakespeare's Rosalind says of individuals, "I'll tell you who time ambles withal, who time trots withal, who time gallops withal, and who he stands still withal." But steam-engines and telegraphs are plainly persuading the whole world to keep in all senses the same time o'day, though what that time shall be is still uncertain. I may be allowed, in passing, to indulge the hope that our people will be content to go at the approved national pace of the trot. We have not as yet learned to amble gracefully, and we cannot often afford to indulge, as we have recently been doing, in the expensive luxury of a headlong gallop. But this by the way. What I am earnest to urge as foremost in importance is, that the world opened up so widely to us, and our long separated brethren brought before us, face to face, could not but affect us strangely, although all that world were an African desert, and all its inhabitants wild men practising rude aboriginal arts. But that world contains many a people, as wise at least as ourselves, and their industry, as well as ours, has been quickened by discoveries and inventions not less marvellous than those which are embodied in the steam-engine and electric telegraph. Within the period which divides us from Waterloo, including, however, as organically connected with it, all the years of this century, each of the older sciences has known a new birth, and on every side infant sciences of giant blood have grown before our eyes into a stately adolescence, which, but that we anticipate for them a protracted old age, we should style a grave maturity. Since 1800, great chemists have arisen in France, Germany, Italy, Scandinavia, England, America, who have shown us, to the wondrous extent He has permitted them to show, how God has weighed the mountains in scales, and the hills in a balance; and how we, as His children, reading His laws impressed upon every thing He has made, may transmute air, earth, and sea, into all that the body needs, or the senses, the intellect, and the fancy require. Within the century great mechanicians have wrought with a faith in God's laws which has enabled them to remove mountains, to make hills valleys, and crooked places straight; and though they themselves perhaps did not always care for that, many have in consequence run to and fro, and knowledge has increased. Within the century, great geologists have opened up for us, and deciphered the pages of that most ancient of books, in which in primæval lithography is written, ages before Job announced it—"Surely there is a vein for silver, and a place for gold where they fine it. Iron is taken out of the earth, and brass is molten out of the stone." Within the century, great naturalists, patiently gazing with the eyes of genius when there was light sufficient for illumination; and, when all was dark, feeling about with sensitive fingers, have caught the clues which lead into some of the innermost recesses of living nature, and have brought us through what seemed hopeless labyrinths, face to face with the mysteries of organic life, and shown us how to make practical application of the open secret.

I name no other class of philosophers. Those named may stand for all. Throughout this century each of the physical sciences, moving exultingly forward, has acted on all the other sciences, and been reacted on by them; and together they have conspired to give industrialists of every class a command over material nature, such as the most sanguine of our forefathers did not hope to see attained, even after the lapse of centuries.

Side by side with all this, the moral earnestness of the community has increasingly deepened. The slave has been set free. The liberties of the people have been enlarged. The rights of conscience have been day by day more respected. Feelings of mutual respect and sympathy have been fostered among the different ranks of the nation, and among the different nations of the world; and the breasts of all thoughtful men have brimmed with gratefulness to God that he has so long heard and answered their prayer—"Give peace in our time, O Lord!"

The culmination of the star of peace, under which this progress was made, marked the close of the half-century. In 1851 the monarch of Modern Babylon wrote as did Nebuchadnezzar of old from his great city beside the Euphrates:—"Victoria, the Queen, unto all people, nations, and languages, that dwell in all the earth, peace be multiplied unto you." And, at her august bidding, the nations gathered together within that wondrous Crystal Palace, which seen across the drifting thunder clouds and bloody horizon that have too largely blotted out the clear sky since, appears rather a Midsummer Night's Dream woven by fairies, than a temple built by hands, on which with waking eyes we gazed. The Great Exhibition of 1851 was one of those cyclical blossomings of the mighty banyan tree of the nations which occur only at immense intervals. According to the older botanists, the aloe or agave flowers but once in a hundred years. Their successors think that they made the cycle too long; for my purpose it is too short: but take it either way, 1851 marked one of the aloe-flowerings of the human race, and of the fruits which followed that flowering, the Industrial Museum is one. I do not mean by this that but for the Great Exhibition we should not have had industrial museums. On the other hand, it would, I believe, have been born to us at any rate, only at a later period, and as the fruit of a lesser tree. In actual fact, however, it came to us through the outburst of peaceful energy, which built and filled the Palace of 1851; and whilst we are indebted to a very few individuals for its local development, we must refer its birth, as well as that of the Crystal Palace itself, to a conviction, slowly reached and lying deep in the hearts of men, that industrial museums were a want of the age.

In truth, to recal the former comparison, as the flowering of the aloe at the close of the hundred years (if that is its cycle) implies that the ninety-nine preceding ones have been spent in patiently amassing and elaborating materials for the crown of flowers which it wears on its hundredth birth-day; so we must look upon the Palace of 1851, not as a Jonah's gourd which rose in a night and withered in a night, but as the quickly expanded flower of a trunk, strong and enduring, like that of a cedar of Lebanon centuries old. The mere summoning of the nations to Hyde Park in 1851 would have been of none effect had the summons not been met half way by a counterpart longing for such a call. Natural philosophers are familiar with the phenomenon of still water, more than ice-cold remaining liquid and uncongealed, till it is shaken or disturbed, when it shoots in an instant into a forest of crystals. The crystalline forces were all the time struggling to assert themselves, and the slightest motion turned the balance in their favour. The long peace had calmed the world into a similar quiescence; but the latent activities were longing for action, and the Prince Consort had scarcely spoken the words of invitation, before the glass and iron crystallised into a palace, and the nations, as if they had been intently waiting for the call, rose like one man, and piled their works under its graceful dome.

It is in this ready acceptance of the invitation to London, and in the subsequent crowdings to the exhibitions of New York, Dublin, Paris, and Manchester, that I find the strongest arguments in favour of industrial museums. In support of this argument, I would also, but with qualification, refer to the erection of the Sydenham Palace, which, though eminently deserving of encouragement on many grounds, cares only in part for the Industrial Arts. It is further strengthened by a consideration of the circumstances which preceded the birth of those older, yet withal recent, museums in or near London; that at Jermyn street, which originated in the fact of important minerals accumulating in the hands of the geological surveyors; and that of Kew, which originated in the accumulation of equally important vegetable products in the hands of the Curator of Kew Gardens. Unless the authorities had thrown away the one class of objects and burned the other, they could not well have done otherwise than give them house-room. No sooner, however, had they done so than everyone saw that these collections which had, as it were, come together of themselves, were of the greatest interest and value. Out of a similar conjuncture of circumstances, arose the Museum of Irish Industry in Dublin. I might name other institutions, but these may suffice to prove the truth of the statement with which I commenced, that the other industrial museums of the country created themselves; in other words, they were not the result of *a priori* views on the part of speculative founders, or sudden creations of government. You will not for a moment suppose that I mean to say that the museums referred to suddenly came into existence without human help. On the other hand, each of them owes its development to the labours of many energetic men, who found these labours no light task. But it is most remarkable that alike Sir Henry de la Beche, in describing the origin of the Industrial Geological Museum in Jermyn street, London: Sir William Hooker, in describing the origin of the Industrial Botanical Museum at Kew; and Sir Robert Kane, in describing the origin of the Industrial Museum at Dublin, state explicitly, that it was because materials accumulated around them, not because they looked about for materials that their respective museums came into being. In no case, moreover, did government come to their assistance, till it was placed beyond doubt that, in possession or near prospect, specimens were largely available for each of these museums; and in conformity with this, when government resolved to establish an Industrial Museum in Scotland, it made the collection of specimens the first thing, the building of a permanent museum the second. I dwell upon those points, because they are scarcely known to the general public whom you represent, and because I cannot but think that the independent origin of the three non-Scottish industrial museums affords a powerful threefold argument in favour of the value of such institutions, as things for which the time was ripe, and by neglecting which we shall certainly suffer.

In no part of the empire has the value of museums, as important aids in practical education, been longer or more fully recognised than in Edinburgh, so that I may say that, with one consent, and having the interests of all Scotland in view, the whole of our public bodies have come forward to encourage the industrial museums.

The Industrial Museum, like the College, the Court of Session, or the House of Commons, is at once a walled-in space, and an embodied idea or cluster of ideas. The walled-in space takes its character from the idea which it embodies, and that idea is fourfold. It includes the conception of—

1. An ample exhibitional gallery, where the raw or workable and other materials of industrial art, the tools and machines employed to modify these, and the finished products resulting from their modification, shall be displayed.

2. A laboratory and workshop, where the qualities of industrial materials and products, and the effectiveness of industrial apparatus and machines, may be investigated.

3. A library, where the special literature of industrial art may be consulted.

4. Systematic Lectures on the contents of the galleries, the investigations of the laboratory and workshop, and the records of the library, as illustrating the nature of Technology or industrial science.

Let me suppose the industrial museum of the future already existent and realising to the full the idea just referred to.

When that museum shall be erected, I will ask its architect to sculpture on its front an emblematical device, namely, a circle, to imply that the museum represents the industry of the whole world ; within the circle an equilateral triangle, the respective sides of which shall denote the mineral, vegetable, and animal kingdoms, from which industrial art gathers its materials ; within the triangle an open hand, as the symbol of the transforming forces which change those materials ; and in the palm of that hand an eye, selecting the materials which shall be transformed. Gazing through that eye, let us see what the industrial museum can do for commercial enterprise.

I. The commerce of the world deals, in the first place, very largely with mineral, vegetable, and animal substances, as related to industrial art, in three ways. 1. Many of them we style raw materials. The term is a very expressive one, as implying that they need to be cooked, and that they admit of being cooked. Originally applied to food, the meaning is not felt to be forced as used in relation to coal, to metallic ores, to sugar, to skins, or to other bodies, which can be changed, especially by chemical processes, from useless into useful substances. 2. Whilst, however, we are all willing to regard coal as a raw material from which gas and naphtha are prepared, and skins as a raw material from which glue is elaborated, we should scarcely call marble the raw material of a statue, or linen the raw material of paper. The term *genetic* I feel to be too pedantic for general use, and the equivalent word *parent* is too vague. Let us say *workable* material, and we can include in a second division all those substances, such as wood, stone, gutta percha, which are convertible, chiefly by mechanical treatment, into articles of higher utilitarian value. Take as examples the difference between sheep's wool and Yorkshire broadcloth, or between the silkworm's cocoon and imperial velvet.

3. There is a third large class of substances, which are neither raw nor workable materials, but rather serve to modify both—such, for example, as the iodine and bromine which the photographer uses, the chlorine and alkalies applied by the bleacher, the colours used by the dyer, the oils employed by the leather-dresser.

Now one-half at least of all the ships and waggons of the world are continually occupied in transporting from point to point over the earth's surface the raw, workable, and modifying materials of mineral, vegetable, and animal origin, on and with which our manufacturers exercise their skill. One great service accordingly which an industrial museum may render, is to enable those whom it concerns to detect and distinguish from each other, the various important raw, workable, and modifying materials with which industrial art works. A collection, therefore, of all the more prominent characteristic or typical utilitarian materials, so arranged that the public might readily understand their nature, could not but be of signal service. Consider how the case stands at present. No systematic effort is made by our merchants to search the earth for its liberal treasures. The noblest, as men speak, and the vilest of things, gold and guano, are stumbled on by chance, and gathered at haphazard ; and this whether they occur at our own door, or at our antipodes. With a kind of mad patience we go submissively year after year to the same cotton land, and sugar land, or tea land. If it shall please Providence to make cotton, sugar, and tea plants grow elsewhere than in those lands, we of course shall go to the new regions, but we must wait till these are revealed. We are reckless and daring enough in unceasingly scouring strange lands and seas, but of what avail is all this if we only guess at the value of the strange objects which we encounter ! Charles Dickens has, however, undesignedly, profoundly satirised this folly of ours in his account of Captain Cuttle's endeavour to keep the shop of his friend the philososophical-instrument maker. All went well till a customer inquired for a particular instrument. Whether it was one of the many strange pieces of apparatus consigned to his care, the captain did not know. And as his customer, on being asked if he would know what he wanted if he saw it, replied in the negative, the transaction came to an end. We are like the captain's customer. We go forth in hundreds every year, as pilgrims over the earth, *to seek*, as we say, *our fortune*, as if all the seeking were on our side, and we should certainly know our fortune if we saw it. And all the while it may be our fortune, like a lost bride, is seeking us, and too often, like Gabriel and Evangeline in Longfellow's sad story, we pass each other in the dark, and all unconscious of the fact, bid farewell for ever.

How many of the young men who visit foreign countries or the colonies, bent on commercial enterprise, could tell gold from mica or pyrites, or diamonds from rock crystal, or platina ore from iron sand? How many of them, if shown a white shining stone, would be able to say whether it was quartz, limestone, alabaster, cryolite, felspar, or apatite? The first they might afterwards discover was of no pecuniary value; the second might be wrought as marble; the third might carve into sculptures, and would at least burn into stucco; the fourth is the choicest ore of the strange metal aluminium; the fifth is to the potter, enamel-maker, and other industrialists, of the greatest value; the sixth, mineral phosphate of lime, is at present the object of universal search among agriculturists. How many of the youths in question could tell whether the exudation from a tree was a gum, a sugar, a manna, a resin, a gum-resin, a camphor, a caoutchouc, or a gutta-percha? How many could tell whether the white crust or hoar-frost-like efflo-resence on the soil was carbonate of soda, nitrate of potash, borax, or common salt, substances of immensely different money-values? How many could say whether the coloured juice or infusion of a particular plant or tree was a fugitive or permanent dye? Whether a particular seed would yield oil or would not! Whether the fibres of a plant were suitable or not for textile fabrics, for ropes, and for paper-making? Whether a particular wood was soft or hard, lasting or destructible? Whether a particular rock would yield a good building stone or not? Whether the district they had travelled over was a limestone, granite, or sandstone formation? Whether coal was likely to be found in it? Whether it possessed any metals or metallic ores, or other precious minerals? Whether water was likely to be plentiful all the year round? and so on. Now, were it proposed to teach any single youth to distinguish with certainty, wherever he found them on the earth's surface, the various objects which have been referred to, you might well pronounce the endeavour madness. It is not necessary, however, that he should attempt this.

The naturalists who accompany our exploring expeditions, are not trained to identify on the spot every remarkable mineral, vegetable, and animal they encounter. In truth, seeing that it is strange objects which they are specially sent to discover, it is impossible that they should be forewarned of these novelties. It is counted enough that they are amply qualified to detect and preserve all the rare things which come in their way. Of some of these they recognize the full significance at the time, but the majority they send or take home for careful investigation by themselves or others. Besides those purely scientific agents, a large class of travellers of all professions aid natural history solely by sending home the objects with which it is concerned. So important are the services of this class of naturalists to the cause of science, that under the auspices of Sir John Herschell, prompted by the Admiralty, a manual was drawn up some years ago by some of the ablest writers of the country, suitable for the guidance of all intelligent voyagers who may feel desirous to gather materials for our natural history museums whilst wandering in distant lands. In this volume instructions are given as to the objects worth collecting, and the observations worth making, by those amateurs for whom the work is intended. But natural history includes a much wider range of subjects than industrial art, and it should be as easy to instruct travellers how to serve the latter as the former : that it is even more easy, I think will appear from the following considerations.

The raw (and other) materials of industrial art are not after all very numerous. Food, clothing, fuel, building-stones, mortars, timber, clays, metallic ores, and some other minerals, drugs, vegetable extracts, dye-stuffs, manures, oils, acids, and alkalies, form the chief material pabulum of intelligent industry. Now even, if we suppose a young man sent with a roving commission to search for *all* of those materials throughout the world, it would not be difficult to teach him how to recognise each one, at least to the extent of ascertaining to what class it belonged. It would of course be still more easy to equip him intellectually for a search for some of them. He could only learn by actually looking at, tasting, touching, and otherwise handling the typical representatives of the objects which he sought to gather; but if he laid a foundation in this practical experience, he could afterwards in distant lands widely enlarge it, and be enabled by a guide-book or manual, both to refresh his memory and to extend his knowledge. Thus, in the matter of food, it can be shown ; M. Soyer and all the other culinary authorities concurring ; that the nutritious value of every edible vegetable, root, fruit, seed, or stem, can be ascertained sufficiently well for all great practical purposes, by resolving it, as it always can be resolved, into one class of substances represented by starch, gum, sugar ; and into another represented by the curd-like body called albumen or fibrin, which gives to wetted flour or dough its stickiness. Had this simple test been trusted and applied, Ireland would not have been decimated by the potato famine ; nor, were it believed in at home, would unwise mothers tantalise hungry infants with meagre arrowroot, or unwise farmers, attracted by its cheapness, diet their horses upon sago ; neither would mysterious noblemen advertise their restoration to health through assimilation of costly packets of Revalenta Arabica.

Again as to fuel. No doubt it is a nice question, What is coal ? and somewhat hard to answer ; but there is no difficulty in ascertaining whether a strange body is combustible, and if so, whether it is easily kindled, burns long, burns brightly, gives off much or little smoke, yields a large cinder, and leaves little ash.

As for clothing materials, if they are of vegetable origin, the strength, tenacity, softness, lustre, colour, and durability of the textile fibres can be tested by simple and decisive means; and the hair, wool, or fur of animals is not more difficult to gauge, so far as its textile and felting characters are concerned. The essentials of a good building-stone may be counted on the fingers of one hand, and although prolonged trial often reverses summary judgments upon mineral masses, we can always at least distinguish a bad from a very good stone, and appraise with some nicety the blocks from every quarry.

The qualities of timber are not recondite or mysterious. As for the metals, the most valuable are the most easily detected. The softness, yellow lustre, abiding splendour, and insolubility of gold; the quickly tarnished paleness of silver; the liquid silveriness of mercury; the obtrusive density of platina; the magnetic characters of iron ore; the striking colour of ores of copper; the prominent crystals of ores of lead, forbid their escape from keen eyes. Each, indeed, of the great classes of industrial materials have qualities with which any moderately sagacious, and sufficiently patient observer may soon become familiar.

In proof of this, look at the astonishing amount of information concerning the resources of a strange country which a single intelligent traveller can give us. The solitary example of Livingstone is sufficient for my purpose. He had far fewer advantages, before he left this country, as I who was his fellow student know well, than could be placed at the disposal of travellers now-a-days; but he made himself as skilful as he could in the knowledge likely to be serviceable to him in Africa, and he turned it all to excellent account.

Some of our industrialists have discovered the importance of systematically employing trained agents abroad, and have profited by the discovery. Foremost among them are the horticulturists and florists of the country, who have long been in the habit of sending skilful practical botanists to distant regions to select and send home their rare and useful plants. All whom I address are familiar, I presume, with one or more of the works on China by Mr. Robert Fortune, and know how much he has done to introduce Chinese plants into this country, as well as into India.

Recently, this example has been followed, in even a more interesting way, by the great English firm, Price's Candle Company, who have published directions for the use of all visitants of distant lands who care to look out for plants yielding wax, butter, or oil, and desire to form on the spot some notion of their value, as sources of candle and lamp-fuel, and as elements of importance in the soap-manufactory.

This example has in turn been followed by the energetic scientific officers and civilians in India, in all the Presidencies. One of those gentlemen in particular, Dr. A. Hunter of Madras, has drawn up rules for the selection and treatment of textile fibres from new plants found in the East, which would serve for the guidance of searchers for such in all parts of the world.

Next to the horticulturists, in recognition of the principle under notice, are the metallurgists. The great metal merchants of Birmingham despatch over the world skilful mineralogists to seek for precious ores. One former assistant and friend of mine is at present in Spain on such a search; another, who knows all the mines of Northern Europe, has sailed to Chili on a similar errand.

I may also refer here to the volume of 'Lectures on Gold,' published by the Government School of Mines in London a few years ago, as a guide to the multitudes of our countrymen flocking at that time to the gold fields of Australia. It illustrated the perfect possibility of equipping travellers intellectually for the reaping of that industrial harvest which awaits the sagacious in every land. Contrast with this the vast amount of time, labour, money, and energy, which have been wasted in vain attempts to discover by chance, or through glimpses of half-knowledge, the riches of unknown regions. Bags of iron pyrites have been sent home as gold-dust; lumps of red oxide of iron, as the cinnabar ore of quicksilver; pieces of flattened lead-shot, as grains of platina. Men have exchanged abroad heavy gold-dust for light diamonds, alas! too light! for they proved, on reaching home, to be quartz crystals; and single-witted knaves have felt so confident of the general ignorance, that sham nuggets, manufactured in Birmingham, have been sent out to the gold diggings, where they were scattered on Sunday mornings over exhausted mines about to be offered up for sale: entry immediate.

Let any one, indeed, take a map, and mark upon it all of Europe, Asia, Africa, and America, which is still unexplored, and after reflecting upon the immensity of the area thus brought into view, ask himself how its material riches are to be ascertained, and he will not, I imagine, propose to leave them to be stumbled on by such chance visitors as may wander aimlessly and ignorantly through that region.

I have spoken specially of distant lands, but he who does not know valuable objects at a distance, will as little recognise them at his own door; nor need I remind you that around and between the two chief cities of Scotland, lie beds of iron-ore, building-stone, and gas-fuels, besides other minerals whose existence and value have been fully recognised only within the memory of living men, and these in most cases not past their prime.

One great service, then, which an industrial museum may render to commercial enterprise, is the teaching of those about to be scattered over the world, how to recognise the important raw, working, and modifying materials of industrial art. Scotland has always, in virtue of being "Caledonia stern and wild," kept her poets who could live on a little oatmeal at home, and sent her hungry practical men abroad. At the present day, more than of old, from the bosom of almost every family, one or more sons are sent forth over land and sea. Surely, then, we should give them opportunity before they part from us, to make themselves familiar with the typical industrial materials of all countries, and after singing "Auld Lang Syne" for the last time with them, and before bidding them farewell, should place in their chests, beside the Bible and the volume of national songs, some brief treatise which might help them to know whether it is a fish or a serpent which is offered to their grasp, and to perceive that they are receiving bread, where they thought it was a stone.

II. The Home Industrial Museum, secondly, should be a place where the nature and value of the unknown products of this country and of foreign countries might be ascertained and made public. Investigations into native products calculated to serve the entire nation have been prosecuted in all the practical museums of the country since their establishment. I mention one or two. At the Museum of Economic Geology, London, an elaborate and most valuable series of researches on the steam coals of the navy, was made some years ago by Sir Henry De la Beche, and Dr. Lyon Playfair. An equally important series of analyses of the iron-ores of England has recently been completed under Dr. Percy of the same museum; and Dr. Hoffmann and Mr. Witt, who are also among its officers, have investigated at great length, the question—How far, without prejudice to the public health, the sewage of great towns may be rendered agriculturally useful? Sir Robert Kane, Director of the Museum of Irish Industry, Dublin, has devoted an entire volume to the discussion of the Industrial resources of Ireland. Along with Dr. Sullivan, he has also made a detailed report on the modes in which the too abundant peat of his native country can be rendered useful; and in the laboratory of this museum, the question of cultivating beet-root in Ireland as a source of sugar has been very fully considered. Similar investigations are continually in progress.

As for foreign countries, every day ships bring to our great seaports important raw materials which, through the ignorance of brokers, are wasted or neglected. Samples of every strange raw material which passes through the Inland Revenue Office, should be sent to one or other, or all, of the industrial museums of the country, to be examined and reported on for the good of the community. It is not intended by this to come in between the importer and his profits, but only to supplement his ignorance or neglect of the value of what he has imported. But whatever may be thought of this proposition, none will probably deny that it would be of signal service to the mercantile public to be assured that whatever raw materials their correspondents or agents sent home, would be examined, if desired, by skilled adepts, and their commercial value proximately determined. If you only call to remembrance the immense stimulus which commercial enterprise has received within but twenty years, from the discovery abroad of gutta percha, guano, gold, and nitrate of soda, besides many other bodies less familiar to the general public—you will perceive how essential it is that every possible workable material should be collected abroad, and carefully examined at home.

III. Commercial enterprise is as much interested in sending finished products to a distance, as in bringing raw materials to its own door. The perfected results, accordingly, of industrial art, are as much the concern of an industrial museum, as the raw material from which they are elaborated; and so also are the machines and tools needed for their elaboration, and in effecting the useful application of the elaborated products.

A large portion, therefore, of the exhibitional galleries of the museum must be assigned—1. To such finished products as wrought iron, steel, glass, porcelain, paper, leather, cotton, linen, woollen, and silken tissues, naphtha, sugar, sulphuric acid, soap, bleaching powder, lucifer matches, and the like. 2. To all the intermediate products which intervene between such products and their raw materials; for example, between iron-ore and steel; between sand and glass; between clay and porcelain; between rags and paper; between skins and leather; between cotton-wool, flax-fibre, merino-fleece, and cocoon-floss on the one hand, and chintz, linen-damask, broad-cloth, tartan, carpeting, and satin or velvet on the other; between coals and naphtha; cane-juice, and loaf-sugar; sulphur and oil of vitriol; palm-oil and soap; common salt and bleaching powder; burned bones and lucifer matches. 3. To the tools, machines, and apparatus required for the conversion of raw materials into finished products, such as agricultural, mining, and paper-making machinery, furnaces, mills, lathes, moulds, looms, gas-retorts, stills, printing presses, and the other engines of the graphic arts, and all the manipulative implements of handicraft trades. Many of the objects of this third division would of course be shown only in model, not of their actual size. 4. Besides machines or instruments of the kind described, the object of which is to transform workable materials into wrought goods, a prominent place in the museum galleries must also be given to those forms of apparatus which are employed in the application to useful purposes of finished products, and in the exercise of what may be called the Dynamical Industrial Arts. Such instruments are pens, pencils, brushes, thermometers, barometers, compass-needles, lamps for burning solid, liquid, and gaseous fuels, the batteries and other requisites for producing and maintaining the electric light, the whole machinery of the electric telegraph, the whole apparatus of the photographer, and much else. In this department, only the *practical* forms of those instruments which it includes would be shown; such refined modifications of thermometer, barometer, electric machine, optical lens, and the like, as theory pronounces best for the purely scientific student, not falling within its province.

On the one hand, it is important that the idea of the industrial museum should be fully and impartially carried out, and that every economic art should receive its just share of illustration. On the other, it would be culpable folly to collect the same objects in adjoining or neighbouring buildings, and thus needlessly multiply duplicates. The pre-eminently important art of medicine, for example, is so amply cared for by the University, the College of Surgeons, and the College of Physicians, that it would not be necessary for the industrial museum to do more than supplement in certain directions those illustrations of medicine as an art which the medical museums in the city contain. Thus the forms of electrical machine most suitable for therapeutic use, the qualities of steel best fitted for surgical instruments; the similar qualities of caoutchouc and gutta percha ; the varieties of distilling, and other pharmaceutical apparatus ; the different kinds of glass and porcelain vessels useful in the laboratory and surgery ; and some other things, would probably find a place in the museum, but the art of medicine as a whole would not be represented.

In the same way, so long as the Royal Agricultural Society and Highland Society watch over the interests of agriculture ; the Royal Academy over those of the fine arts ; the Architectural Society over those which occupy the builder ; the Society of Antiquaries over the ancient progress of all the arts, the extent to which the industrial museum will charge itself with illustrating the scope of agriculture as an art ; with collecting the pigments, marbles, bronzes, and other materials with which the painter and the sculptor work ; with the accumulation of building materials ; and with the acquisition of examples of the earlier and ruder stages of industrial processes, will to a great degree depend upon the limits which may hereafter be agreed to, as bounding the domains of the different societies named. Each of these bodies has a central province peculiar to itself, on which, even if it were unoccupied, the industrial museum would not intrude. Each of them has also a border-land which the museum cannot help overlapping, as it has a border-land which they unavoidably overlap. The extent to which this mutual infringement shall take place must be matter of amicable compromise. In any case an ample area, entirely its own, will be left to each institution, and all will be gainers by a wise division of the debated land.

Such a collection I have supposed, of raw and workable materials, modifying agents, transforming machinery, and finished products, would prove specially instructive—1. To those ignorant of the capabilities of an industrial art, and solicitous to appreciate them ; and 2. To those desirous of ascertaining the imperfections of an industrial art with a view to improve it. To the latter only will I refer. The chief and ultimate aim of an industrial museum is the improvement of the useful arts, which cease to exist, or exist only as stunted dwarfs where they do not make progress. But it is not only from the ranks of experienced workers in an art, that its improvers always or perhaps most frequently come.

We are accustomed to say that every man knows his own trade best, and to warn the shoemaker not to step beyond his last. Although, however, the improvement of particular arts must mainly be looked for from those who have inherited a special pecuniary as well as professional interest in them, still we must not forget the effect of custom in rendering men indifferent to defects, or of age in making them impatient of change; nor, on the other hand, must we overlook the influence of novelty and curiosity in exciting inventive ingenuity. The great improvers of the arts are either their devoted followers or total strangers to them; the indifferent general public prove, when they offer advice, only ignorant intermeddlers. The Huntingdon brewer, called Oliver Cromwell, could teach a military trick or two to Prince Rupert and his cavaliers. The Newcastle collier, George Stephenson, was so wonderful at engineering, that they would not make him a civil engineer. The gardener, John Paxton, because he knew nothing of architecture, became Sir John as the architect of the Crystal Palace. I am not certain, indeed, that the industrial arts have not been as much advanced by strangers as by acquaintances.

At all events, one of the chief, and I confess unexpected, obstacles I encountered in seeking to fill the industrial museum with examples of art, is the too humble estimate which men form of their own callings. I cannot persuade a shoemaker that shoes are of interest to any but shoemakers and the barefooted public, although he looks with eager curiosity at my collection of hats in all their stages. I tried in vain to induce a very intelligent glassmaker to send me certain specimens of glass, till I showed him a full series of illustrations of brush-making. His eyes brightened with interest, and he admired the ingenious and unsuspected devices which an art strange to him revealed. Well, said I, be sure the brush-maker will be as much interested in your glass as you are in his brushes, so send me what I ask. I cannot, accordingly, help inferring that a stranger's curiosity will often make up for his defective experience, and that the industrial museum would secure his services for all the arts it represented.

But whether such services be rendered by experts or by novices, this at least is most certain, that not one of the great industrial arts can stand still. In proportion as they are flourishing, every day witnesses old processes altered and new ones introduced.

When the duty upon common salt was removed, and our practical chemists began to make soda from it, they threw into the air all the muriatic acid evolved from the salt. Their neighbours complained of the acid fumes, and, at immense expense, the chemists built gigantic chimneys to send the vapours nearer the stars. By and by the price of sulphur, with which they cannot dispense, rose, and they changed the construction of their furnaces so as to burn iron pyrites in them. Then the price of soda fell, and they blew up or dispensed with their tall chimneys, using instead great condensers, and converting all the obnoxious vapours into chloride of lime, or bleaching powder. Then the value of bleaching-powder altered, and they took to producing the chlorine which it contains in a new way; afterwards the oxide of manganese, which is needed for that manufacture, grew scarce, and a most ingenious method of recovering it and using it again was devised, and is in practice. Lastly, not satisfied with the quality of the soda they made, they had mounted their huge furnaces on axles, and make them revolve like barrel-churns roasting on spits, so as thoroughly to intermingle all the ingredients which, by their mutual action, produce the alkali.

This is no solitary case. Some years ago they were trying in a London court of law, at the instance of the excise, the question: "What is paper?" This is one of those subtle legal problems which—like that other, "What is metal?" argued between a road mender, a glass blower, and an iron founder, each of whom calls the material with which he deals metal—will multiply on our hands in virtue of the very progression of the arts which I am considering. Yet waiving the question, "What is paper?" the theory of paper-making is simpler than that of almost any other of the industrial arts, but how is it with its practice? For years I have at short intervals availed myself of the privilege of visiting the admirable paper-mills in our neighbourhood. At every visit I find some great change; since I saw several of them a few months ago, important alterations have been made, and are still making. When our venerable townsman, Mr. Alexander Cowan began paper-making, it was all made by hand, by a process so slow, that they can do now in hours what took weeks, sometimes months, before. Year after year everything has been altered. On the chemical side—new bleaching agents, new correctors of the evils of over bleaching, new sizes and ways of making sizes, new colouring matters, new modes of glazing. On the mechanical side—new machines for rag-cutting, washing, boiling, paper-weaving, sizing, drying, cutting, folding, stamping. One half the arrangements within my own remembrance are totally new, and above the horizon, newer and newest devices arise on every side.

If it is so with a comparatively simple art, how must it be with the more complex ones. The hot blast is but one accompaniment and index of the improved manufacture of iron. The Sydenham Palace is but one mark of the improvements in glass-making. Coal gas is but one step in the improved use of fuel. The whole machinery of sugar-making is as novel as it is economical. Bread can be baked on an hour's notice by iron hands as cleanly as expeditious. Steam-engines, which almost seem intelligent, card, dye, and weave, whatever textile raw material you give them and by and by cut it and sew it, if required.

Had we only, accordingly, the old industrial arts, thus for ever renewing themselves, the necessity for keeping pace with them would be argument enough for an industrial museum, where their progress could be watched and studied by all. But besides those elder sons and servants of mercantile enterprise—who, like the eagle, seem to grow younger as they grow older—think of the infant arts which have been born in our own day, and are younger than most of us. Each of them, a Hercules in his cradle, has already strangled serpents, and has more than twelve labours before him. Railway-making, electro-metallurgy, electro-telegraphy, and photography, may here represent those Titanic babes, who, already with mature faces, are bidding all men look to the new time-ball which they have dropped before them, and see that their chronometers are set by that.

IV. I have hitherto referred almost solely to the exhibitional galleries of the museum. To render, however, their contents useful to the public, they must be carefully classified, intelligibly labelled, and described at some length in suitable catalogues. The museum therefore must include within its walls a laboratory and workshop, where the nature of unknown substances, and the powers of new machines, may be investigated, and a library where the literature of industrial science may be available for the guidance of the officers of the institution in classifying the contents of the museum. Further, an essential appendage of an industrial museum is a lecture-room, where detailed prelections may be given on the contents of the museum, and where, in addition, the various industrial arts may be expounded in relation to the laws and principles on which they are based, and may be illustrated not only by the objects in the exhibitional galleries, but by maps, diagrams, drawings, chemical and mechanical experiments, the exhibition on the small scale of manufacturing processes, and of machines at work; as well as through the medium of the other appliances employed in university and other class-rooms by teachers of the physical sciences.

All the existing industrial museums, except that at Kew, are supplemented by laboratory, library, and lecture-room in the way mentioned. All three likewise have, from the first, been associated with the industrial museum of Scotland, which, moreover, is the only museum of the kind, or indeed institution in the country, having a special chair of Technology attached to it.

V. Apart, however, from the importance of those supplementary institutions in enabling the curators of the museum to render it more instructive to the public, two of them, namely, the laboratory (including the workshop) and the library, may themselves be made directly serviceable to the community.

The laboratories of the industrial museums, besides affording those in charge of the latter the means of examining substances of general economic interest, are at the service of the public in two ways:—1. As schools of analytical chemistry; where, for moderate fees, young men may learn the art of chemical analysis as applied to industrial objects. 2. As analytical laboratories; where likewise, for moderate fees, merchants or others may have confidential analyses made of substances whose composition they seek for their own guidance to know; and where the officers of the museums may be consulted by those engaged in legal contests, or in other transactions where the services of scientific advisers are required.

An engineering workshop, as distinguished from a chemical laboratory, has not yet been fully recognised, so far as I am aware, as one of the complements of an industrial museum, but sooner or later I cannot doubt it will be. I indulge the hope also, that it may be made serviceable to the general public, for the testing of mechanical inventions, as the laboratories are for the testing chemical products and manufactures. Certainly, whether in connection with industrial museums, or with other institutions, it is very desirable that ingenious workmen and others of limited means should be able, at a moderate cost, to ascertain confidentially the value of embryo inventions before expending labour, time, and money on their perhaps unwise elaboration. Meanwhile, however, I only name the workshop as a subsidiary appendage to the laboratory.

VI. The libraries of our industrial museums, as at present organised, are chiefly intended for the officers of these institutions, including to some extent the students in daily attendance for each session. Nor is it necessary or desirable than an industrial museum should provide reading for the general public, which is, or, if it chooses, may be, well cared for in the way of libraries. But a collection of books on applied science in French, German, and English, including the records of the patent offices or similar institutions of the civilised countries of the world, geographical, geological, and mining maps and sections, illustrated works on architecture, ship-building, and machinery, and the like, would greatly add to the utility of an industrial museum, if arranged in its library, so as to be accessible for reference and consultation by practical men. Such a library, it cannot be doubted, would receive many donations, and in all likelihood would prove the least costly, though not the least useful, complement of the museum.

Such, then, is the fourfold idea embodied in the galleries, laboratory, library, and lecture-room, which together constitute an industrial museum. As the counterpart of this, the merchants of the world have a fourfold duty to discharge :—

1. To gather workable materials from the ends of the earth.

2. To send forth finished products, derived from those, to the four quarters of the heavens.

3. To employ the most perfect mechanical and chemical appliances which can change the one into the other, and facilitate their transmission throughout the world.

4. To encourage new arts and hope for still newer ones.

Before I close, let me indulge in two brief moralisings.

What are the ends of commercial enterprise? I will name but two: —1. The making of money. 2. The civilising of the world.

Firstly, I suppose you will not blame me for saying that the immediate end is the making of money, or for adding, that this money-making seems to me one of the most honest, innocent, and pleasant of occupations. I am not fortified in this original opinion by remembrance of any passage in Adam Smith's 'Wealth of Nations,' which indeed I never read. I am thinking of a passage in one of the writings of the poet Southey, who, like myself, never lost the pleasure of money-making by having a surfeit of it. To "owe no man anything," and that it is to be "worse than an infidel" not to provide for his own household, are as certainly divine precepts, as that "the love of money is the root of all evil," and that "hasting to be rich multiplieth sorrows." There is only the difference that a blessing goes with the first, and a curse with the last. Southey was right. Honestly earned wages are as true a *quiddam honorarium*, a gracious largesse, as any sum which the lawyer or physician, looking the other way, finds fall into his palm. To know that, by work of brain, or heart, or hand, or rather by all together, you have earned a penny, copper or golden as the case may be, which you may honestly expend on some lawful want, in gratification of some innocent intellectual taste, or æsthetical desire, for the carrying out of some moral purpose, or for the comfort of some beloved relative or friend, is one of the truest delights left to us, after the flush of early youth has passed away.

And the necessity which lies upon every man, high and low, except the uncaught thief, to serve other men, and be paid by them as his task-masters, is not the least pleasant leaf of that *Dulcamara*, bitter-sweet, which Adam found growing everywhere beyond the gates of Eden. Honourable service is the only freedom which belongs to man, and the spirit of brotherly interest and sympathy never rises higher than between the noble master and the noble servant.

Secondly, The museum which I have been commending to you is a museum of the industry of the world in relation to ourselves. It cannot be less than this; and as this it will increase our civilization, and add to our power to civilize the rest of the world. We have deserved well of the other nations of the globe as improvers of the industrial arts, but they also have deserved well of us. Tea, coffee, sugar, tobacco, opium, cinchona, cotton, caoutchouc, gutta-percha, guano, have all been bestowed upon us by distant tribes. The Chinese have taught us to weave silk, to make paper and porcelain. The Indians have shown us how to dye. The Venetians have given us the modern art of glass-making. Our soda process is originally a French invention. The improvements introduced into the colonial manufacture of cane-sugar are largely borrowed from the processes introduced by the continental growers of the beet-root. There is not a single invention or discovery, indeed, not excepting even the steam-engine, of which we as a people can claim more than the lion's share; and seeing that in our veins runs the mingled blood of I know not how many unlike races, it would be very strange if it were otherwise.

To no one nation has been given the monopoly of genius, constructive skill, and practical sagacity. All our modern arts, such as photography and electro-metallurgy, have been rapidly developed by the combined activity of quick-witted men all over the globe. Take in special illustration of this two examples. The lucifer-match, although it was born late in our own day, has this peculiarity about it, that no one, dead or living, claims its invention. Although there is nothing God-like in its name, it is as much dissociated from a human inventor as those universal instruments of art, which the ancients held to be of divine origin. And the cause of this simply is, that it embodies the productions of so many countries, and the skill of so many men, and the thoughts of so many centuries, that no individual of any nation or epoch can call it his.

The same remark applies to the electric telegraph. It belongs to no single man or nation. Volta the Italian, Oersted the Dane, Steinhill the German, Ampere the Frenchman, Faraday and Wheatstone of England, Bain and William Thomson of Scotland, Morse of the United States, are but a few among the many between whom the merit of establishing the telegraph must be, though unequally, divided.

The inability, as all history shows, of any single nation to be sufficient for itself, and the teaching of the nations by each other, which each successive age sees carried further and further, furnish the sure and broad foundation of the mighty civilizing power of commercial enterprise. The vast ends which God has had in view in dividing the globe amongst races so different as those which, since the secular historic period, have occupied its surface, are to us but dimly apparent. Yet we seem able to read a purpose of slowly opening up the world more and more as the centuries flow on. Not to the Egyptian, the Assyrian, the Indian, the Hebrew, the Greek, or the Roman, but to men of our own day and generation, has the Ruler of All given the keys with which our Watts and Stephensons and Faradays have unlocked the barrier-gates of the world, and made over its surface one continuous highway. Surely, without cant or pretence, I may affirm that this is the sign of the times for you. If we refuse to interpret Chinese and other placards bearing the ambiguous statement, "No passage this way," and suffer only the announcement, "No admittance but on business," let us see, when admitted on that plea, that our business is a noble one. Once, like the raven from the Ark, we found in the days of war no rest in all the world for the soles of our feet; now, like Noah's dove, we may pluck the olive leaves of peace wherever we will. To civilize the world through commerce, and stretch forth the hands of brethren to all the nations of the globe, is a mighty work, which God has largely given to our nation to effect, and he has laid the duty specially and honourably on those represented by you.

But why do I trouble you with my words? Was there not a parable spoken more than 1800 years ago, in answer to him who asked, "Who is my neighbour?" Did not the lawyer, the physician—even the clergyman—pass by him that had fallen among thieves, and leave the Samaritan merchant to interrupt his business journey, and help the unfortunate? Is it not curious to come across so minute a piece of ancient business-detail; the pouring of oil and wine into the wounds; the payment in ready money to the innkeeper of as much as could be spared from the scantily-filled travelling purse; the bond for further expenses which might be incurred by the sick man, and which the merchant should repay when he returned with the monies which he expected to receive? And do not all nations since call that merchant the *Good* Samaritan? Yes! and the parable was spoken by Him who, with His divine hands, handled the carpenter's tools, and in thus honouring the humblest handicraft, left us, as in all else, an example that we should follow His steps.

THE CULTURE AND TRADE OF SUMACH.

BY THE EDITOR.

Sumach is an article of great importance to the Sicilians, as well as to ourselves and other countries, for dyeing and tanning purposes, for in many years our imports exceed 19,000 tons This article and sulphur are the main staples of Sicily.

There are two species of sumach grown in Europe.

1. The currier's sumach (*Rhus coriaria*, Linn.), so named by the ancients from the bark and all the parts of the plant, owing to their astringent character, serving to tan skins. Pliny (Book xxiv. cap. 11) speaks of the employment of this shrub for tanning, and it is also mentioned by Dioscorides. This species is found growing spontaneously in dry and stony ground in the south of France, Spain, Italy, the Levant, and Barbary.

2. Fustic sumach (*Rhus cotinus*, Linn.). The leaves of this species are employed in manufactures for the same purposes as the former. The shrub is found growing on hillocks and arid soils in Switzerland, Italy, and the southern departments of France.

In Algeria *R. pentaphylla*, an indigenous species, is used for tanning and dyeing; and the powder of it was shown at the last International Exhibition. In North America several indigenous species are also used. The bark of the Virginia sumach, *R. typhina*, is powdered for tanning in the Northern States, and *R. glabra* in the Middle States.

Professor Arnaudor (TECHNOLOGIST, vol. iii., p. 287), in an article on the Tanning Materials, &c. of Italy, has given some information on the trade in sumach, to which may be added with advantage the following further particulars.

In Sicily they set the roots or small plants from two to three feet apart, not always in regular rows. They hoe it two or three times before the rains finish in May, and gather it in July and August. The leaves are the only parts made use of. After being separated from the twigs by threshing or by treading off with oxen or horses, the leaves are then ground to the state of fineness in which we see it in commerce, being passed first through sieves or bolting cloths, and afterwards put into bags of 160lbs. each.

The proper season for planting the roots or plants is in November, December, and January. When the season is rainy the plants take root better. The root or stump is cut off from four to six inches above ground. The scions or sprouts spring up four to six out of each root ; and when at maturity, which in Sicily is July or August, they are all cut off at the stump and laid in small handfuls (not spread out much, as the sun will turn the leaves yellow) to dry—say for a day or two—great care being taken that no rain falls on them.

The leaves are ground in mills mostly by horse power, but water or steam power would be much cheaper and better. The perpendicular running stones weigh nearly 3,000 pounds; they run double or single round an upright shaft. The nether or foundation stone is heavier and one-third larger in diameter than the running stones. The grinding surface of these latter is slightly rough, being occasionally touched with the pick or cold chisel. Hard granite stones answer; in Sicily they use a volcanic stone which is as hard as marble. There follows round the running stones a little piece of wood that keeps the leaves always under the stones. When ground fine enough it is sifted or bolted in a large air-tight room, with a door to enter and fill the bags. In Sicily the article is more or less adulterated with spurious stuff, such as other kinds of leaves, and an article called *brucca*, which resembles the juniper bush of North America, and has no value in itself.

I believe the first year they do not cut off the sprouts. In the second and following years a curious freak of nature produces a single plant a foot or so distant from the original root, and this little sucker it is, which they usually make use of to transplant.

The soil of Sicily generally is a limestone formation or a reddish soil. Sumach is cultivated in the valleys or level grounds, or on the sides of the mountains ; it requires no rain for two months before harvesting it. The soil is so fertile that the ground is not manured at all for sumach. The superiority of Sicilian sumach over that of other countries arises apparently from the mode of cultivation. All the leaves are the production of the sprouts that spring up from the stump every year. Being so young, the leaves are full of life when cut, and have not decayed like those of old trees. This with a dry climate in the latter part of the season, and the soil suiting the plant, gives it the high reputation it has all over Europe and America.

In some parts of Naples, and in Sardinia, as well as Sicily, a great trade is carried on in sumach, and there are few arid hills in the latter island where this small shrub is not cultivated. At Palermo, especially, bags of sumach are at all times to be seen piled up destined for shipment to various places, chiefly to England and the United States, where there is a large consumption. It is to the trade in sumach that several merchants in Sicily owe their large fortunes.

An infusion of sumach yields a fawn colour bordering on green. It is a substantive colour, but may be altered and improved by the judicious application of mordants. The principal use, however, of sumach in dyeing is the production of black by means of the large quantity of gallic acid which it affords.

In calico printing sumach affords with a mordant of tin a yellow colour; with acetate of iron, weak or strong, a gray or black; and with the sulphate of zinc, a brownish yellow. Sumach is much used in tanning for preparing the skins of sheep and goats for Turkey or Morocco leather. The odour of sumach is agreeable and penetrating. Davy found in 480 parts of Sicilian sumach 78 parts of tannin.

Under the name of tanner's sumach, and "*sumac de Redon*," in France the powdered leaves of *Coriaria myrtifolia*, from their astringent properties, are occasionally used on the continent for tanning leather and dyeing black, but this substance is much inferior to the powder obtained from the leaves of the *Rhus*.

THE WILD RICE OF NORTH AMERICA (*ZIZANIA AQUATICA*).

The water-oats, or wild Indian rice, common in many parts of the North American continent, and we believe also in Russia, is a wholesome nourishing article of diet, which deserves to be better known than it is at present.

The flower-stem comes up sheathed in a delicate green, membranous leaf, and displays the elegant awned flowers; from these the anthers depend, of a delicate straw colour and purple, which have a most graceful effect waving in the wind. The upper or spiked part is the one that bears the seed. The green grassy leaves fall back from the stem, and float upon the surface when they are no longer needed to protect the seed. The plant grows in vast beds, in still waters, in a depth of from three to eight feet, where there is a great deposit of mud and sand. In many places, where there is little current, these beds increase so as materially to fill up the shallow lakes, and impede the progress of boats on their surface.

The plant is usually six feet high or more, and has a panicle with male flowers above and female below. It has been found growing wild in the North West Territory, in the lakes and streams all over the country. In Minnesota, Illinois, and many other American States, as well as Canada, it is common.

When the rice begins to show the tender green blade above the water, the lakes seem to be studded with low verdant islands. It comes into flower in July and August. The leaves attain a great length, some have been measured of the great length of 11 to 13 feet. In the month of September, in Canada, in the North Western states, rather earlier, the grains are fully ripe and withered. It is so loosely enclosed between the bearded husks as to fall out at the slightest puff of wind, hence the harvest can only be continued for a few days after the maturity of the crop. The stalk and the branches or ears that have the seed, are described as resembling oats, both in appearance and manner of growing, the stalks being full of joints, and rising from two to four feet above the level of the water.

The squaws collect the seed by paddling through the rice beds, and with a stick in one hand, and a sort of sharp-edged curved paddle in the other, striking the ripe heads down into the canoe, the ripe grain falling to the bottom. Many bushels are thus collected. An Indian squaw will gather from five to ten bushels per day. Very great quantities grow on all the lakes in the Minnesota territory. The outlets and bays are filled with it. It is the main reliance of the Indians during the winter months, for their subsistence. The green rice is dried in the following manner in Canada. The Indians make an enclosure on a square area of dry ground, by sticking branches of pine or cedar close together, to form a sort of hedge. In the centre of this place they drive in forked sticks, in a square of several feet, across which they lay others, and on this rude frame they extend mats of bass or cedar, for the manufacture of which the Indian women are renowned. They light a fire beneath this frame, and when reduced to hot glowing embers, the rice is spread on the mats above the fire; the green enclosure is to keep the heat from escaping; the rice is kept stirred and turned with a wooden shovel or paddle, and after it is dried, the husk is winnowed from it in large open baskets shaken in the wind.

Professor Randall, of Cincinnati, and General Verplanck, late Commissioner to the Chippewa Indians, consider it to be superior in taste, and far more nutritious than Southern rice. It is long, narrow, and of an olive-green colour outside. The kernels are larger, and its flavour is better; for when boiled and stewed, and left to cool, it forms a consistent mass, like good wheat bread. Boiled like ordinary rice it is very palatable. The appearance, however, is not inviting, as the outer skin of the hulled rice is dark-coloured, though the inside is white as the Carolina kind. This may be owing to some difficulty in preserving it, and, probably, if more completely hulled the objection would disappear.

The parched Indian rice is heated in pots over a slow fire, till it bursts and shows the white floury part within the dark skin. This sort is eaten by the Indians in their soups and stews, which are chiefly made of game, venison, and wild fowl; and often also dry by handfuls, when on journeys, as the parched corn of the Israelites. The wild rice is sold in the stores of Canada at 10s. a bushel. The Indians sow it up in mats or coarse birch baskets to keep it.

The gathering of wild rice is rarely practised by the settlers, whose time can be more profitably employed on their farms; but we have thought the description of harvesting it might not be devoid of interest, since in men, who have gone exploring or "lumbering" on the shores of lonely lakes and rivers, far from the haunts of civilised man, have sometimes been reduced to worse shifts than gathering wild rice to supply their wants.

THE TRADE IN LOGWOOD.

BY THE EDITOR.

Of the annual imports of logwood—some 41,000 tons per annum of the value of 256,000*l.*—the largest quantity, more than one-third, now comes from the West India Islands, and about 6,000 tons each from Hayti, from Belize, and from the Northern Atlantic American ports. The tree which supplies it, the *Hœmatoxylon Campeachianum* reaches fifty feet in height. The wood is hard and dense, having a greater specific gravity than water. The pinnate leaves are handsome, of a fine dark glossy green colour; the flowers are pea-shaped in fine yellow racemes. The trunk is cut into large logs; the bark and alburnum, or white wood is chopped off; the dark-red inner wood being the only valuable portion. The value is in proportion to the size of the logs, the largest being the most prized: but it is chiefly imported in short lengths. We chip or grind, and pack it in casks and bags ready for the dyers', hatters', and calico printers' use, who esteem it as affording the most durable, deep red and black dyes; but before doing so it is generally conveyed in the state as imported to the manufacturing towns, where it is frequently deposited and stacked on wharves for a great length of time before being ground or used. The wood being very hard, of a fine compact grain, is almost indestructible by the atmospheric influence. It was first introduced into England in the reign of Elizabeth, but as it afforded to the unskilful dyers of her time a fugitive colour it was not only prohibited from being used, under severe penalties, but was ordered to be burned wheresoever found, by a law passed in the 23rd year of her reign. At length, after a century of absurd prohibition it was allowed to be used. Alcohol extracts most of the active principles of this wood and forms a deep coloured tincture. The cutting, barking, and transport of logwood also known in the European market as Campechy wood (Palo de Campeche) is a branch of industry conducted in Yucatan. The tree is indigenous to the forests of Tabasco, to the lowlands, islands, and banks of rivers, and lagoons, and gives employment to very many, forming the principal article of foreign export from that State.

Far from the land producing it in abundance it begins to disappear. It is seldom met with near the mountains, although when planted on the highlands and hills it arrives at perfection. To procure it cutting establishments are formed in those places where it abounds, which are called "tintales," and a more or less considerable capital is employed in procuring hands, tools, boats, victuals, and other articles necessary to the undertaking. It is cut with the axe, and is a work of torment, for the low lands in which it grows are very marshy, and teem with mosquitoes. However, it is the most lucrative for the labourer. For instance, in husbandry, say in the breeding of cattle, the labourer, if married, gets four dollars per month, and three if unmarried, besides the food necessary for his family. Whilst in the tintales every labourer whether married or single, is paid according to his labour, and as there is no overseer, as in cultivation, to take note of their work, each makes a separate delivery, keeping a daily account of weight and date in the "tintales," from which they cannot remove the wood until the floods.

They employ themselves in cutting and stacking it, till the season approaches in which it is removed in small boats; then each person barks and delivers by weight as much as he has cut, and this is divided into daily tasks (tareas), and the value of each tarea is placed to his credit. These tareas consisted formerly of 25 pieces, averaging nine inches in thickness, and weighing between ten and twelve Castilian quintals, or cwt. without the bark. This method is still in vogue in some establishments, but in others the tarea has been reduced to four or five light quintals barked and brought to the loading-place. It is calculated that when there is abundance of wood a man of mediocre strength can compass that amount of labour in a few hours. Some labourers are paid a real and a half (9¾d.) for every quintal delivered within certain bounds; these are called quintaleros, and their families are not maintained by the proprietor. But most commonly eight reals per tarea are paid, and that shows that the labour applied to this branch produces 150 per cent. more than the farm labour, supposing a man does not cut more than half a tarea a day, which, including the food he receives, amounts to five reals. The farm labourer only receives two, hence it is that logwood cutters look better and are more comfortable than the others, although they work much harder, having the means of satisfying all their wants. The export of logwood in the last year of the Campeche settlement, 1716, was no less than 5,863 tons.

The Honduras logwood trade has not increased of late years, although the dye it yields is superior to that obtained from the wood cut in Jamaica and St. Domingo. The Honduras and Yucatan wood sells for 6*l.* 6s. to 9*l* 10s. per ton, and the Jamaica and St. Domingo wood for 5*l.* to 5*l.* 10s. per ton ; this is a very different price from that which it realised in Dampier's days. He tells us that it then sold for 100*l.* per ton, which, allowing for the difference in money, would be equal to nearly 200*l.* at the present day. The Jamaica and St. Domingo wood is used in the dyeing of carpets and other coarse cloths, while the Central American is employed for dyeing all kinds of woollen, cotton, and silk fabrics. A considerable quantity of logwood is shipped from Honduras to Oporto (according to a paper by Chief Justice Temple in the 'Journal of the Society of Arts'), whence it comes to us as prime port wine, recommended by the faculty for its superior nutritious and astringent qualities. A large quantity of logwood is also exported to the United States.

Captain Dampier, the celebrated navigator, who wrote an account of his voyage to the Bay of Honduras in the year 1674, gives some interesting details of the rise of the logwood trade. He thus describes the trees :—"They are much like our whitethorns in England, but generally a great deal bigger ; the rind of the young growing branches is white and smooth, with some prickles shooting forth here and there, so that an Englishman not knowing the difference, would take them for whitethorns, but the body and the old branches are blackish, the rind rougher, with few or no prickles. The leaves are small and shaped like the common whitethorn leaf, of a palish green. We always chose to cut the old black-rinded trees, for these have less sap, and require but little pains to cut and chip them. The sap wood is white and the heart red ; the heart is much used for dyeing, therefore we chip off all the white sap till we come to the heart, and then it is fit to be transported to Europe. After it has been chipped a little while it turns black, and if it lies in the water it dyes it like ink, and sometimes it has been used to write with. Some trees are five or six feet in circumference, and these we can scarce cut into logs small enough for a man's burden without great labour, and therefore we are forced to blow them up. It is a very ponderous sort of wood, and burns very well, making a clear strong fire and very lasting. We always harden the steels of our fire-arms when they are faulty in a logwood fire, if we can get it."

Logwood contains, according to Chevreul, a peculiar colouring principle, which he has termed hematin, and which may be obtained as follows :—On the watery extract of logwood digest alcohol for a day, filter the solution, evaporate gently again, and then leave the liquid at rest. Hematin is deposited in small crystals, which after washing with alcohol, are brilliant and of a reddish white colour. Their taste is bitter and astringent.

Hematin forms an orange red solution with boiling water, becoming yellow as it cools, but recovering when heated its former hue. Alkali converts it first to purple, then to violet, and lastly to brown, in which case it seems to be decomposed. Metallic oxide unites with it, forming blue compounds. Gelatine throws down reddish flocculi. Protomuriate of tin renders it lilac.

Logwood shavings yield their colour to water and alcohol ; the latter extracts it more readily than water. The colour of its dyes is red, inclining to violet or purple. Its aqueous decoction, left to itself, becomes yellowish, and at length black. Acids turn it yellow ; alkalies deepen its colour and give it a purple hue. Stuffs would take only a slight and fading colour from decoction of logwood, if they were not previously prepared with aluminous mordants. A blue colour may be obtained from it by the addition of verdigris, but the great consumption of logwood is for blacks, which are obtained by alum and iron bases, and of any requisite degree of intensity.

The bark and the gum of the logwood tree are used as astringent remedies.

Scientific Notes.

Maple Sugar in New Brunswick.—It is not easy to estimate the average quantity of Maple sugar manufactured annually, as it is not subject to any regulation by which it could be ascertained. We know, however, from the census returns, that in 1851 it amounted to 350,957lbs. ; but again in 1861 it had fallen to 230,000lbs. It would be unfair, however, to conclude that the average manufacture had really declined, because very much depends upon the character of the season, and the pressing nature of other employments. There is no systematic plan in existence for developing this production. All that is manufactured is by individual farmers and their families, and the whole work must be accomplished in a few weeks in the spring, generally from the middle of March to the middle of April. In order that the sap may flow freely, it requires cold frosty nights, succeeded by clear, bright days, and when, as sometimes happens, the interval is marked by dull, cloudy, or stormy weather, it almost precludes the prosecution of the work. It is quite certain, however, that a profitable trade might be made of the article if a little enterprise and capital were employed for its production. The sugar is of excellent flavour and may be refined to any degree of whiteness.

EXPERIMENTAL FARMS IN SOUTH AFRICA.—A colonial botanist, writing under date, "Riversdale, Oct. 17," says:—"In developing the resources of the colony, much may be done by experiments on vegetable productions of the land which may be turned to economic use, or may be otherwise employed in the arts and manufactures. Amongst these are the following:—Experiments on its grasses, which are all important to a pastoral people; experiments on its Olives, of which we have more than one species indigenous at the Cape, and it remains to be proved whether the land can or cannot be made to produce the cultivated olive or to produce the wild olive in such a form that the cultivation of it might be remunerative; experiments on its Indigo plants, of which we have a great many species, and in regard to which the same remarks may be made which have been made in regard to the olive; experiments on its numerous Euphorbias, the milk of which seems to be similar in its constituents to that producing the India-rubber and the gutta-percha, for which there is now a great demand; experiments on its Aloes and its Buchus, the products of many of both of which are already exported in considerable quantities; experiments on its Castor-oil plants and its Candleberry myrtle, both of which are growing abundantly in many localities. There are also experiments to be tried on the preparation of the refuse of the Maize to fit it for economic uses; on the cultivation of Flax, of Rape, and of Mustard, for seed and oil, on the cultivation of hill Rice and Cotton, and on the improvement of Tobacco and Wine. All of these experiments ought to be made with the accuracy of research for scientific purposes, with accurate details of weights and measures, of time actually employed in culture, &c.; of actual expense; and of actual pecuniary value of returns obtained. And, for the good of the colony, it is desirable that these should be published. It is too much to expect that this will be done by men actually engaged in agriculture, finding it necessary to give their whole time to what more immediately demands their attention. But there are many who would gladly avail themselves of the results obtained by such experiments if explicit statements of the experiments were furnished to them. By the establishment of an experimental farm the number who would do so would probably be greatly increased if provision were made for the board and training of young men on the farm, while their training there would fit them for carrying out similar experiments on a larger scale in the field. To teach men to philosophise is of more importance than to teach them philosophy, and to educate is of more importance than to instruct. By the labour of such young men the expense of the establishment would be somewhat reduced. Of the experiments of Liebig in agricultural chemistry, it is said (I know not with what truth) that the whole have been conducted under his direction by young men paying a high fee for permission to labour under him in his laboratory; and so it might be with such an establishment as I have supposed, if properly conducted."

How the Chinese make Dwarf Trees.—We have all known from childhood how the Chinese cramp their women's feet, and so manage to make them "keepers at home;" but how they contrive to grow miniature pines and oaks in flower-pots for half a century has always been much of a secret. It is the product chiefly of skilful, long-continued, root-pruning. They aim first and last at the seat of vigorous growth, endeavouring to weaken it as far as may consist with the preservation of life. They begin at the beginning. Taking a young plant (say a seedling or cutting of a cedar), when only two or three inches high, they cut off its tap root as soon as it has other rootlets enough to live upon, and replant it in a shallow earthen pot or pan. The end of the tap-root is generally made to rest on the bottom of the pan, or on a flat stone within it. Alluvial clay is then put into the pot, much of it in bits the size of beans, and just enough in kind and quantity to furnish a scanty nourishment to the plant. Water enough is given to keep it in growth, but not enough to excite a vigorous habit. So, likewise, in the application of light and heat. As the Chinese pride themselves on the shape of their miniature trees, they use strings, wires, and pegs, and various other mechanical contrivances, to promote symmetry of habit, or to fashion their pets into odd fancy figures. Thus, by the use of very shallow pots, the growth of the taproots is out of the question; by the use of poor soil and little of it, and little water, strong growth is prevented. Then, too, the top and side roots being within easy reach of the gardener, are shortened by his pruning-knife or seared with his hot iron. So the little tree, finding itself headed on every side, gives up the idea of strong growth, asking only for life, and just growth enough to live and look well. Accordingly, each new set of leaves becomes more and more stunted, the buds and rootlets are diminished in proportion, and at length a balance is established between every part of the tree, making it a dwarf in all respects. In some kinds of trees this end is reached in three or four years; in others ten or fifteen years are necessary. Such is fancy horticulture among the Celestials.

Wild Arrow Root.—In the jungles of Chittagong, and other parts of India, is found a species of ginger, commonly known as "wild arrowroot." The leaves of this plant die off at the end of the rains, and its tubers are found during the cold weather abounding in starch, which they yield to slicing and maceration in water. Starch is largely used in manufactures in England, and a great quantity of the rice exported from America is converted into starch. If this Indian starch were imported in quantity at a cheap rate, it would find a ready sale. The supply of the wild arrowroot is inexhaustible, and if removed at the proper time of year, would furnish materials for a simple and valuable manufacture, while at the same time the growth of a noxious jungle would be checked.

Amianthus.—In Corsica a few years since they made use of amianthus in the manufacture of common pottery, which gave it great toughness and tenacity, and enabled it to resist most efficaciously the effects of a blow, or of irregular dilatation. Amianthus is also found mingled with the paste of some Chinese vases of common manufacture.

Fibres of Bermuda.—The Cotton plant (*Gossypium Herbaceum*), or common short staple cotton, is a perennial in the Bermudas, enduring for a period of from twelve to twenty years, grows to a height of eight or ten feet, producing abundantly during the whole time of its existence, and bears two crops a year. We have specimens from trees fifteen years old growing wild in barren spots; but if the plant were cultivated with the care that is bestowed upon it in the Southern States of America, abundant crops of the long-stapled variety could be grown here, possessing all the silky fineness so desirable in the fibre. Both the climate and soil are admirably suited for its production, and there is land enough lying wild and useless that, if cultivated, would yield a million of pounds annually. Fibre of the Changeable Rose (*Althea Flos-mutabilis*). This plant grows wild in the Bermudas, and, if cultivated, would yield an abundance of fibre suitable for the manufacture either of cloth or paper. The specimen sent was obtained from the bark of the tree, but the stems of the smaller boughs and twigs would also furnish good fibre. Besides fibre, the bark yields a gum, which might also be made useful. Fibre of the American Aloe (*Agave Americana*). This plant grows wild in the Bermudas, and in great abundance. It delights in rocky soils, and would do well on hill sides and in exposed situations, where scarcely anything else worth cultivating would grow, and it would also form a good hedge. The fibre is admirably adapted for the manufacture of all kinds of cordage.

New Fibre for Paper.—The dearness and scarcity of rags has in some cases compelled the makers to experiment and make use of other substitutes in the room of rags. Whatever may be said about the permanent injury to the trade from the condition of the rag question, no one can doubt that the greatest benefit must accrue from the encouragement and favourable reception of other fibres. Already the most salutary benefit has been felt from the steady increase in the use of esparto. But for its timely relief the price of rags would be enhanced to such a degree, that it would be ruinous to work at present prices. The makers are beginning to see that their antagonism to growing fibres has left them in a very sad state, now that foreign legislation has crippled the free use of rags. The knowledge of esparto is not so very modern that we should only now be going to school to know its qualities and its worth. It has been before the world from a remote time, and the use of it in paper-making has been known since the middle of the last century. We have found it referred to in a work of Schauffer, published in 1753, at Nuremberg. The only thing required has been the spirit of enterprise to make it subserve our purpose. No paper-maker will venture on a trial with a *new fibre* until some outside difficulty drives him to do it. The difficulty has come, and so also has come the free use of it, and encouragement given to it in quarters that would formerly have scorned to lift it for the price of carting it into their mill. In Britain we have taken up esparto to the exclusion of all other new fibres nearly, but on the continent we find several substitutes have taken a permanent hold of the market. The only place on the continent in which esparto is used to any great extent is in Belgium. In France and Germany they make use of wood fibre, prepared according to M. N. Vaelter's patent. They also use alfa fibre for esparto. This they do on account of its growing in Algiers, which is a French colony. The paper-makers are actively using beet-root and maize in paper-making, and herein show far more enterprize than we do to find a material at once suitable and cheap.—'Paper Trade Review.'

Cultivation of the Sunflower.—To produce this plant (*Helianthus,* annnal sunflower), in perfection, there is required a light, rich soil, as unshadowed by trees as possible. The earlier the seed can be got into the ground the better, say the end of September, or the beginning of October, as the crop will be ready to harvest the latter part of February, which will be the greatest importance to growers. The necessary quantity of seed required for an acre depends on the condition of the soil, and varies from four pounds to five pounds; but of course it is advisable to sow a little more than is actually wanted to provide against accidents. The seed should be drilled into the ground, and the distance from row to row eighteen inches; the plants to be thinned out to thirty inches from plant to plant, and the number of plants at this distance would be about 14,500 per acre; at eighteen inches from plant to plant 25,000 per acre; and at twelve inches from plant to plant 32,000. The produce of this kind, like that of most others, varies considerably, according to the state of the soil, the climate, and the cultivation that is employed; but the average quantity of seed is about fifty bushels per acre. This will produce fifty gallons of oil, and of oil cake 1,500 pounds. The stalks when burnt for alkali, give ten hundred weight of potash. The seed forms a most excellent and convenient food for poultry, and it is only necessary to cut off the heads of the plants when ripe, tie them in bunches, and hang them up in a dry situation, to be used as wanted. They not only fatten every kind of poultry, but greatly increase the quantity of eggs they lay. When cultivated to a considerable extent they are also capital food for sheep and pigs. The leaves, when dried, form good fodder for cattle. When the flower is in bloom it is most attractive to bees. The stalk is admirably adapted from its fibrous character, for the manufacture of paper.

Growth of the Bamboo.—In the Royal Botanic Garden at Edinburgh, the average growth of one specimen was six inches a day in a temperature of from 65° to 70°. The Burmah Bamboo (*Bambusa gigantea*) is considered the prince of Bamboos. It attains the height of 100 feet, each joint ranging from 20 to 24 inches in length, and as much as 36 inches in circumference. It has been known to grow 18 inches in 24 hours. This bamboo in Bengal attains a height of 65 feet. Of indigenous kinds the *Bambusa Tulda* rises to its full height of 70 feet in about one month. This is at the rate of about an inch an hour and should be visible. The "Balcoo Bans," chiefly used in house building on account of its toughness and solidity, averages from 50 to 60 feet in height. The "Tulda Bans" was used some seven years ago in a novel way by some Burmese villagers as a means of defence. By taking three joints, then cutting one to make a mouth, scooping out the centre joint, and boring a hole in the third, and then loading it with powder and shot, they managed to keep off the intruders. These imitation guns would often stand out five or six shots when well wrapped up with jute fibre, or any other strong description of rope. In the absence of this protective covering, they would often burst in the second discharge.

PUBLICATIONS RECEIVED.

Popular Science Review. No. 10.—Dental Review. No. 1. Robert Hardwicke.—The Paper Trade Review. No. 1, Vol. II.—The Paper-Makers' Monthly Journal for January.—Journal des Fabricants de Papier.—Revue du Monde Colonial.—Ironmonger.—Chemist and Druggist.

THE TECHNOLOGIST.

THE PAPER-TREE OF SIAM (TON-KHAI), *TROPHIS ASPERA*, W.

BY SIR ROBERT H. SCHOMBURGK, PH.D., F.R.S., ETC.

At the present time, when the question from whence are we to get the material for our supply of paper has become of some importance for want of rags, the old legitimate substance for its manufacture, the description of this tree, and the manner in which its bark is prepared in Siam into paper, may perhaps be of some interest.

The quantity which is used as writing paper is far from insignificant. For common purposes, the haberdasher, the grocer, and the huckster, use the common yellow paper from China to wrap parcels in for their customers, but for legal documents, letters, account books, &c., they are written on Siamese paper. The Government authorities address their officials upon the white Siamese paper of the size of one of our own sheets of foolscap, not folded; but for composing the draft of a letter, or to be used as a waste-book in commercial affairs, to write a tale, or some poetic composition (offered for sale in stalls at the bazaar or talat), then the Samut dam, composed of black paper, is used. But the Siamese artist who illustrates the tale or an allegory, uses the white paper, and upon it, rough as it appears, represents his objects in as vivid colours as the Chinese do upon their soft rice paper.

The crayons or pencils are prepared of carbonate of lime, or common limestone, and the mass for black pencils is coloured with the coal produced by burning the sticks of a Cassia, which is likewise used for colouring the black paper books.

The King dictates or writes himself his despatches on the Samut dam; they are then given to one of the copyists, who are lying prostrate before him, to transfer them on white paper with black crayons, and they are then despatched to their destination. The usual size of the

Samut on which the drafts are written is fourteen inches in length, and four inches in breadth. It is folded up in such a manner that the writer, having filled one page, has merely to turn over to commence a second, and then he continues in the same manner until sixty, if the importance of the matter requires it, are filled up in a similar manner; so that, when the book has been entirely employed, and is spread out, it will extend to twenty-one feet. There are, however, others of less size.

The tree which yields the bark is *Trophis aspera*, of Wildenow, a species of the Ramon tree of the West Indies, the leaves of the latter of which are frequently used for fodder for cattle and horses when, during the dry season, grass is scarce. The scabrous state of the East Indian species would prevent this.

The paper-tree is called by the Siamese "Ton-Khai," and is by no means uncommon. It is to be found as well on the alluvial soil of Siam, as up the country, for three hundred or four hundred miles from the sea-shore. The trees which I have seen were only of middle size, but I understand that the trunks of old trees reach a diameter of from two to three feet. But it is not such old trees which are used for the manufacture of paper—those as thick as a man's thigh are preferred. After they have been cut down, and the superfluous branches lopped off, they are laid in pieces of about three feet in length for a short time on a coal fire, which facilitates the stripping of the bark. The latter is then steeped in water for two days, after which the liber is easily separated from the outer bark, which is of a dark colour, but not entirely useless, as it is added to the stuff for making black paper. The liber is now kneaded, and put on a wooden table, round which, in the present instance, I saw sitting three men, beating the mass with mallets until it came to a certain consistency; it was then placed in baskets, the bottoms of which were constructed like a sieve, and water having been added, the pulp is percolated free of impurities and fibres. This mass was then spread equally on perforated cloth within frames, of the size the paper was to possess, and taken to the adjacent canal, dipped three or four times into it, when the frame was raised slightly out of the water, and a stick of smooth bamboo about as thick as the size of a finger and of the length of the sheet, rolled carefully four or five times over the mass, which then adhered and formed a smooth surface. The frame was now taken out of the water, and placed in a somewhat slanting direction against a scaffolding to dry.

The proprietor told me, that with fair weather, and three or four assistants, the materials being prepared, only requiring their being beaten into a mass, he could make 100 sheets in a day (each about 6 feet in length and 16 inches in breadth), for which he receives from the retail merchant, 4 ticals (10 dols.), the latter sells them at 1 fuang (3¾d.) for two sheets. There are likewise sheets of smaller size, not much larger than our usual foolscap.

I have it not in my power to state how much matter, convertible into paper, a cwt. of the bark contains. Its bulky size would prevent its being shipped with any advantage to Europe—but another question presents itself—might not the paper with stamping mills and other improved machinery be prepared at Siam in a raw state, transhipped, and converted into letter, note, and printing paper, or for any other purpose, by being re-manufactured ? I think if my memory bears me out, I have read that already now a good deal of paper, printed or otherwise, is again reduced to pulp to make clean sheets of it.

For the purpose of rendering the sheets of the Samut black, as I have already stated, the shrubby branches of a Cassia, which grows along the canals in abundance, are burnt to charcoal, pounded, and dissolved. The solution is then applied with a piece of rag to the paper. The green paper which is only tinted on one side, is coloured by a mixture of Indigo and Turmeric.

I must not omit to state that the leaves of the paper tree, which are scabrous on both sides, are employed like those of the *Curatella americana* by the Indians in Guiana to polish articles of wood, to clean rusty knives, swords, muskets, &c.

Bangkok, Siam.

SOME ECONOMIC USES OF NUTS AND SEEDS.

BY THE EDITOR.

There are many nuts and seeds which are collected in different countries, and converted into various uses. Our continental neighbours seem to be more ready and clever than we are in applying nuts, seeds, and such small articles to purposes of personal decoration; and although, from being cheap, many of these ornaments are despised by our belles, yet none can deny their interest and beauty, and the ingenuity and taste with which they are worked up. The field is an exhaustless one, and many well-known ornamental nuts and seeds of India and South America have not yet made their appearance in this country. Many wild nuts and seeds are also used for food.

The spherical and curiously sculptured or corrugated seed of the *Elaeocarpus ganitrus* and other species cleared of their soft pulp, are used by the Brahmin priests as beads. They are also made into necklaces and bracelets for ladies, which are much admired, especially if gilded or capped with silver mountings. Those of *Monocera tuberculata* are used for a like purpose in Travancore. The nuts of *Putrangiva Roxburghii*, called in Hindostan "Jeeopatra," are strung by the natives and put round the necks of their children, as an amulet, to keep them in health.

Various modern travellers speak of the import of the turbinth seeds

(*Pistacia terebinthus*) into Egypt; and Belon mentions a tradition that the Persians lived on these seeds before becoming acquainted with bread.

The turner has profited largely by the extensive introduction of the vegetable ivory and coquilla nuts from South America, which are now applied to a great variety of useful and ornamental purposes. They are mere waste products in the countries whence they are obtained. These nuts have been already described in the TECHNOLOGIST, vol. ii., p. 38, and vol. iv., p. 259.

The seeds of the shreetaly or talipot palm (*Corypha umbraculifera*), being a species of vegetable ivory, are turned into marbles, beads used by certain sects of Hindoos, button moulds, and various small articles. Little bowls and other fancy ornaments are made from them; and, when polished and coloured red, are easily passed off for genuine coral. These nuts could be obtained in large quantities in Canara Malabar and other parts of India; the chief objection is that they are of small size. A kind of flour is obtained from the nut.

The fruit of the doon palm is turned into beads for rosaries, and, in Africa, made into little oval-shaped cases for holding snuff. These have a small opening at one end, stopped by a wooden peg.

The ribbed seeds of the common bead tree or Persian lilac (*Melia azedarach*, Linn.) are frequently bored and strung for beads by Roman Catholics. A valuable oil is also produced from them.

The fruit of the bladder nut tree (*Staphylea pinnata*) is a bladdery capsule, containing a nut as hard as bone. The nuts, in some parts of Europe, are threaded for paternosters by Romanists, and made into necklaces and chaplets. They are also called cut-noses and false pistachios. The kernel of the nut has a little of the flavour of pistachios, but is very acrid, and occasions nausea if eaten to any extent. It yields by expression a bland oil.

The large red seeds of *Adenanthera pavonina*, a leguminous tree, called in India red sandal wood, weighing almost uniformly four grains, are frequently employed by jewellers and others in the East as petty weights. In Burmah they are called the large ruay, in contradistinction to the seeds of *Abrus precatorius*, which are known as the small ruay. Two small ruays are there equal to one large, and valued at a pice, and four large ruays are equal to one bai, or an anna, which is 1½d. In some parts of India the seeds are called goonch. Very pretty rosaries, bracelets, and other trinkets, are formed of them. A cement is made by beating them up with borax and water. The natives in Travancore have an idea that, taken internally, they are poisonous, especially when in a powdered state. But in Ceylon the seeds called madeteye are roasted and eaten.

The beautiful seeds of the wild liquorice plant (*Abrus precatorius*), of a bright scarlet colour, with a jet black spot at the top, are used by the jewellers and druggists of India as weights, each weighing almost uniformly one grain; also for beads and rosaries, whence the specific name.

From their extreme hardness and pretty appearance the Hindoos and others prize them for necklaces and other ornaments. In the Feejee Islands they are used for covering oracles and other sacred objects. They form an article of food in Egypt, though considered hard and indigestible. They are reduced to a fine powder by the native goldsmiths, who use them in this state to increase adhesion in the more delicate parts of manufactured ornaments. In Hindostan they are known as the Retti weights.

The larger seeds of the necklace tree of the West Indies (*Ormosia coccinea*), of a brilliant red hue, with a black spot at one end, are now beginning to be used for sleeve-links and shirt studs. The red Barricari seeds of *Erythrina corallodendrum*, a leguminous tree of the West Indies, are also used for ornamental purposes.

The grey bead-like seeds, known under the popular name of Job's tears (*Coix lachryma*), are the stony fruit of a graminaceous plant. They are chiefly used in Catholic countries for rosaries, but in times of scarcity they have served for food in some countries. Another species is used in the Laos country of Asia to ornament dresses.

The large, bony, shining, grey, nearly globose seeds, called Nicker beans or Bonduc nuts (*Guilandina Bonducella*), are used for bracelets and rosaries, and are very ornamental when capped and set. They are sometimes called in this country Molucca beans. I have in my private collection, baskets, bracelets, rosaries, and other fancy articles formed of them, and ornaments made of the seeds are common in most museums. In Barbadoes the plant is known as the horse nicker or chick-stone. The medicinal properties of this seed are described in vol. iii., p. 304.

The Indians of Brazil put small stones into the empty nuts of *Cerbera Ahouai*, with which they ornament their legs. The fruit is a deadly poison.

The small, round, black seeds of the Indian shot (*Canna Indica*), are used by the Burmese for sacred beads, and by Hindoos for necklaces. It is called in Guiana buck-shot, and the natives use them as shot. They have also been employed as a substitute for coffee, and yield a purple dye. Another round, black seed, of a larger size, is the kernel of the fruit of *Sapindus saponaria*, Linn., and of *S. emarginatus*, Vahl., and other species, which is much used now for rosaries, necklaces, bracelets, and other ornaments. The nuts are exceedingly hard and tough, and take a fine polish. The kernels of *S. esculentus* are eaten in the West Indies, and deemed as palatable as the hazel-nut or almond. They are generally termed soap-berries. The fruit are used as indicated by the native name, and sold in all the bazaars in India ; they are used for a similar purpose in South America. The arils, or capsules, are very acrid ; they lather freely in water, and will cleanse more linen than sixty times their weight of soap, but in time, it is said, they corrode or burn the linen. This assertion, however, requires confirmation.

It may be incidentally mentioned that the saponaceous principle "saponine" exists in many other seeds and roots, &c., in the legumes of *Mimosa saponaria*, Roxburgh, and of *Mimosa abstergens*, in the leaves and root of *Saponaria officinalis*, in the root of *Vaccaria vulgaris*, *Agrostemma Githago*, and *Anagallis arvensis*. *Gypsophila struthium* is used by the Spaniards for scouring instead of soap. It also occurs in various species of *Dianthus* and *Lychnis*, in the bark of *Quillaria saponaria* and *Silene inflata*, and the bark of the root of *Monnina polystachya*, which, pounded and moulded into balls, is used for soap by the Peruvians. The *Phalangum homeridianum* is the soap plant of California. The bulb, when stripped of its husk and rubbed on wet clothes, makes a thick lather, and smells not unlike new brown soap. A considerable trade is carried on in some parts of India in the pods of *Acacia concinna*, which resemble the soap-nut, and are used, like it, for washing the head. They are also employed by the Hindoos for marking the forehead.

The seeds of *Achyranthes aspera*, Linn., are administered by native practitioners in India in hydrophobia, and in cases of snake bites, as well as in ophthalmia and cutaneous diseases.

The small brown seeds, something like apple pips, so commonly used, when strung thickly together, for bracelets, fancy reticules, nets for the hair, candlesticks, and other ornamental work, are the produce of *Desmanthus virgatus*. They are frequently dyed black for effect. The seeds of the pod of the Carob tree (*Ceratonia siliqua*), are said to be the original carat weights of the jewellers. They are now ground up as cattle food, the pods being a large article of commerce. In the Portuguese settlement of Ambriz, Africa, the seeds of the custard-apple are strung upon thread as necklaces. In the Kew Museum are rosaries made of olive seeds and other stones. Immature oranges, when polished in the lathe, make very pretty rosaries, with a pleasant aromatic odour, and they are also sold in chemists' shops as "issue peas." Under the name of orange berries they are used for flavouring curaçoa.

The seed of the tamarind is seldom made use of in this country, but I have seen them strung as necklaces. In times of scarcity, the poor of India eat them. After being washed and soaked for a few hours in water, the dark outer skin comes off; they are then boiled or fried. An oil has also been obtained from the seed. The seed is sometimes given by the Vytians in cases of dysentery, and also as a tonic.

Date-stones have their uses. It is stated that in certain parts of Egypt they are boiled to soften them, and the camels and cattle feed upon them. The Chinese burn them, and they are said to enter into the composition of China ink. In Spain they are burnt and pounded for tooth-powder, and vegetable ivory nuts and others are also burnt for the same purpose.

The nuts and kernels of some stone-fruit, as apricots, peaches, prunes, and cherries, and also bitter almonds, bruised and distilled with spirit, give a not unpleasant flavour. This spirituous extract, whether made by infusion or distillation, when sweetened with sugar, is the too famous cordial called noyeau (from the French *noyau*, a nut). This liquor contains a notable proportion of prussic acid, and is probably the most noxious of all the spirituous compounds. The kernel of the nut of stone fruit is mucilaginous, and might be malted, but in most of those fruits it is of a doubtful character, and in some it is believed to be absolutely poisonous. Nevertheless, these kernels, as well as their shells, are occasionally made use of for the purpose of imparting an aroma, which is sought after by connoisseurs. The stones of apricots have of late years been collected at Damascus, and sent to Beirut for exportation, probably for the sake of the prussic acid they contain. In 1862, about 200 cantars, or 110,000lbs., were exported, at a cost of 8¼ piastres per rottol, or a little under 2d. per lb. More than double that quantity was exported in 1861.

Under the names of Mahleb, or Melub, the fragrant kernels of *Prunus Mahaleb*, Linn., strung as necklaces, are much valued by the women of Scinde and other parts of India. They are also used by the Turkish bakers to sprinkle over bread.

Cherry and other fruit stones are often seen carved and highly ornamented, and made into rosaries, &c., evidencing the patience and skill of the workman who has laboured on them. I have many of the hard stones of the date plum, and other indigenous fruits, very beautifully carved by the Chinese and Japanese.

Several kinds of hard brown beans have lately been brought into use for making bracelets and other ornaments. Their plainness and monotony is relieved by gilt or steel studs and settings, and small beads intermingled with ornamental pendants. The large horse-eye bean, a species of *Mucuna*, is really ornamental and curious, when mounted for bracelets. The large brown seeds of the sword-bean (*Entada gigalobium* and *E. Pursœtha*), are made into spoons, small coin-cases, scent-bottles, &c.

Walnut shells are frequently mounted with hinges, and used as the ornamental cases for miniature articles, such as scissors, thimbles, &c. The Limerick gloves are packed in walnut shells, while rings, jewels, and other small presents are often disguised in this rough case as an agreeable surprise.

The shells of the cocoa-nut are in large demand over India for the hookah pipes used by the natives. They constitute the common water dipper of many countries, and are used for oil lamps, water bottles, and goblets. In Ceylon, and other parts, they are often elegantly carved, and formed into fancy articles, such as small card baskets, sugar basins, and mounted in silver as drinking cups. Special virtues have been attributed to such cups, they are supposed to give an anti-apoplectic quality to intoxicating liquors. In Siam the shell serves as a measure for liquids. The capacity is graduated by the number of cowry shells it will hold; thus there are cocoa-nut cups of 1,000 cowries capacity, 500 cowries, and so on.

The fleshy pulp of the fruit of some of the calabash trees is eaten, but in most species it is deleterious. The young fruit are pickled. The most valuable part of the calabashes is their rind, which is tough, and applied by the negroes to a variety of purposes.

Calabashes—the hard covering of the fruit of *Crescentia cujete*—are used for all kinds of domestic utensils in Africa, the West Indies, and South America. Cups and saucers, baskets and bowls, pepper and salt dishes, &c., of various sizes, made of them, plain or carved and ornamented, take the place of crockery, and are not so easily broken. Many will stand the fire for cooking as well as an iron pot.

I have already described the various uses of the betel-nut (vol. ii., p. 332). The nuts of various other palms have some few economic applications. The gru-gru nuts of the West Indies, the seeds of *Acrocomia sclerocarpa*, are turned and carved into very pretty beads, rings, and other small articles, the hard black texture of the nut taking a fine polish. The albuminous fruit of *Raphia vinifera* are carved into little figures by the African negroes.

The seeds of *Oncoba spinosa* are used by the Kaffirs for snuff boxes. The fruit of *Barringtonia speciosa* is used instead of cork for seine floats at the Feejee Islands and Sooloo.

The seeds of the greenheart tree of British Guiana (*Nectandra rodieii*) are used as a febrifuge and tonic. Occasionally, in time of scarcity, grated and mixed with the decayed Wallaba wood (*Eperua falcata* Aubl.) They are used by the Indians as food.

The musk seed of commerce (*Abelmoscnus moschatus*) is the "Kalakustooree" of the Hindoos, the "Hubbul mooshk" of the Arabs, a celebrated ingredient, used in their coffee with such wonderful improvement of its flavour, as to have led to its introduction for the same purpose amongst Europeans, even in India.

The Tonka bean, also termed Gayac bean, the seed of *Dipteryx odorata*, is used for perfuming clothes and snuff. Its peculiar principle is called coumarin.

The shell of the fruit of the *Adansonia digitata* is used by the Soahili of Africa as a substitute for water buckets.

The trade in the principal edible nuts of commerce has been described in vol. iii., p. 456, but a few incidental notices of some other nuts which are eaten may be here given.

The kernel of the nuts of *Terminalia catappa*, Linn., has the taste of an almond, and may be used for the same purposes, but does not contain so much oil. The expressed oil is edible and pleasant tasted, but becomes turbid by keeping. It only requires care and attention in its preparation to render it of greater commercial value and importance. The kernels of the fruit of *Buchanania latifolia*, Roxb., are a general substitute for almonds among the natives of the Indian Peninsula.

They are much esteemed in confectionary, or roasted and eaten in milk.

The fruit of *Canarium commune* in taste is something like an almond. An oil is expressed from the nuts, which in Java is used in lamps, and when fresh is mixed with food. Bread is also made from the nuts in the Island of Celebes. If eaten fresh or indulged in too freely, they are apt to bring on diarrhœa. From the almond of the *Geoffroya spinosa*, Jacquin, is extracted a white and nutritive fecula, of which the inhabitants of parts of Brazil make much use.

The natives eat the fruit of the wild almond of the Cape (*Brabejum stellatifolium*, R. Br.), after many days soaking in water, as they attribute noxious qualities to it when fresh. The roasted kernel serves as a substitute for coffee.

The nuts of the Otaheite chestnut (*Inocarpus edulis*) are called Rutta by the natives. The kernel of these is kidney-shaped, about an inch in diameter, and is eaten roasted by the inhabitants of the Society and Friendly Isles, the New Hebrides, New Guinea, the Molucca Isles, &c. It is sweetish, but less pleasant than the chestnut, harder, and less farinaceous.

The albuminous seeds of *Morinda bracteata*, the bean of *Inga dulcis*, the acorn of *Castanea indica*, and the seed of the Jack fruit (*Artocarpus integrifolius*) when roasted are articles of food.

The seeds of the Moreton Bay chestnut (*Castanospermum Australe*) are eaten by the natives on all occasions; it has, when roasted, the flavour of a Spanish chestnut; and Europeans who have subsisted on it exclusively for two days state that no other unpleasant effect was the result than a slight pain in the bowels, and that only when it was eaten raw. It grows along the rivers Logan and Brisbane, in Queensland. Although the large and handsome seeds are eaten by the natives of Brisbane river, some persons assert that they are hard, astringent, and not at all better than acorns.

The cone of the *Auracaria Bidwelli*, Hook., (native name Bunya Bunya) of Northern Australia, is produced on the extreme upper branches It is large, measuring nine to twelve inches in length, and nine inches diameter; on coming to maturity, the seeds are readily shed; they are from two to two and a half inches long, by three-quarters of an inch broad; sweet before being perfectly ripe, and after that resemble roasted chestnuts in taste. They are plentiful once in three years; and when the ripening season arrives, which is generally in the month of January, the aborigines assemble in large numbers, from a great distance around, and feast upon the seeds; each tribe has its own particular set of trees, and of these each family has a certain number allotted, which are handed down from generation to generation with great exactness. The Bunya is remarkable as being the only hereditary property which any of the aborigines are known to possess, and it is therefore generally respected by the settlers.

The Italian stone pine (*Pinus pinea*) has edible seeds, which are eaten at dessert, under the name of pine nuts. They are largely used for consumption in Italy, under the name of Pinoli-molese. They come chiefly from Tuscany and from the Province of Ravenna, and are thought to give a peculiar relish to wine. In the South of Europe they are also called pignons doux. Athenæus speaks of the imports of the seeds of the stone pine into Egypt. They are brought to market at Lisbon, strung upon threads like beads, and suspended upon a girdle round the waist. The seeds of *P. Lambertiana* of North America, and those of *P. Gerardiana*, of Thibet and Affghanistan, are also eatable, when fresh.

In Switzerland, the seeds of the Siberian stone pine (*P. Cembra*) are used in some places as food and in others as an article of luxury; and the shell being very hard, and requiring some time and skill to separate it from the kernel, the doing so forms an amusement for some persons in the long winter evenings, as separating the films from the kernels of the walnut does in the Tarantaise. The kernels of another species, Llaves' pine (*P. Llaveana*, Schiede) are eaten in Mexico, and those of the imbricate-leaved or Chilian pine (*Araucaria imbricata*, Pav.) in Chile. The pinones of the Cordillera pine are nutritive and farinaceous, in flavour resembling a roasted chestnut. They are found in great abundance in the Chilian part of the Cordillera, and have become so necessary an article of consumption among the Indian tribes, that, whenever the crop is scanty, or the snow precludes their access to some of those parts where they have been accustomed to collect them, they are subject to considerable inconvenience. As the seeds will keep long, they are often imported into the southern districts of Chili, and, when boiled, are eaten by the country people, either hot or cold.

With the exception of one or two trees near the coast, which have been planted, it is only found in the interior of the Indian country, south of the Biobio. The Indians of that neighbourhood subsist entirely on the seed of the Araucaria, which they harvest and bury in pits for winter use. The name of the tribe is derived from that of the tree which affords their food. The Araucaria being called *Pehuca* in the Indian language, and *Ches*, signifying people.

ASAFŒTIDA IN AFFGHANISTAN.

A SUPPLEMENTARY NOTE. BY M. C. COOKE.

To what was before known with certainty of Asafœtida in Affghanistan may be added the following particulars, communicated principally by Dr. Bellew, who was formerly attached to the Mission to Kandahar. Some portion may be a repetition of the same facts previously obtained by other travellers, and which are hereby corroborated—for other information now communicated for the first time Dr. Bellew is mainly responsible. This brief notice can, however, only be regarded as supplementary.

The asafœtida of commerce is obtained from only one plant in Affghanistan—viz., *Narthex asafœtida*. It grows wild on the hills about Herat and Furrah, and is never cultivated, though hundreds of the Kakar tribe from the Boree valley, who collect the gum, remain in the deserts to tend and water the plant.

The "tear" sort is the gum resin that exudes, and dries drop by drop, from incisions around the top of the root; the "lump" sort is the gum resin as it exudes from a broad surface, as when the top of the root is sliced off. The latter sort is more frequently met with than the former, but I do not know of any difference in the qualities of the two sorts. There are several other umbelliferous plants in Affghanistan which resemble the asafœtida plant in external appearance, and which, also, like it, when wounded, exude a milky viscid sap, but I never heard that the sap of these plants (also gum resins) was ever collected by the natives, though the plants are very abundant, especially on the western slopes and ranges of the Sufaid Koh.

The frail vaginated stem, or the lower cluster of sheathing leaves (of the asafœtida plant) the former belonging to old plants, and the latter to young ones, is removed at its junction with the root, round which is dug a small trench about six inches wide and as many deep. Three or four incisions are then made around the head of the root, and fresh ones are repeated at intervals of three or four days; the sap continuing to exude for a week or fortnight, according to the calibre of the root. In all cases as soon as the incisions are made, the root head is covered over with a thick bundle of dried herbs or loose stones, as a protection against the sun; where this is not done the root withers in the first day, and little or no juice exudes. The quantity of asafœtida obtained from each root varies from a few ounces to a couple of pounds weight, according to the size of the roots, some being no bigger than a carrot, whilst others attain the thickness of a man's leg. The quality of the gum differs much, and it is always adulterated on the spot by the collectors before it enters the market. The extent of adulteration varies from one-fifth to one-third, wheat or barley flour or powdered gypsum are the usual adulterants. The best sort, however, which is obtained solely from the leaf-bud in the centre of the root-head of the newly sprouting plant, is never adulterated, and sells at a much higher price than the other kinds. The price of the pure drug at Kandahar varies from four to seven Indian rupees per "man-i-tabriz" (about 3 lbs.), and of the inferior kinds from one and a half to three and a half rupees per "man." The asafœtida is commonly used by the Mahometan population of India as a condiment in several of their dishes, and especially mixed with "dal." It is not an article of general consumption in Affghanistan, though often prescribed as a warm remedy for cold diseases by the native physicians, who also use it as a vermifuge. The fresh leaves of the plant, which have the same peculiar odour as its secretion, when cooked, are commonly used as an article of diet by those near whose abodes it grows. And the white inner part of the stem of the full grown plant, which reaches the stature of a man, is considered a delicacy when roasted and flavoured with salt and butter.

The annual value of the asafœtida trade with India is estimated in the government reports of the North West Provinces at about 2,200*l.*

SERICULTURE IN OUDH.

BY DR. E. BONAVIA,
Secretary of the Agri-Horticultural Society of Oudh.

About the beginning of 1847,* Captain Hollings, who had charge of the Charbagh in Lucknow, introduced the large-leaved China mulberry plant into that garden. He had formed a small plantation; commenced making experiments with silkworms, and had actually reared some, but as he quitted the station, and no one undertook to continue the experiments, Captain Hollings' successes did not result in anything. The mulberry plantation was eventually dug up, and the land used for other purposes. In 1861, when the Agri-Horticultural Society of Oudh was instituted, I undertook the propagation of all the kinds of mulberry trees that were found useful by those who had tried the rearing of silkworms.

I discovered that some of the trees of the large-leaved China mulberry, originally introduced by Captain Hollings, were still in existence in the Charbagh. I procured some cuttings of them, and commenced a plantation in the Badshabagh, consisting of about one hundred plants or so. From these in 1862, I distributed two hundred cuttings to each District Officer in Oudh, and planted a good number for my own experiments. When the Agri-Horticultural Society's Garden was first commenced at the Secunderbagh, I procured a supply of mulberry cuttings of the small-leaved and of the cut-leaved† China mulberry from Saharunpore, subsequently I procured a second supply from the same place, and smaller packets from Mr. Turnbull, of Bengal, and Captain Hutton, of Mussoorie.

This year (1863), I have distributed from the Saharunpore stock planted in the Agri-Horticultural Society's Garden, nearly 9,000 of two or three sorts.

* Vide Pamphlet "On the Introduction of the Silkworm into the Punjab," by Mr. H. Cope.

† I do not designate the kinds of mulberries by their Botanical name, because I do not think those we are acquainted with have yet been referred to their proper species; possibly they are mere varieties.

Further, the Deputy Commissioner of Fyzabad, reports that he has requested the Talookdars of that district to plant each five thousand cuttings of native mulberry, and has planted himself a large number; and the Deputy-Commissioner of Durriabad has, to my knowledge, been distributing from the Government Garden, cuttings of the large-leaved China mulberry to the Talookdars of his district at the rate of several hundred cuttings each. I also understand that the Deputy-Commissioners of Baraitch, Luckimpore, and Sultanpore, have already a large number of plants and are continuing to multiply them.

Mr. Foy, of Fuzlnuggur, reports that he has planted 65,000 cuttings of the native mulberry. Major Orr, of Roy Bareilly, is also forming a plantation of mulberries.

If, as I hope, in other districts an equal interest is being taken in the multiplication and propagation of this valuable plant, we shall have, in the course of a few years, the commencement of a large number of mulberry plantations. Of course, in the Seetapore district, extensive experiments with silkworms are being made on Government account, and mulberry plants are being rapidly multiplied.

All kinds of mulberry trees thrive wonderfully in the Oudh soil, and I have little doubt that we shall be successful in grafting a branch of industry on this province, which will require time only to benefit its inhabitants considerably.

The following are reports to the Chief Commissioner of Oudh, on the progress of Government silkworm experiments, which he has kindly permitted me to publish.

Report of an experiment with the Cashmere Silkworm in the Hurdui District, by C. Lindsay, Esq., Deputy-Commissioner:

"During the course of last cold weather, I received a small quantity of eggs from Mr. Cope, of Umritsur. Owing to various causes, the box containing the eggs was not opened till the end of February, 1863. I found many of the eggs hatched, but for want of air and food most of these worms had died. The remaining eggs were speedily hatched; the last egg was hatched about the end of March. The worms were fed four times daily on the common native mulberry leaf. (The worms were not fed during the night). The eggs were hatched in large wooden boxes, and the worms kept in similar boxes till they were about an inch long, when they were transferred to large shallow baskets. The worms began to spin in the first week in April, and the first cocoon was formed about the 7th. Mr. Carnegy, of Seetapore, kindly gave me the pattern for the spinning baskets. I believe they are similar to those used in Bengal. During the whole period the worms remained remarkably healthy. I forgot to mention that the worms were kept in an empty room in my house. Specimens of the cocoons have been forwarded to Mr. Cope, Mr. Turnbull, Mr. Carnegy, and Dr. Bonavia."

The following is Mr. Turnbull's reply regarding the sample of cocoons produced at Hurdui:

" If from the Cashmere stock, they have deteriorated much. This is not only the case with yours (Mr. Lindsay's), but with those I received from Messrs. Carnegy and Cope. On the whole, I consider your cocoons very passable, and send you the silk reeled from them, which I am sure you need be pleased with, as it is as good in every way as what was sent to the Exhibition. The 69 cocoons weighed two tolas, and the silk from them weighs four annas."

The sample of cocoons sent to me from Hurdui appeared good, but they were smaller than my own.

The following is from Mr. P. Carnegy, Deputy Commissioner, concerning an experiment made at Fyzabad with the Cashmere silkworm :

"The mulberry plants received from Lucknow are thriving famously. I am doing my best to promulgate the species, which has been pointed out to me as the *Morus multicaulis*, as it is believed to be the very best.

"I do not know whether it has been brought to notice that the *Phalæna paphia*, otherwise the *Bombyx mylitta* or Tusseh silkworm, is well known all over Oudh, and is called by the natives '*Kooswaree*.' It feeds upon the *Byer*, and it has been said, also on the leaf of the *Saul.* It cannot be domesticated, and takes wing on reaching the moth stage. As far as I can learn, the only use made of the Tusseh fibre in Oudh, is as a band for tying the barrels on to the stocks of matchlocks, but in the neighbouring districts of Azimgurh, Tusseh cloth is made, and so far back as 1837, there were over 3,000 silklooms. The band which fastens the Tusseh cocoon to the tree is as hard as leather.

"The report on my cocoons by the Agri-Horticultural Society of the Punjab, was as follows : *Hurdui cocoons* fair, but somewhat thin. *Fyzabad cocoons* of a slightly better quality than the above.

"These cocoons were taken at random ; had I sent picked ones, the report would of course have been more favourable, but the estimate formed would not have been so just a one.

"On receiving the Chief Commissioner's circular, of 22nd February, 1862, I at once made its contents known to the Talookdars of the district, and indented on Mr. Cope for silkworm seed.

"It had occurred to me that the care of this experiment might with great advantage, be confided to the female prisoners in the jail, as being in every way calculated to suit their strength, sedentary habits, &c., consequently on the 21st January, when the seed was received, it was made over to the women.

"The eggs at once began hatching, but so ignorant were we all of the process, that it was not till the 25th February, that the worms lived and prospered. Many had died before these, some from the effects of being put on jail-made paper, in the preparation of which a solution of bluestone had been used. On that day a man returned from Seetapore, to which place I had sent him to be instructed by my cousin, Mr. P. J. Carnegy, and from that time all has gone on well, and few worms subquently died.

"On the 15th March, the first silk was produced, and the hatching went on till the 15th April, when it in a great measure stopped. The worms remain a month or so in the feeding state, changing their skin more than once. Then about two days giving out silk; then in seven or eight days they are moths, when they give about thirty-seven eggs each, and die.

"Three thousand cocoons are the result of the experiment. Of these 600 have been sent to Mr. P. J. Carnegy to be reeled, and he pronounces them to be 'very good ones, about as good as my own, and better than some sent from Hurdui.' Of the remainder, fifty have been sent to Mr. Cope, and the rest have been kept for seed, for next year's operations.

"The worms have been fed with the common country mulberry, (the fruit of which is dark purple and pale green). They had fresh leaves four times a day, and the refuse leaves were removed every fourth day. I may mention that while I write (4th May), eggs still go on hatching, and the feeding and spinning processes are still in progress, but of course on a limited scale. I have cocoons made since the 1st inst., which seem good, only somewhat smaller than our best ones; our operations are carried on in an airy room with glass windows.

"Maharaja Maun Sing and another Talookdar, applied through me to Mr. Cope for seed, but they were too late in the field. Next year I hope to supply the Maharaja, who seems to be much interested in the matter; myself and he will have the benefit of our experience.

"I think in the introduction of a new product, it is much the surest way of ensuring success, to try it first in the government garden, and find out the whole art of producing. This prevents natives, who may be public spirited enough to move out of the old groove to try experiments, from suffering disappointments, which act very much as a check on progress.

"We have now arranged for three acres of mulberry plantation, in connection with the new station garden, and have got from Dr. Bonavia, a supply of the better sorts of mulberry, in addition to the native variety, so that in two or three years I hope to see this important product fully established in this district.

"Just as I concluded this report, I received the following from my cousin, on the silk sent to him to reel off.

"It is a very good specimen, and as good as any I have seen. The reelers particularly praise the colour. A maund of these cocoons would yield about two seers, ten chittacks of silk, which would be a very high rate of produce, the common average in Bengal being about two seers."

On the 17th January, 1863, I received five ounces of eggs of the Cashmere silkworm from Mr. Cope, of Umritsur, and I had brought down from Capt. Hutton, of Mussoorie, a small quantity of eggs also of the Cashmere silkworm, but reared at Mussoorie.

About the 20th January they began to hatch. I had great difficulty in procuring mulberry leaves for them, as the trees had not yet begun to bud, and the leaves of the *Morus multicaulis,* (small entire-leaved China mulberry) the only one in leaf at that time, had been injured by frost. But fortunately in Makkagunge, a village near Lucknow, a tree more forward than the rest was discovered. It was of a kind which the natives call *Bedana.* From this I procured food for the first worms, until the regular crop of leaves came out. I took the precaution to cover the worms at night, as the difference of temperature between the day and night was still very great. I don't know how far this was necessary, but I thought that in making a first experiment, it was advisable to take every possible care of them. A large number of the eggs continued to hatch every day. For the first month I had them fed four times a day, and afterwards, when the days became hotter, I had them fed seven times in the twenty-four hours, twice of which were after sunset. The dry leaves and excrements were cleaned away once every day. I don't think it is quite necessary to clean their trays so often, but as I had on the establishment a sufficient number of men to do it, I was desirous of giving the worms every advantage.

They thrived well, and were all extremely healthy. The deaths were rare, and the small number that died, did so during their first stage, when the weather became hotter. I attributed the death of these to the leaves drying up rapidly from the heat of the day.

The place in which they were reared, was the Baradaree in the Badshabagh. The archways were closed by *jamps* and *chicks* to prevent the wind from blowing through the building, and to keep out birds, bats, and insects, especially wasps, which are very inimical to the worms. The *jamps* and *chicks* kept these animals out very effectually.

The worms were kept on trays, consisting of common *narkool* mats, with a split bamboo frame. The trays were supported in layers on stands, made of thin bamboos, tied together with common string. The stands and trays could have been made more elaborate, but my object in making them of simple construction, and of cheap and easily procured material, was to show the natives employed on the establishment, that the whole arrangements for rearing the Cashmere silkworm might be easily made up by themselves from materials procurable in all the villages.

The worms went through their usual changes of skin regularly, and began to spin about the 7th March. At this time their condition was very good, so much so that Lieut. Marsh, of the 18th Bengal Cavalry, who takes an interest in silkworms, and who was at the time also making some experiments with them, was so struck with the size and healthy appearance of the worms in the Badshabagh, that he asked me to take some of his own under my care, until they had spun, which I did. He undertook to send a man to look after them. I attributed the healthiness of mine entirely to plenty of air and plenty of food.

The arrangements I made for the worms to spin upon were of the simplest kind. When the worms approached their spinning time, dried twigs of *mehndee* (*Lawsonia inermis*), were stuck all round the trays between the meshes of the mat, and bits of paper stuck in here and there among the twigs to afford nooks for the worms to creep into. And as soon as the worms which were in the middle part of the tray left off feeding, they crept upon the twigs and spun their cocoons. In Bengal, coils of bamboo are prepared for the worms. But the advantage* of my method is, that it can be used by any villager in Oudh. The *arhar* plants, which villagers sow in their fields, will snpply the twigs, and any largish dry leaves of any sort will supply the place of the paper.

The best cocoons were put aside for a supply of eggs for future operations, and the rest were sun-dried for reeling.

In about twenty days after the worms had begun to spin, the moths were emerging from their cocoons. The moths were kept in shallow boxes covered with netting, to prevent their wandering away, but a *chick* as a cover would have done just as well.

One of the moths was kept separately, and the eggs it gave were counted. They were 575 in number. The total amount of eggs produced by the moths of the cocoons kept for the purpose was $11\frac{1}{2}$ oz.

I apprehend I shall have some difficulty in preserving these eggs in a good condition for the next season, on account of the excessive heat during the summer months. I have divided them into three portions, and have kept each in a different place and in a different way. I shall be able to say next season which, if any, of these different methods I adopted, is the best for preserving the eggs through the summer.

With regard to the quality of the cocoons, the best were those which were spun before April, as their worms, having hatched early, had the advantage of the cold weather to grow in; consequently they grew slowly, their leaves kept fresh for a longer time, and they were vigorous at the time of spinning. Those that spun later, for opposite reasons, produced smaller cocoons, and the aggregate amount of silk produced by these cocoons was comparatively less. It appears that want of vigour in the worm does not so much affect the *quality* as the *quantity* of silk produced.

In order to try how the Cashmere worms would fare in the hands of the villagers, I constructed a small hut of grass with a common thatch, against a wall with northern aspect, having only a chick to close the door. I placed, as soon as they hatched, several thousands of worms in it on trays, as before, and fed them in the hut till they were ready to spin. None of them died. They produced smaller cocoons than those reared in the building (which I attribute to the hut being hotter), but their silk appears to be just as good. To test further the possibility of villagers rearing silkworms at their own homes, I gave a small quantity of eggs to a man named Sooklal, son of Fukeer, of Gungrowlee, in the

* In later experiments with the China worm I had, by the assistance of a Bengalee reeler, made up some spinning trays, Bengal fashion, and I have no doubt that they will be found the best.

district of Gonda, to whom I had the previous year given about 200 cuttings of the mulberry plant. I told him to put the eggs in a small bottle, and wrap it in a piece of rag to be kept wet, until he got to his village. This arrangement was intended to keep the temperature of the bottle low, in order to prevent the eggs from hatching on the road. It appears to have answered admirably.

His mulberries, on arrival, had not begun to bud yet, as it was early in the season. With difficulty and perseverance he hunted about for mulberry trees, and found some about two *kos* from his village. From these he fed his worms until his own mulberries bore leaves. He stuck long pegs into the wall of his hut, and placed on them trays made of *sirkee*, on which he fed his worms. At the time I gave him the eggs I never thought he would be successful in rearing them; but, to my astonishment, he one day brought me a lot of cocoons, the majority of which were in every respect as good as mine. Another lot which he brought me later, on account of the heat, were not so good.

There can be no doubt as to his having actually reared them, as he possesses certificates to that effect from several lumberdars who saw them; and Captain Ross one day saw some of the worms in his cutcherry at Gonda, which the villager had taken to show him. This man was with me for about a month during the time I was carrying on a small experiment with the China silkworms. He took great interest in the business, and I was therefore induced to let him try his hand at the Cashmere worm unassisted. For his successfully rearing these silkworms under difficulties, the Chief Commissioner has been pleased to grant him a reward of 20 rupees. I consider this villager's success the most interesting portion of my experiments, and it is certain to do a great deal in spreading the culture of silkworms among natives.

Lastly, I made a totally different experiment with the Cashmere worms. I placed about 1,000 of them, about a week old, on mulberry plants in the open air, but after a few days not one of them was left. The worms, having been for many generations, fed upon trays, appear to have lost, to a great extent, the use of their muscles, as the shaking of the trees by the wind knocked them off quite easily; they had not the power to hold on, and very few of them attempted to creep under the leaves to avoid the heat of the sun. A boy scared away birds and insects from the trees. However, if a few trees are planted in a sheltered place and protected from the sun, a number of worms may be successfully reared in the open air, from which a hardy race of worms may be bred. If at the same time selection and hybridization are brought into play, some wonderful results may be obtained.

With regard to the kind of leaf I used for feeding the silkworms, I am of opinion that the China mulberry, with large and crumpled leaf, is the best for the first stage of the worms. They eat it greedily, while at that stage they do not appear to care much about the other kinds, although of course they eat them when they have no other choice.

After the first stage, the native mulberry leaf, which is called *dasie*, is the best; it is more consistent than the others, and therefore dries less quickly, which is always a great advantage: at the same time the worms, in their older stages, like it very much. I cannot say I think very highly of the leaves of the *Morus multicaulis* (or small entire-leaved China mulberry) for the Cashmere worm. But it may be very useful, if the eggs are forced to hatch early by artificially increasing the surrounding temperature, as it is the only one I know of which produces tender leaves during the winter, but then it must be protected from the frost.

I must here express my sincere thanks to Nawab Mosim-od-Dowlah Bahador, for the kind and ready assistance he has given me in allowing me to use the leaves of about 100 native mulberry trees which he possesses in Makkagunge, and without which I could not have fed all my worms. The number of men employed were twenty-four. All these men were not necessary to look after the number of worms I was rearing, but I considered that the greater number that could become acquainted with silkworm culture the better; and as all the men asked for from the different districts of Oudh were not sent, I employed some that were willing to learn the business from Lucknow and Gonda districts.

Mr. Turner very kindly sent me a reeler on Rs. 15 per month, and a year's engagement, and also paying his expenses from and to Calcutta. He was not procurable under cheaper terms.

He arrived in Lucknow on the 2nd May, 1863, long after the worms had spun; so that I did not keep all the men to see the reeling, but selected six of the most intelligent, and who appeared to take an interest in the business.

There should, properly speaking, have been two reelers, one to throw the threads of the cocoons and the other to reel; but I found a great advantage in having only one, because, as he was put to great inconvenience by not having proper assistance, he took great pains in teaching my men, two of whom, more intelligent than the rest, learnt the art in a week; so much so, that the Bengalee reeler, after that time, allowed them to reel, and he only looked on, his face indicating a slight trace of disgust at my men having learnt the work so quickly; I have no doubt that, by a little practice, they will be able to reel as well as their teacher. Of the cocoons that were spun early in the season, one pound contained on an average about 1,037 cocoons, and about 5,000 cocoons produced one pound of silk. Of those that were spun later, one pound contained more than the above, and it took a larger number of cocoons to the pound of silk.

Upon an average, 5 lbs. of cocoons produced 1 lb. of silk.

The total weight of cocoons produced during the season, exclusive of those kept for eggs, was 15½ lbs., and the amount of silk reeled from them was 2 lbs. 12½ oz., also 1 lb. 7 oz. of refuse silk, which the reeler calls chashum, and which is saleable and used for coarse fabrics.

I cannot say how much silk can be expected to result from a given amount of eggs, under favourable circumstances. Unfortunately, I omitted to weigh the eggs sent to me by Mr. Cope. Although I do not in the least doubt the words of Mr. Cope, as to there having been 5 oz., still as I could not be scientifically correct, I would rather leave the decision of this point to future experiments. Besides, a small quantity of eggs which Captain Hutton kindly gave me got mixed up with those procured from Mr. Cope. The temperature in the Baradaree ranged from 72° to 82° up to April; after that it was hotter. One might now ask, What advantages have been gained by this experiment with silkworms ?—I may reply, the following :—

The knowledge that the Cashmere silkworm can live and produce good silk in Lucknow; that the native mulberry, common to the province, is quite sufficient as a feeding material, though other kinds may be very useful. Twenty-four natives from different parts of Oudh, who never saw a silkworm before (aud who had some idea that silk was produced by a plant like other fibres), have become acquainted with silkworm rearing, and six of them with the mode of reeling. Two of the latter have become reelers, by means of whom many others may be taught.

These men will disseminate the germs of a new trade in Oudh. They have learnt that they have the power in their hands of creating this new trade, and with it a new means of living quite differeut from the ways handed down to them from father to son. This alone is of sufficient importance. It will be the means of rousiug them from that apathy which generations of oppression and prejudice have engendered. All these advantages will result, provided we discover some means of preserving the eggs during the hot months.

I sent some of the cocoons produced during the above experiment, and taken at random, to Mr. Turnbull, Mr. Cope, and Captain Hutton. The undermentioned are the replies I received.

From Mr. Turnbull :—" Your cocoons have arrived, and they are certainly very fine, and better than Mr. Lindsay's (Hurdui), though they have deteriorated much."

Mr. Cope pronounced the sample I sent him "of very fair average quality."

Captain Hutton wrote the following in reply :—

" Mussoorie, 9th June, 1863.

" MY DEAR DR. BONAVIA,

"The box coutaiuing cocoons of *Bombyx mori*, reared from Cashmere stock at Lucknow, reached me safely a few days since. The size and hardness are precisely what may always be expected in cocoons reared in the plains, whether at Lucknow or in the Punjaub; and the number of these that were required to produce a seer of silk shows how greatly they have degenerated below the Europeau standard.

You tell me that 10,400 cocoons produced one seer of silk; *ergo* 5,200 went to the lb.; while in France, previous to the late epidemic, 2,500 cocoons produced that quantity. Hence yours are more than 50 per cent. below the late European standard. According to Mr. Turnbull's report of last year, I think he said Mr. Cope's cocoons were 56 per cent. below the Cashmere standard, and as these are certainly very inferior to the European, I am inclined to regard all cocoons reared in this country from Cashmere stock, as at least 75 per cent. below what they ought to be, and would be were it possible to eradicate the numerous diseases by which the worms are overwhelmed. It is a folly to contend that some are not diseased, for all are so, as is shown in the wide departure from the natural colour, proving that the constitution of the worm has been completely undermined by a long course of "breeding in and in." Various diseases have arisen in consequence, and the only remedy that can be effectual in restoring health, will consist in causing the worm to *revert* to a state of nature. Upon this I am now engaged, and with a very fair chance of ultimate success.

In your climate, or in any part of the plains, no good can be expected in the way of adding strength. The worm will always degenerate from the heat it must endure, and hence if you continue to cultivate Lucknow bred stock, your worms will go from bad to worse. Your only plan will be to procure every year a fresh batch of eggs from a cooler climate, from Cashmere if possible, until we can establish supplies in the hills.

There is no reason, however, to be discouraged in your attempt if you find the present return remunerating. You can never hope to compete with colder climates in the amount of silk produced, but unless the secreting glands become affected, which at present does not appear to be the case, the quality of all our produce from this stock will remain the same or nearly so. It is in quantity only that you will be deficient. When I say *quality*, I do not allude to the thickness of the fibre, because that is regulated by the size of the orifices in the lip through which the gum is compelled to pass from the reservoirs. As long as these reservoirs contain gum, the fibre will be of the same thickness, but it does not follow that elasticity and other qualities are regulated by the orifices. Indeed, we know that they are not, but are dependent upon temperature and the quality of the leaf. The thickness of fibre will increase or diminish with the size of the worm, and the quality will be regulated by feeding and temperature. In the fineness of the fibre I recognize decrease in the size of the worm, arising from degeneracy. Some regard the fineness as an advantage, but then they look to the market, while I look to the health of the insect. You will, I think, find that the quality of your silk this year will be the same as that of the Punjab, and of mine at Mussoorie, but in a year or two our climate will tell, and we shall leave you far behind in the amount of produce from equal numbers of cocoons. As to the difficulty of introducing the worm either into Oudh, Rohilcund, the Punjab, or any other part of India, there is absolutely none, and never has been, provided funds were available. The worms may be reared with very tolerable success wherever the mulberry thrives, provided care as to temperature be bestowed. Upon this point there has been a very great and unnecessary outcry and self-laudation in some quarters, for the only things necessary to insure the introduction of the worm with a reasonable chance of eventual profit, are funds, and attention in rearing. Depend upon it that with perseverance and proper attention to the speculation, you will succeed to your satisfaction. You have asked for my opinion, and I have given it candidly, though I speak rather as a naturalist, than as a mere speculator."

On the 14th November, 1862, I received a small quantity of eggs of the China silkworm from Mr. Turnbull. They hatched on the 18th November, 1862. Cast their first skin on the 27th; cast their second, 3rd December.; cast their third, 11th December; cast their fourth, 22nd December. Began to spin on the 8th January, 1863.

A very few worms died when quite young. The nights were frosty, and I took the precaution to cover the worms at night with sheets of paper to prevent the cold from killing them. I did so because this worm was not acclimatized in Northern India, but has been reared for many generations in Bengal, so that it was necessary to give it every possible advantage in rearing it for the first time.

The worms grew very well. A small proportion died when they were ready to spin, others had already spun a thin layer of silk round themselves, and then died in the caterpillar state. Some spun a thin layer of silk and changed into a chrysalis, and finally the majority made apparently good, but small cocoons. Only two weak moths came out of the cocoons, which I had kept for eggs, and on inspection, I found the chrysalis of all the others dead. I sent a number of the cocoons to Mr. Turnbull, for his opinion as to their quality, and the following was his reply :—" I will be candid, and tell you your cocoons are what we consider rubbish, and unfit to reel."

So that as far as silk was concerned, this first attempt with the China silkworm was a failure. But as I knew the cause of the failure, I was not at all disheartened. The worms as I said hatched in November, a time at which the leaves of all the mulberry trees excepting the *Morus multicaulis** turn yellow and drop off. One can easily imagine that such was not the proper food for producing good cocoons.

The *Morus multicaulis*, it is true, had good and tender leaves, but one frosty night disposed of them all at once. So that the unfortunate worms were obliged to choose between half withered leaves and leaves injured by frost. Add to this the coldness of the nights, which in November I should say are very different from the Bengal nights, and the cause of failure is anything but difficult to understand. Nevertheless, the worms lived with a very small mortality up to the spinning time, and most of them spun, which indicates a certain amount of

* Small entire-leaved China mulberry.

hardiness, but the spontaneous death of the chrysalis within the cocoons, was sufficient indication of their general unhealthiness.

If plants of the *Morus multicaulis* are planted in a sheltered place so that they may not be injured by frost, there will be plenty of leaves in the winter months, and then, I do not think there will be much difficulty in acclimatizing the China worm.

About the 23rd June, 1863, I again received some eggs of the China worm from Mr. Turnbull. They hatched on the same day. They were spinning on the 10th July, and the moths came out on the 18th July. The eggs of these were again hatching on the 25th July, and on the 16th August, 1863, the latter were again spinning. They produced very good cocoons, which the Bengalee reeler said were equal to the Bengal ones of China stock. They have been reeled, and the silk appears to be very good. 10lb. 7½oz. of this silk have been reeled by two natives of Oudh.

This worm in Bengal produces about seven crops in the year, and it appears to suit the climate of Oudh very well in the rains. We shall have some difficulty in keeping it through the winter, but not such as cannot be overcome by proper arrangements. I dread the hot winds more than the winter.

On the 21st July, I sent a small supply of eggs of the China silkworm to each Deputy Commissioner in Oudh, with no other object, at present, than that the natives of the district may acquire some idea of the nature of the silkworm, and thus understand the reason for which we are so anxious that they should plant mulberry cuttings.

On the 19th December, I received some eggs of the *Dasie* worm from Mr. Turnbull. They hatched on the 23rd December, and all died within the period of their first stage. I have not been able to discover the cause of their death, probably cold and bad food. Some of them lived till the period of their first change of skin, but were not able to throw it off completely, and so they died. Further experiments with this worm at more favourable seasons may end in better results.

On the 26th May, 1863, Lieut. Marsh, of the 18th Bengal Cavalry, sent me a considerable number of young worms, which had just hatched, of the Madrassee kind, and which he had received from Purtipore. They all dried up within the first two days from the excessive heat and dryness of the atmosphere. The temperature within doors was 92°.

A short time ago the Chief Commissioner of Oudh, sent me a number of Tussur cocoons obtained from the Rajah of Oel, which the natives call *Kooswaree*, for the purpose of making experiments upon them. The worm which produces this cocoon, feeds on the *Byer* leaf (*Zizyphus jujuba*). Many of the moths came out of the cocoons, but unlike those of the mulberry silkworm, the male when in confinement does not take any notice of the female, so that the eggs laid by the latter are useless.

Continued and varied experiments may lead to the discovery of some mode of domesticating this valuable insect.

Another difficulty is in reeling the cocoons of the Tussur worm, as they do not reel in the same fashion as those of the mulberry silk-worm. I managed to get some of them reeled by burying them in a mixture of charcoal ashes and water for a few hours, in order to dissolve the gum by which the threads adhere to each other, and which is not even softened by the common process of steeping in hot water. The silk is of a light brownish colour, and appears to be very fine. I sent some of it to Mr. Turnbull for his opinion, and the following is his reply:—"I have rewound the silk, and it winds very well, the thread is 10-12, or crape size. The only drawback to that description of silk is that it will not take the dye."

Notes on the production and food of silkworms called "Tussur," by the Rajah of Oel:

"At the end of May, the moths leave their chrysalis and commence laying. The eggs are hatched after nine days; the worms are fed on the leaves of two descriptions of plants, viz.:—The "*Beree*" and "*Koron*" or "*Sakhoo*," and about a month after they form their cocoons, within which they remain for about 20 or 25 days, and leave them at the end of September, or beginning of October, and commence laying as above stated. The young worms from them make their cocoons in the beginning of October and November, which are kept for eight months when, at the end of May, the moths leave them, thus giving two crops. In this province there are no reelers. To the East, viz: in Gya there are several; moreover in this district the generality of the people are not acquainted with the method of rearing silkworms, but I have extended the cultivation."

Report on silkworm experiments made on account of Government at Seetapore, by P. J. Carnegy.

"In all, five varieties of silkworms have been reared, viz.: *Cheena* and *Dasie* worms from Bengal eggs; *Cashmere* from eggs direct from Cashmere, worms of the stock acclimatised at Lahore, and worms from eggs saved at Seetapore last season.

"Of the above varieties, the *Cheena* received from Mr. Turnbull, of Ghataul, were the first reared. The worms, a small quantity, were hatched almost simultaneously on the 10th of November, and continued healthy until they formed cocoons, although at that time fresh tender mulberry was very scarce. The cocoons formed were of average quality, rather inferior in quality to the original stock, but superior in size. Their success proves that silk culture can be carried on in Oudh during the cold weather. Of the second variety, *Dasie*, I received a small quantity of eggs from Mr. Turnbull. These eggs almost all hatched on the 29th December, the worms were upon the whole healthy, and the cocoons produced by them were fully equal to the Bengal stock.

"On the 20th of January, I received twenty ounces of eggs from Mr. Cope, of Umritsur. Ten ounces were from stock acclimatised at Lahore, and ten ounces from Cashmere. The former showed symptoms of hatching as soon as they reached Seetapore, but I retarded the hatching as much as possible until the middle of February, when fresh leaves were procurable. By the beginning of March almost all were hatched, and only about a thousand eggs left. The worms throve well, and the cocoons produced were, on the average, equal to those so highly reported on by Mr. Turnbull last year.

"The Cashmere eggs did not begin to hatch until March, and have hatched very irregularly; at the present time at least 30 per cent. remain unhatched, though two or three worms come out daily. The worms have not been quite so healthy as the other varieties, but the cocoons have generally been very superior and slightly heavier than the Lahore cocoons.

"The eggs saved at Seetapore last season have, like the Cashmere ones, been irregular in hatching, and about 25 per cent. are still unhatched. The worms, however, have been pretty healthy, and have produced good cocoons, which are as heavy as the Cashmere ones. All the cocoons spun after the middle of April are inferior to those spun before, but the falling off has not been so great as it was last year, and the cocoons produced even now, will, I believe, be found to yield a very good quality of silk.

"Since the middle of February, there has been a plentiful supply of mulberry procurable, and the worms have been fed both from the leaves of the shrubs planted in the Public Garden last season, and from the trees growing about the station. The leaves of the *Morus multicaulis* growing in the garden are much the finest and largest, and the worms relish them much. Besides the men taught to rear silkworms in Seetapore, men from Oel, Biswah, Mahoomdavad, Hurdui, Fyzabad, and Aurungabad, have been taught.

"The Rajah of Oel asked for eggs, and succeeded in rearing some very good cocoons. He sent me six hundred to be reeled off, and asked for more worms. Mr. Lindsay sent a small quantity of cocoons from Hurdui to be reeled off. The silk produced was very superior, especially in colour. Six hundred cocoons from Fyzabad have been reeled with an equally good result. Small quantities of cocoons have been received from Biswah and Mahoomdabad, but they were not so good as the others, apparently they had been under fed.

"The Bengalee reelers, who arrived on the 7th of May, were not able to commence reeling silk until the 1st of June, owing to the necessity of erecting the requisite apparatus. Unfortunately the basins used for reeling which the men brought with them were broken, and those made here to replace them also broke on being used, and it was not till the date above mentioned that the reelers fairly got to work.

"The silk produced consists of forty-two skeins, weighing three seers and one and a half chittacks. Of this quantity I have packed up thirty skeins, weighing two seers, four chittacks, for transmission to England. This consists of ten skeins of each of the following kinds:—silk from

Cashmere eggs; silk from eggs acclimatised at Lahore; and silk from eggs acclimatised at Seetapore. The remainder, twelve skeins, weighing thirteen and a half chittacks, I send loose, and from it you will be able to judge of the quality of the silk. That from Cashmere eggs I consider very fine, especially in colour; in that quality it is superior to the other two samples, both of which are very much alike, and both appear to me very good silk. The thread is finer than the Cashmere, it being of that quality called 5-6, while the Cashmere is 6-7, or one cocoon coarser.

"I also forward a few small skeins of silk reeled by men of this district. The white skein was reeled by the head Mallee of the Public Garden, and is really very good silk, and, with a little more teaching the man would be a good reeler. The other skeins are about as good as the silk commonly reeled in the native Filatures of Bengal. Two men sent by the Oel Rajah reeled a little silk, and the Rajah has promised to send them back when there is any more silk reeled here. He has taken much interest in the experiment, and the worms he reared turned out very well. Two men from Fyzabad also reeled off a few cocoons. I also send one seer, twelve chittacks of *chussum*, or refuse silk. It is the outer floss of the cocoons, and from it a great deal of the common silkcloth is made in England. Its value is about forty rupees per maund. There is, in addition, about half a maund of cocoons which would not reel off properly, and from which a coarse kind of silk can be made. It is from this silk the cloth commonly known as Bhaugulpore silk, is made. Its value is about five rupees a seer.

"I have received from Bengal a supply of the Bengal monthly worm. These eggs hatched on the 24th instant, and I made over the worms to the Bengalese. They are thriving very well, and I believe the rains will be found a very favourable season for rearing silkworms in Oudh.

"I am sorry to report that the out-turn of silk has not been nearly so large as I expected. The silk reelers did not arrive till late in the season. As you are aware a delay of a month was caused by Mr. Palmer not forwarding the money for the reelers to Mr. Turnbull. When the men did arrive, there was another delay for the reasons before stated. In the meantime the cocoons had been kept for a long time, and when the damp weather set in, a great portion of them became injured by the chrysalis inside rotting, and rendering the cocoon unfit to reel off. Besides when cocoons are kept for any length of time, the produce suffers very much. The cocoons spun after the hot weather set in, were of rather inferior quality too. It is to these reasons I attribute the falling off in the quantity of silk. In future, however, things promise a very different result, as the reelers are on the spot, and all the necessary apparatus ready for reeling off the cocoons as soon as they are spun. I would also venture to hope that the quality of the silk will be found to make some amends for the smallness of the quantity.

"Five ounces of eggs have been saved for next season. The cocoons from which the moths have eaten out their way, fetch a good price in England, and I would suggest that a few might be sent in the box with the silk, to find out what they are worth."

In conclusion, I think there can be little doubt about our ultimate success, but what is immediately wanted is the propagation of all kinds of mulberry trees, more especially the native kind. The China varieties are very useful, and I should add to a great extent indispensable. As almost all the natives of Oudh are entirely ignorant of the nature of the silkworm, and, as I said before, have not the slightest idea that silk is produced by a worm, but that, like other fibres, it is produced by plants, the only way to make them acquainted with it, is for them to see it in its various stages, and see the worm produce the silk. This will be greatly facilitated by little independent experiments in various parts of Oudh, even of a private nature, and with not more than a few hundred worms. The incredulity of natives will scarcely be believed. They are accustomed to hear such falsehoods from their own countrymen, that without actually seeing the silk produced by the *worm*, they put the fact down among the category of the *usual* items of information.

All that these little experiments can do just now is to create a desire for the propagation and multiplication of the mulberry plants. By the time they are well diffused throughout Oudh, and several plantations commenced (without which no silk for commercial purposes can be produced), those who are making experiments on a large scale on Government account, will have a number of experienced natives to distribute over the province, and to teach commercially the culture of the silkworm.

The following instructions may be of use to those who are not acquainted with the rearing of silkworms :

Cashmere Silkworm.—The eggs of this worm are loose—that is, when deposited, they do not adhere to the object on which the moth lays them. When first deposited they are of a yellowish white colour, and the good ones a few days after turn grey.

They begin to hatch about the middle of January, or beginning of February, and produce only one crop in the year. Their hatching will be retarded or accelerated, according to temperature. They can be forced to hatch earlier than they would naturally do, by artificially increasing the temperature of the place in which they are kept, but there will be no object in doing so, unless leaves can be procured to feed them earlier than the usual time at which mulberry trees, left to nature, commence to bud. The small-leaved China mulberry, if properly protected from the frost, will remain in leaf throughout the winter.

The time the Cashmere worm takes from hatching to spinning is about forty-six days. This period will vary according to temperature. A higher temperature than usual will cause them to go through their changes more rapidly, and will also be the cause of diminishing the quantity of silk each worm produces. H H 2

As soon as they hatch, tender leaves are to be placed upon them, on which they rapidly creep. They change their skin four times, and while they are moulting do not feed, and therefore it is unnecessary to give them leaves. They do not require to be handled at all. Wet leaves should on no account be given to them. They should be fed several times in the day, and I think feeding them once or twice in the night also is a great advantage. They can be kept on trays made of any kind of matting, and as they increase in size they are to be distributed over other trays. They should not be too crowded. When they are removed from one tray to another, the leaf on which the worms are attached is to be lifted with the worms on it. The dry leaves and excrements ought to be removed occasionally. This can be easily effected by placing fresh leaves on the worms, and when they creep on them remove them to a clean tray. It must not be forgotten that silkworms have many enemies, such as ants, wasps, birds, etc., from all of which they must be secured. When they are ready to spin, their skins are tight, and their usual colour changes into a pinkish one. At this stage they are sufficiently large to allow of their being handled. They are then to be placed wherever they are intended to spin. The spinning lasts three or four days, according to temperature, during which time they must not be interfered with. When the cocoons are fully formed, they can be removed from the spinning places. Those which are intended for silk are to be exposed to the sun, or otherwise sufficiently heated, in order to kill the chrysalis, which is the form the worm acquires after spinning, and which otherwise would come out in the shape of a moth and spoil the cocoon for reeling purposes. Those which are intended for eggs must be kept in a cool place. As a rule, the cocoon containing the female chrysalis is larger than the one which contains the male. Some days after the cocoons are fully formed the moths emerge,* they pair, the female lays her eggs, and in a few days both male and female die. The eggs are then gathered, and put in a dry and cool place for the ensuing year.

For spinning purposes, if the experiment is on a small scale to show natives the nature of the insect, etc., any thin twigs will do, such as the twigs of dried *arhar*, etc., fixed round the trays, upon which the Cashmere worms will of their own accord creep when they are ready to spin.

The Bengal spinning trays will be found the best, as the worm is allowed a definite space to finish its cocoon in, and so it is forced to make a compact cocoon, and thus economises its silk. Among the twigs, many of the worms get into a large space, and spin a large and thin cocoon, which does not reel so well as a small and compact one.

It must be remembered that, in any case, if the worms are too crowded during spinning time, they often spin *double* cocoons, that is, two worms spin into one cocoon, which not being composed of one thread is not reelable.

* The moths should be placed on sheets of paper or pieces of cloth, in order that the eggs may be easily collected.

CHINA SILKWORM.—This is smaller than the Cashmere worm, and differently marked. From the time of hatching to the time of spinning, during the rains, it took seventeen days.

It is to be treated in the same way as the other. In Bengal during the first stage, the China silkworms are fed on leaves, cut up into thin strips by means of a knife, and they are kept up to their first change of skin, in shallow earthen pans (gumlahs). They are regularly fed four times in the day and twice at night, and not touched till they change their first skin, when whole leaves are placed upon them, and as soon as they creep upon the leaves, they are removed to clean trays. The old leaves and excrements are only changed at each moult.

The eggs of the China worm adhere to the object on which they are laid, and therefore the female moths after pairing must be placed on sheets of paper a little distance from each other. The eggs of this worm will hatch again in about eight or nine days after they are laid. In Bengal, it gives about seven crops in the year. Temperature has great influence in retarding or accelerating the period of its existence. Those that hatched in June took seventeen days, and those that hatched in November took fifty-one days to go through all their changes.

The above is intended only to give some idea of rearing silkworms, but those who wish to learn more about them can easily obtain a small quantity of eggs, and observe the worms while going through their various stages.

Lucknow, Sept. 1863.

ON A MEANS OF RENDERING OSTENSIBLE THE SPECIFIC WEIGHT OF WOODS, &c.

BY PROFESSOR J. ARNAUDON.

When passing in review the different systems of classification of woods,* I had previously taken the opportunity of considering the weight as the starting point of an artificial arrangement which pretty well agrees with another one by which the woods are classified according to the greater or less resistance they oppose to tools. In the collections arranged according to their specific weights, the wood is generally presented so as to exhibit one form and one volume, the difference of heaviness of these similar pieces indicating their corresponding specific weight. It is obvious that, disposed in this manner in a museum, nothing else than a label or inscription will indicate to the visitor the relative heaviness of the wood; but if, on the contrary, we give the same

* See TECHNOLOGIST, vol. iii., p. 97.

form to equal quantities in weight of the different sorts of wood, we shall have proportionate visible representations to the specific weights of the wood. We can thus at the same time have spheres of more or less volume when we shall have given that shape to the same weight of different woods. We can also vary the experiment by giving the form of a cube, a cylinder, or of a prism; but it may be remarked that the first-named presents the greatest difficulty, as in shaping it the small fractions of weight cannot well be accurately shown; the cylinder or prism form will be found better suited to our object, those differences coming more together on one side, the height. I give the preference to the prism with a square base, but the difficulty often of finding woods of a certain thickness, leads me to adopt the prism with rectangular base; and this is the shape in which was prepared the collection of woods I showed at the International Exhibition of 1862, in the Italian Department.* The different sorts of wood, having been conveniently dried, are disposed in parallelopipedes of an indefinite length, two centimetres thick by five centimetres broad, and from each is forthwith cut the necessary length to represent 200 grammes of weight. In this manner we obtain a series of prisms, which are as long as the wood from which they were formed. Disposing them naturally as I did, from the lowest to the highest, we could obtain immediately a curve of which the "ordonnées" are inversely proportioned to the density of the wood's weight by the air.

I will now give the heights, which I have measured in centimetres, and by means of which may be retraced the curve obtained with those woods I had at my disposal.

Table of the Specific Weights of different Woods, indicated by the length of a Parallelopipede of two centimetres thick, and five centimetres broad, weighing 200 grammes.

	Length in Centimetres.
Epaw, a species of Ebony from America	150
Catayba of Paraguay	170
Medicago arborea of Sardinia	170
Quebracho of Paraguay, resembling an Acacia, probably *A. tenuifolia*	173
Amaranth, or violet wood, Palo morado of Paraguay, probably a *Copaifera*	185
Rose or tulip wood (*Liriodendron tulipifera*) . .	185
Brazil wood (*Cæsalpinia echinata?*)	186
Hawthorn, Aubepine, or Bossolo (*Cratægus pyracanthus*)	187
Logwood (*Hæmatoxylon campechianum*) . . .	190
Olive (*Olea Europea*)	193
Lignite, or Fossil wood of Lango, in Piedmont . .	200

* This collection was formed and shaped in 1860, at the Technical Institute, Turin.

	Length in Centimetres.
Evergreen oak (*Quercus ilex*)	200
Lima or Peach wood (*Cœsalpinia echinata*)	203
Jujube of Sardinia (*Zizyphus vulgaris*)	207
Green Ebony (soufre), Taigu of Paraguay, Ipé of Brazil	208
Jacaranda or rosewood	209
Rosewood of Brazil (*Jacaranda sp.*)	213
Boxwood of Piedmont (*Buxus sempervirens*)	214
Service tree (*Pyrus domesticus*)	215
Filaria (*Phillirea*)	217
American box (*Buxus sempervirens*)	218
Apple (*Pyrus malus*)	218
Service tree of Piedmont (*Pyrus domesticus*)	221
Olive of Genes river (*Olea Europea*)	221
Arbutus (*Arbutus unedo*)	224
Oak of Piedmont (*Quercus robur*)	225
Laburnum or false ebony (*Cytisus Laburnum*)	228
Bitter orange, Sardinia (*Citrus vulgaris*)	232
Jujube of Tuscany (*Zizyphus vulgaris*)	236
Alaterne of Tuscany (*Rhamnus alaterne*)	237
Oak of Italy (*Quercus robur*)	245
Wild orange (*Citrus aurantium*)	250
Fustic of Cuba (*Maclura tinctoria*)	250
Oak (*Quercus robur*)	250
Cypress of Tuscany (*Cupressus sempervirens*)	252
Sorbier des oiseleurs (*Pyrus Aucuparia*)	252
Yellow wood or morab of Paraguay—Natare	255
Sparto of Sardinia	256
Apple of Piedmont (*Pyrus malus*)	257
Larch (*Pinus larix*)	260
Beech (*Fagus sylvatica*)	262
Maple of Genes (*Acer campestre*)	262
Ash (*Fraxinus excelsior*)	264
Ash of Tuscany	264
Ash of Piedmont	265
Elm (*Ulnus campestre*)	266
Peach (*Amygdalus persica*)	266
Larch or Nileze of Piedmont (*Pinus larix*)	270
Laburnum of Piedmont (*Cytisus laburnum*)	271
Pear (*Pyrus communis*)	271
Beech of Piedmont (*Fagus*)	275
Maple of Tuscany (*Acer loppo*)	283
Lot tree of Sardinia (*Cratœgus Aria*)	285
Birch of Piedmont (*Betula alba*)	291

	Length in Centimetres.
Hornbeam (*Carpinus betulus*)	292
Beech of Piedmont (*Fagus sylvatica*)	292
Maple of Tuscany	294
Hornbeam of Piedmont (*Carpinus betulus*)	295
Plane tree of Tuscany (*Platanus hippocastanum*)	300
Lignite of Piedmont	300
Ailanthus of Tuscany	300
Cherry of Piedmont (*Cerasus*)	300
Maple of Piedmont	300
Arbre de Judee of Tuscany (*Cercis siliquastrum*)	300
Hazel-nut (*Corylus avellana*)	301
False acacia or locust (*Robinia pseudacacia*)	308
Black walnut (*Juglans nigra*)	311
Fig-tree of Piedmont (*Ficus carica*)	317
Apple of Piedmont	322
Walnut (*Juglans regia*)	326
Mulberry (*Morus alba*)	329
Red walnut of Piedmont	337
Lime of Tuscany (*Tilia Europea*)	341
Cypress of Tuscany (*Cupressus*)	346
Pear of Piedmont (*Pyrus*) moire ousatiné	348
Walnut of Tuscany—reinee brune	349
Alder of Tuscany (*Alnus glutinosus*)	356
Araucaria Cunninghami	358
Lierre of Tuscany (*Oedera helix*)	359
Lime of Tuscany (*Tilia Europea*)	376
Alder of Piedmont (*Alnus glutinosus*)	391
Catalpa (*Bignonia catalpa*)	398
Lime	407
Red alder of Piedmont	408
White poplar (*Populus alba*)	420
Norway spruce fir (*Pinus abies*)	426
Fir of Piedmont (*Pinus abies*)	444
Stone pine (*Pinus pinea*)	445
Poplar of Piedmont (*Populus alba*)	446
Italian poplar of Tuscany (*Populus Italier*)	470
Poplar	475
Piedmont pine (*Pinus abies*)	484
Tuscany pine (*Pinus abies*)	520
American pine	569

It will be seen that not only the same species but the same kinds give results differing from each other, a fact happening nearly always when you do not limit yourself to taking several times the specific weight of the same part of a tree, but extend the experiment to other parts and other individuals of the same sort of wood developed in a different locality. Whatever be the method adopted to determine the specific weight, the numbers obtained have nothing absolute; they are averages coming more or less near the truth, according to the circumstances taken into consideration which may influence the results. It is right to be suspicious if the experimenter has not taken the trouble to indicate the age of the tree and of the branch, the season in which it was cut, the nature of the soil, its exposition, mode of culture, of drainage, &c.

The means at my disposal did not allow me to conduct the experiments with the rigour I could have desired, and with the intention of repeating them, if possible, I begin with giving the stated results for what they are worth, as an essay made with the object of adding something more to our knowledge on these matters.

A part of the woods named in this list are in the Museum of Construction of the South Kensington Museum, the others will be found in the Conservatoire Imperial des Arts et Metres at Paris. I had desired to examine and experimentalize upon some of the large collection of woods forwarded to the International Exhibition by the British Colonies, but I regret to say that I received a refusal from all the Commissioners in charge to whom I applied.* With a polite courtesy I received, however, such natural products as I required, to investigate their application for the purposes of dying or tanning, from the Commissioners for Spain, Netherlands-India, the French colonies, &c.

Technical Institute, Turin.

ON MALABAR CARDAMOMS.

BY THE EDITOR.

The fruit of the *Elettaria cardamomum*, Maton, constitute the true, small, officinal Malabar cardamoms. It is an ovate, oblong, obtusely-triangular capsule, coriaceous, ribbed, greyish or brownish yellow. It contains many angular, blackish or reddish-brown rugose seeds, which are white internally, have a pleasant, aromatic odour, and a pungent, agreeable taste.

One hundred parts of the fruit yield 74 parts of seeds and 26 parts of

* This refusal arose, no doubt, from the bulk of the Colonial collections of woods having been promised to Sir W. J. Hooker for the Economic Museum, Kew Gardens.—Editor.

pericarpal coats. According to Tromsdorff, they contain essential oil, 4·6; fixed oil, 10·4; malate of potash, fecula, yellow colouring matter, woody fibre, and other unimportant ingredients. The fixed oil is somewhat like castor-oil, and the volatile oil is of specific gravity 0·943, insoluble in potash; it is the source of the aromatic quality of the seeds. The vernacular names of the plant are—Malabar, Yalum; Tamil, Aila-cheddie; Teloogoo, Yaylakooloo; Hindostani and Bengalee, Eelachie.

The principal places where these cardamoms are cultivated are the hilly parts of Travancore and Malabar, Wynaad, Coorg, Nuggur, and North Canara. In the Travancore forests, they are found at an elevation of three to five thousand feet. The mode of obtaining them is to clear the forests of trees, when the plants spontaneously grow up in the cleared ground. A similar mode has been mentioned by Roxburgh, who states that in Wynaad, before the commencement of the rains in June, the cultivators seek the shadiest and woodiest sides of the loftier hills; the trees are felled, and the ground cleared of weeds, and in about three months the cardamom plants spring up. In four years the shrub will have attained its full height, when the fruit is produced, and gathered in the month of November, requiring no other preparation than drying in the sun. The plant continues to yield fruit till the seventh year, when the stem is cut down, new plants arising from the stumps. They may also be raised from seeds.

Cardamoms grow in abundance on the north-eastern range of hills which lie on the western borders of the Dendegul, Madura, and Tinnevelly districts. Although these plants grow spontaneously, yet with care and attention they thrive much better than if left to nature, and the cultivators therefore make separate gardens on the hills, and fell the large trees on the ground, in the months of March and April. The place is left till plants shoot from the earth, which is soon after the first rains; and when the plants grow to the height of five or six inches, the cultivators resort to the place, and secure the plants from being injured by the wild animals till they attain the height of some two feet, when they are considered not to require further care. The plants take three years to bear. In June and July of the third year, they commence yielding from the stem of the plant, just above the ground, a number of twine-like roots, on which are formed the cardamom flowers and fruits; these grow gradually to the size of a cocoa-seed, and are ready for collecting in the months of November and December. A small quantity, however, those that shoot the roots on the first fall of the rain, will be found fit for collection in the months of July and August. The extreme age of the plants is ten years, when they all die off. The remuneration of these cultivators for their labour in taking care of the growth of the plants and collection, is 210 rupees for each candy (21*l.*) for 500lb. produced and delivered over to the sircar by them. The annual average produce of cardamoms in Travancore, in the ten years ending 1854, was about 300 candies. It is a government monopoly in that State. The value of the cardamoms exported from Madras from 1852 to 1856, chiefly to Bengal, Mauritius, Pegu, and Britain, was 109,473*l.*, besides the quantity consumed in the producing country. The export from North Canara is also considerable, mostly to Bombay.

The plant is widely cultivated in North Canara, wherever there is a rich, reddish, damp soil, which seems to be preferred by the shrub to any other. It is very hardy, and thrives even if much neglected, but a little care bestowed on its cultivation is amply repaid by the increased yield. In North Canara the plant is generally grown in betel-nut (Areca) plantations in the spaces between the palms. It is commonly raised from seeds, and then produces in the third year, each tree yielding about three-quarters of a pound of cardamoms per annum, the average price of which is about 40 rupees per maund of 28lb., although often much higher. The seeds are here gathered in September. Twelve or fifteen hundred cardamom shrubs may be grown on one acre of ground. The cultivation of the plant is reckoned among the natives of the district one of the most profitable undertakings known, and there is no doubt that it would be very much more largely engaged in by them, were it not for their general want of capital, and their invincible dislike to parting with their land.

The following details show the cost of culture and returns :—

Probable Cost of Farming and bringing into Bearing a Cardamon Plantation of Fifty Acres in North Canara.

	R
To rent of 50 acres of land at 5 rupees per acre per annum for 3 years	750
Clearing and levelling 50 acres of land . . .	2,000
Three maunds of seeds for sowing, at 40 rupees per maund	120
Hire of 10 coolies for 3 years, at 5 rupees per mensem	1,800
Pay of a superintendent for 3 years, at 30 rupees per mensem	1,080
Tools and sundries	200
Total cost for three years . . .	R5,950

Probable Annual Receipts from a Cardamon Plantation of Fifty Acres in North Canara from the third year.

		R
By produce of 60,000 trees, each tree yielding $\frac{3}{4}$ lb. of cardamoms, at 40 rupees per maund of 28 lb. .		64,285
Deduct annual outlay :—		
To rent of 50 acres, at 5 rupees per acre .	250	
Hire of 10 coolies, at 5 rupees each per mensem	600	
Hire of extra hands at the harvest and other necessary times	150	
Pay of superintendent, at 30 rupees per mensem	360	
Cost of agency—say	1,000	
Sundries	100	
Total annual outlay . . .		2,460
Total annual profit . . .		R61,825

In commerce there are three varieties of these cardamoms, known as the short, short-longs, and the long-longs. Of these the short are more coarsely ribbed and of a brown colour, and are reckoned the best of the three. The long-longs are more finely ribbed and of a paler colour, seeds are white and shrivelled. The short-longs merely differ from the latter in being shorter or less pointed. It is usual to mix the several kinds together when ready for exportation. The seed is aromatic and carminative, and is much valued as a condiment, especially in curries, throughout India and most other countries. As a cordial and stimulant, they are often used medicinally, but more frequently as correctives, in conjunction with other medicines. A volatile oil is procured from the seeds by distillation, which has a strong aromatic taste, soluble in alcohol. It loses its odour and taste by being kept too long. The natives chew the fruits with betel, and use it in decoction for bowel complaints, and to check vomiting. In infusion they are given in coughs.

The following shows the quantities and value of the cardamoms imported into the United Kingdom from India for five years :—

	Quantity. lbs.	Value. £
1858	149,886	23,551
1859	66,525	13,764
1860	123,296	27,015
1861	104,787	23,660
1862	132,718	37,590

THE GEMS OF AUSTRALIA.

BY DR. BLEASDALE.

I have often wondered that no one undertook to make a collection of, and report upon, the precious stones, which from time to time were picked up about the gold-fields, and aid the miners with a few hints as to the stones they should look for, in what place they would be likely to find them, and the probable value attaching to them in their rough state, or in a wrought condition. When once it became known that our mines yielded gems as well as gold, I could not help thinking it a pity such fine opportunities as were every day afforded of collecting them should be lost, when little more would be required in order to obtain them than a sharp look out when washing for the gold, and occasionally examining the sluices, water-courses and boxes in which the gravel and sand are agitated and washed. Neither would the additional time and labour needed be of much importance, since being for the most part specifically much heavier than quartz pebbles and sand, they would find a lodgment in such cases not far from the gold. In fact, nearly all the diamonds and sapphires were so found, or picked out of the tin dish in the last operation of clearing the gold. Still, no one came forward, as far as I could learn. Notices of discoveries did appear occasionally in the public papers, but they have always been individual and fragmentary. About a year ago, when my leisure became too little and too interrupted to allow me to look to my laboratory for relaxation from my serious duties, it occurred to me that I might find a source of reasonable recreation, without much demand on my time, if I took up once more this branch of my early education, whilst at the same time I might hope to contribute my mite towards opening up a probable source of profit to others, by directing attention to this neglected element of wealth, by eliciting valuable information from others, and by throwing out such practical hints as might occur to me for easily and speedily accomplishing its realisation. To judge from the display of jewellery in the windows of this city, one can have no doubt of the great demand for it; while one regrets that so much of that which is manufactured here should be stuffed with cheap, trumpery stones, and more frequently only paste and imitation stones, notwithstanding that we have both an abundance of fine stones in the country and the requisite means of imparting to them the highest finish in cutting and polishing. In the case before me, I have brought together a somewhat extensive collection of colonial precious stones, some my own, the greater portion kindly lent me by my friends for the purpose of being exhibited this evening. To assist me in the history of some of them, I have invited—and he is here—Mr. Spink, the able lapidary, who cut many of them, and who knows them well; and Mr. Murray, the jeweller, of Bourke-street, who has brought the gem of the evening with him. Here they are in goodly array, and for the sake of enabling you to form a juster idea of them, they are placed, as far as may be, side by side with the best specimens I could obtain of stones of the same kind from Ceylon, the East and West Indies, Brazil, and Peru. Here are three diamonds, two from Beechworth and the third from Collingood flat. I am enabled, by the kindness of Mr. Crisp, of Queen-street, to exhibit the latter to-night. It was found in the gravel spread on a small garden walk in the lower part of Collingwod, the gravel having been obtained either from Northcote or just above Johnston-street bridge. It is small, but even a small diamond is a great fact. The diamond which Mr. Murray has brought is the largest yet found; it weighed in the rough above three carats; it now weighs a little less than two, and is, as you can all see, a magnificent gem. It was sent to Amsterdam to be cut, and has quite recently been returned to its owner here. Its fair value I take to be from £35 to £40. I may remark that all the Beechworth diamonds that I have seen (about a dozen) were beautifully distinct in their crystallographic features. With regard to the price of diamonds, I have copied the following from the most recent work I could obtain—*Bristow's Glossary of Mineralogy*, 1861:—"Diamonds are weighed in carats (151½ of which make one ounce troy) of 3·16 grains each. The medium value of a diamond, when rough, is £2, if of one carat weight; and the value of diamonds of greater weight is estimated by multiplying the square of their weight in carats by two, which gives their value in pounds sterling. Example—To find the weight of a rough diamond of two carats: the square of the weight 2 x 2=4; this multiplied by 2=4 x 2=£8, the value of a diamond of two carats. A polished diamond of the purest water, well cut and free from flaws, is worth £8; above that weight, the value is calculated by multiplying the square of the weight in carats by eight. Thus:—The value of a polished diamond of two carats—2 x 2 x 8=32*l.*; the value of a polished stone of three carats—3 x 3 x 8=72*l.*, and so on." *Bristow*, page 110. The following information is taken from the work of Dr. L. Feuchtwanger, New York, 1859:—"Diamonds are found in talcose chlorite schist and in a breccia, consisting of ferruginous clay, quartz pebbles, sand and oxide of iron fragments; and also in a secondary bed, accompanied by gold, platinum, topaz, beryl, tourmaline, kyanite, amatoze, spinelle, corundum, and garnet. The rocks in which diamonds have been recently found, consist of the itacolumite, a micaceous sandstone, accompanied by mica-schist, accidentally traversed by quartz veins. The gold, diamonds, and other fine stones are always imbedded in the lower part of the alluvium." Speaking of Brazil, he says, "Experience has shown the richest localities to be in Curranlinho, Datas, Mendanho, &c., where the alluvial soil is from eight to twenty feet thick, and is composed almost entirely of silicious sand, strongly colored by argillaceous iron, which forms a species of cement of pebbles of quartz, milky quartz, and itacolumite, which form a coarse pudding stone, called casoelho, and which is considered by the diamond-washers a sure sign of the diamond."—Pp. 188, 189. I travelled last year over a vast area of formations of the above characters. I allude to the district in which the diamonds have been found; it stretches from the foot of the Beechworth hills to Chiltern, and further; and in even more strongly marked features between Chiltern and Rutherglen. The rubbish thrown out of every hole sunk by the diggers at intervals over that plain was strongly marked with the above-mentioned features. The gravelly hill at Northcote, and the one above Johnston street bridge—out of which came the small diamond which I exhibit—are not altogether without these characteristics. Mr. Anderson, of the Junction Hotel, Plenty road, stopped me lately when passing, but before the small diamond was found in Collingwood, to show me quite a quantity of stones—beryls and tourmalines, I think, and others that I have not yet had time to study—which he had picked out of a hill at the back of his house, apparently of the same formation as that at Northcote. Surely it would be interesting if the Government geologists would examine, or cause these formations to be examined. I understood Mr. Anderson who has had much practical experience in mining, both in America and here, to say that he had traced them to the granite hills above the Yan Yean.

CORUNDUM.

Sapphires.—These gems have been found from time to time since the opening of the Ovens goldfields, and perhaps there more abundantly than elsewhere. I have got them in every shade of blue, from nearly black to the palest blue. Their crystallographic forms are generally exceedingly obscure, fine crystals being very rare. 2. Besides the blue, I can exhibit to-night specimens of the green sapphire—the oriental emerald—but I have not a fine specimen polished. The one before you is brownish in this light. 3. Star sapphires.—I believe I may claim to have first discovered any specimens of these gems in Victoria. In fact, until I found some among a quantity of matters collected together from diggers, by Mr. Turner, the enthusiastic collector of gems at Beechworth, I was not aware that this stone had been found anywhere out of Ceylon.

Ruby.—I have seen but one which had been obtained anywhere in Australia, and that was got in Queensland, and cut in Melbourne by Mr. Spink, and turned out to be a star ruby, of good size and great beauty. This stone is, I think, new. It belongs to the asterias; but, instead of having a floating star of six rays of white light, it has a fixed star of six black rays in a deep blue ground. As to the price of sapphires when cut and polished, a good sapphire of 10 carats is valued at fifty guineas, and one of twenty carats at 200 guineas. Under ten carats the price may be estimated by multiplying the square of its weight in carats into half a guinea; thus one of four carats would be worth—4 x 4 x 10s. 6d.=8*l.* 8s.

Topazes.—These are very abundant at the Ovens and about Dunolly, and in smaller crystals of great beauty from Flinders Island. This very beautiful (1) small specimen is one from there, and was cut by Mr. Spink. 2. Blue—Of these I have seen some very large and exceedingly splendid specimens. 3. Red—I have seen none of this kind, but they are reported to have been found at Dunolly. All, without exception, were almost without distinct crystallographic characters.

Beryl.—1. I have seen no true emerald. 2. Beryls, I believe, have been found in several places lately at or near Northcote, but the specimens given to me I have not yet fully examined.

Garnets, Hyacinths, and Zircons.—1. Garnets.—I have seen about half-a-dozen poor. Mr. Butters mentioned a fine one found lately just over Prince's Bridge, near the barracks. 2. Hyacinths.—I have several, one of very fine colour. 3. Zircons are very abundant on several of the gold-fields. They have often been mistaken, when small, for rubies. I exhibit the first white Victorian zircon I have seen. It is cut heart shape, and is a superb stone.

Opals.—District, the Ovens.—1. White and milky, but with a fair share of fire. I have seen in Beechworth some fine specimens, much water-worn and in shape resembling rather long and flat French beans. 2. Fire Opal.—I have seen only one specimen, which was given me by a Beechworth digger. It is a very grand one.

Amethysts.—In great abundance on the Ovens and elsewhere. 1. Yellow, very abundant, and frequently fine, of the Cairngorm variety. 2. Purple, also abundant. 3. White rock crystal: this is the stone which often tempts persons with the notion they have discovered a diamond.

Jaspers and Agates.—Very abundant on the Ovens, and some of them large, and very beautifully variegated.

With regard to improving and diffusing the knowledge of precious stones among the mining populations, especially in districts like Beechworth, where so many have been already found, and facilitating the collection of them, I would suggest two things:—First, that the Athenæum or Mechanics' Institution should be provided with a few suitable and secure glass cases, in which the stones found might be placed for a time by their owners for exhibition. The larger the number of each kind that can be got together the better, as then all the different shapes of the crystals, and their shades of colour, can be compared. It is only by getting together quantities of the different species, and showing them in a collected form, that any adequate idea of either the beauty of individual specimens, the abundance of the material, or even the local monetary value of them, can be ascertained. In this way, too, the various crystalline forms of the different classes can be most easily impressed on the mind, and occurring specimens readily recognised in the often hasty operation of washing for gold. In all cases when practicable, cut and polished specimens should be placed along with the rough stones. The importance of this recommendation cannot be exaggerated. Secondly—As to more carefully searching for gems, I would suggest that schoolmasters, teaching on places like the Woolshed, for example, should try to interest the children in searching for them in their play-hours, and induce them to bring all the smaller crystals, no matter of what colour, that they can find. With very little teaching they would soon learn to reject the mere worthless quartz crystals, and become expert collectors. Their quick eyes and nimble fingers would enable them to pick up rapidly any crystal of value that was lying exposed on the heaps of tailings or in the sluices. It is certain they would often find stones that would be at once worth a considerable sum of money. As to children's fitness for this work or amusement, I will make one extract from the writings of the celebrated traveller and trader in gems, Tavernier. The following was witnessed by him, on his visit to the mine of Roolconda:—"A very pretty sight is that presented every morning by the children of the master miners and of other inhabitants of the district. The boys (the eldest of whom is not over sixteen, or the youngest under ten) assemble and sit under a large tree in the public square of the village. Each has his diamond-weight in a bag, hung on one side of his girdle, and on the other a purse containing sometimes as much as 500 or 600 pagodas. Here they wait for such persons as have diamonds to sell, either from the vicinity or from any other mine. When a diamond is brought to them, it is immediately handed to the eldest boy, who is tacitly acknowledged as the head of this little band. By him it is carefully examined, and then passed to his neighbour, who, having also inspected it, transmits it to the next boy. The stone is thus passed from hand to hand amid unbroken silence, until it returns to the hand of the eldest, who then asks the price, and makes the bargain. If the little man is thought by his comrades to have given too high a price, he must keep the stone on his own account. These children are so perfectly acquainted with the value of all sorts of gems, that if one of them, after buying a stone, is willing to lose one-half per cent. on it, a companion is always ready to take it."

ON INDIAN FIBRES SUITED FOR THE PAPER-MAKER.

BY THE EDITOR.

In eastern countries, paper was manufactured from indigenous fibres long before it was introduced into Europe in the eleventh century. According to Colonel Sykes, for 2,000 years paper had been made in China; never from rags, but always from fibre. The manufacture of paper from pulp has long been established in India, and considerable quantities are made from fibre; but not generally of a good quality—their thick ink not requiring so fine a paper as is used in Europe. The manufacture was probably introduced from China across the Himalayas.

Nearly ten years ago, in a valuable communication in the 'Journal of the Society of Arts,' "On raw materials for the paper manufacturer," Mr. T. F. Henley observed:—"With the immense resources which this country possesses in her tropical dependencies, more especially India, she should have the supply of the world with paper, as she has of other manufactures, instead of being undersold; but new ground must be opened, and the proper direction should be—India." These remarks apply with even greater force now. It is to India, I think, we must look for extensive and cheap supplies, for it is there alone we find the necessary conditions of a very low-priced and intelligent labour, with an abundance of elementary suitable materials; and as articles of small price are particularly sensitive of charges, such as of freight, &c., it is only by large operations that an average of low charges can be accomplished. The lower quality of half-stuff, Mr. Henley considerd, might be imported here, including all charges, at about 13*l.* 10s. the ton, and the better quality, equal to linen rags, at 16*l.* 10s.

The fitness of many of the Indian fibres for conversion into paper was shown at the Paris Exhibition in 1855, in various specimens made of plantain and of aloe fibre; of that of the screw pine; of the sunn of India;

also, from *Daphne cannabina*, bamboo, &c.; and even from the fibres of the jute, by Mr. Hollingsworth and others, in the form of silver, writing, and cartridge paper; though it had been said that the latter fibre could not be bleached. In the samples shown in 1862, by Mr. C. F. Jeffrey, the difficulties attendant upon the bleaching of jute appear to have been, to a very considerable extent, overcome. The jurors in the class of papers awarded, at Paris, an honorary medal to the commissioner of the East India Company, for the active researches made through their extended possessions to discover materials fitted for the manufacture of paper.

That there is no lack of materials for paper-making may be gathered from the variety of substances which have been proposed as substitutes. Between 100 and 200 have been recommended, and a fair proportion of these have formed subjects for special patents. In M. Louis Piette's work now before me, 'Die Fabrication des Papières'—edition 1861—there are nearly 300 specimens of paper made from different materials or mixtures. Some of these form excellent pulp, but are practically useless because of insufficient supply; others are so defective as to prove, that the resulting paper is incapable of resisting strain; whilst perfectly suited for giving body to the paper, they require the admixture of a more tenacious material. In the latter category (observes Dr. J. Forbes Watson), we must place straw and other stems which contain, at best, but a small proportion of indifferent fibre, and whose apparent strength is owing rather to silica than fibre.

Although we fully admit the possibility of removing the great body of the silica by chemical agents, yet do we injure the strength of the paper almost in the same proportion. Certain it is, that those newspapers which are printed on straw paper still contain a considerable quantity of silica. Now, my object is not to depreciate straw paper; I admit its full value, and believe it of extensive applicability. But, in many cases, I cannot but think that it would pay better to substitute a more promising material, than to use a very inferior one, of which larger bulk is required. Thus the strength of the Rhea fibre (*Urtica nivea*) is so great that the tow might, perhaps, be used with advantage in small quantities, to supply the defectiveness of materials partaking of the characteristics of straw. In practice, this is already acknowledged, and it is only for principles that we are contending, for almost all paper consists of rags with varying proportions of raw fibres.

"Possibly," Dr. Watson adds, "thus some of our best and strongest Indian fibres may be employed to give tenacity; but it is improbable that any could be imported specially for the paper manufacture, as those which would have to compete with rags would not be of sufficient strength to compete with the articles to be had nearer home. If suitable machinery could be established in India, so as to turn to better account her boundless resources, then her superior class of fibres might probably be obtained at a cheaper rate; but the proposal to introduce the domestic manufacture of half-stuff into India is not likely to take root for many reasons."*

Now, I differ to some extent from this opinion of Dr. Watson, and the fact of the general manufacture of half-stuff even under difficulties, and the quality of the paper made therefrom tell against him.

Among the papers in the East India Museum, London, to which attention may be directed, are the following—the detailed particulars of which we gather from the 'Descriptive Catalogue of the Indian Department' in the International Exhibition, from Dr. Forbes Royle, and other authorities.

Red jute, white jute, and bleached jute prepared as paper stuff. The jute "gunny bags," as they are termed, which are so largely imported as sacks and wrappers for Indian produce from Bengal, are now very generally collected as a paper material—about 70,000 or 80,000 pieces of these gunnies are annually received in the United Kingdom.

There must also be a good deal of waste available from the 50,000 tons of jute and other fibrous substances now annually imported from India, and worked up in Dundee and other places. That portion of the hank of fibre next the root, or where it has been held in the hand in steeping—being always more or less contaminated with bark and impurities—is cut off for about nine inches. These jute cuttings are sold in Bengal to the paper-makers, and for making up various thick coarse fabrics for bagging. They have only lately been imported here, and could be had to almost any extent, as large quantities are destroyed in India. The present price here is from 12*l.* to 14*l.* per ton, with a large stock on hand. Gunny bagging can be had at 10*l.* to 12*l.* a ton. The import of jute from Bengal for spinning, this year, will probably reach 100,000 tons.

Owing to the great cheapness of the gunny, the bags are rarely used more than once before they fall into the hands of the rag-merchants and paper-makers. In this condition, they constitute the cheapest paper stock to be found in the market. The demand for it, however, has not been extensive, even at low prices, as, hitherto, it was found impossible to bleach the fibres sufficiently to render them serviceable for the manufacture of white paper. This is owing to the fact, that the bark of the plant producing the jute contains a large quantity of humic and crenic acids, together with some mineral bases and tannin. These substances rapidly neutralise and destroy almost any bleaching agent that can be applied. The use of gunny or jute-ends has been, therefore, hitherto restricted to the manufacture of brown wrapping and envelope papers. Mr. Jeffery's numerous specimens of bleached pulp and paper show that the difficulty can be overcome.

Writing and packing-paper made from plantain fibre at Chingleput,

* Lecture "On the chief fibre-yielding plants of India," before the Society of Arts, 1860.

and at Meerut Jail. Experience has proved that the so-called "Manila hemp," or strong fibre from the wild plantain of the Eastern Archipelago (*Musa textilis*) makes excellent paper, and the only objection raised by paper-makers to the general use of this stock is its harshness, and the difficulty of bleaching it perfectly white. The cultivated plantain appears to be less suitable. The sap and gum in solution in all plants, while in their green or growing state, if dried into the fibres, renders them harsh, brittle, and more or less unfit for paper and textile purposes. Very useful and tough kinds of paper have been made in India from the plantain, and some of prime quality, from the same material, both in France and in this country.

Among the articles sent from British Guiana to the New York Exhibition were papers made from the fibre of the plantain stems, now thrown aside to rot on the ground. One sort for writing, another quality resembling parchment, and a coarse strong article for wrapping goods. These having been obtained in the very infancy of the manufacture, there is probability that superior paper of all descriptions may be produced as improvements in the process are effected. Proper machinery to extract the fibre is alone requisite to make the plantain an article of prime, commercial, and industrial value. It is to the West Indies and Africa, however, that we must look for supplies of this waste fibre. Generally speaking, however, the fibre is weak and requires to be mixed with some other material. Mr. Thomas Watson, in December 1855, reported to the Society of Arts the following result of a rough experiment he made to obtain pulp and paper from the plantain of Bengal. He had a quantity of the fibre cut into small pieces by hand; it was then soaked in water for two months, and afterwards well beaten in a wooden mortar, and again stirred up in water. The frame for making the pulp out of this last pan was a fine bamboo sieve. With such an apparatus, it may readily be understood that a rough and wretched description was turned out; but it was paper nevertheless. Although in thickness more like pasteboard than paper, it wanted tenacity, and readily cracked. It had, evidently, been too long steeped, and needed the admixture of tougher material. Other Indian experimentalists consider plantain fibre, which may be had in abundance, well adapted for the manufacture of paper, and have converted it into good pulp.

Mudar fibre paper. This is made from the yercum (*Calotropis gigantea*); but the separation of the fibre is tedious and expensive. It has been suggested that the silky cotton enveloping the seeds of this and many other plants, and not at present applied to any use, might be collected where labour is cheap, and converted into paper pulp. Paper has been made of the downy substance contained in the follicles of the Mudar, as well pure as when mixed with two-fifths of the pulp of the sunn-hemp, used by the natives for making paper. The cost of this material is estimated to be about 3s. a cwt. Should it be found useful, the waste lands of India could be covered with the plant, as it requires no culture and no water.

Paper made of hemp by the prisoners in the Central Jail, Meerut.—This is, no doubt, sunn-hemp, as the fibre of the true hemp is seldom utilized in India.

Paper of "aloe-leaf" fibre.—This is from a species of agava, which, though not indigenous, is now cultivated in many parts of the country. The misnomer of aloe, having now become the trade term, is likely to be retained.

Paper made at Agra of old ropes and gunny bags, and bleached by means of carbonate of soda and lime. Such papers can be procured at about 10s. per ream.

Paper of fibre of *Hibiscus cannabina*, made at Lucknow, and of *H. esculentus.*

Nepaul paper, made of the bark of the stems of *Daphne cannabina*—four qualities are shown. The paper is said never to be destroyed by insects, owing to the poisonous quality of the plant; but this is doubtful. This unsightly paper has been much over-rated. It is certainly tough when kept dry, and can be used like cloth, for wrapping up dry substances in; and it has one other quality which renders it superior, in that respect, to the ordinary country paper—it can be used after having been saturated with water, provided it be carefully dried within a reasonable time after it has been wet.

Mr. Hodgson, in the 'Journal of the Asiatic Society,' describes the process of manufacture as consisting, first, in boiling slips of the inner bark of the plant for about half-an-hour, by which time the slips will be quite soft. These are then broken in a stone mortar with a wooden mallet till they are reduced to a homogeneous pulp. This is then diffused through water, and taken up in sieves and paper-frames, as in the ordinary process for making paper by hand. When dry, the sheet of paper is folded up; sometimes it is smoothed and polished by being rubbed on wood with the convex side of the ponderous chank shell. But Mr. Hodgson does not explain how the very large sheets of several yards square are made. Though called Nepalese, the paper is, in fact, manufactured in Cis-Himalayan Bhote, in the midst of its immense forests, where there is an abundant supply of the plant, of wood for ashes and for firewood, as well as a constant supply of clean water. Some bricks of the half stuff were sent to this country more than thirty years ago, and a small portion made into paper by hand. It afforded finer impressions of engravings than any English-made paper, and nearly as good as the Chinese India proof paper.

Another kind of Nepaul paper is manufactured almost exclusively from the young shoots and leaves of the bamboo—an arborescent grass. After being cut, it is beaten in wooden mortars until reduced to a pulpy mass, then thrown into a vat of water, the impurities separated, and when of a proper consistency, it is spread on linen to be dried; the surface is rendered smooth by friction with a pebble on boards. Its structure is very tough, and cannot be torn rectilinearly, and it is most serviceable for filtration, as the fibres do not separate readily when saturated with moisture, and will resist, in a moist condition, considerable rough handling. Paper is also made from the bamboo in Lahore, Pegu, Assam, Siam, China, &c.

The fibres of the nettle family make admirable paper, but are too costly to come into general use. If the tow could be obtained in quantity from manufactories, it would add great strength to ordinary papers. Among the samples shown are Puya bark fibre (*Boehmeria Puya*) as a paper-stuff, Rhea fibre and tow (*Boehmeria nivea*), paper from the wild Rhea fibre and Bank-note paper made at Laverstoke Mills of Rhea fibre.

Paper from the bark of the Pulas, a leguminous shrub (*Butea frondosa*)—made at Aurungebad. The fibre is unimportant as an article of commerce, but it furnishes the natives with cordage, and is beaten into a kind of oakum. It is possessed of a good deal of strength. It is one of the most generally diffused plants, forming jungle. The fibrous part of many lily and aloe leaved plants have also been converted into excellent paper in India.

Dr. Riddell, from his experiments, strongly recommends the okro plant (*Abelmoschus esculentus*) as furnishing an excellent fibre for the manufacture of paper. Other fibres from the same natural family (*Malvaceaœ*) are likewise worthy of attention. They include the Indian mallow (*Abutilon Indicum*), jungle mallow (*Hibiscus* sp.), and the *Urena lobata*. The latter is the pest of Rangoon and its neighbourhood, and other parts of Burmah, springing up spontaneously wherever the jungle is cleared, and rapidly forming a dense mass of luxuriant vegetation. Any quantities of the plant may be had for the mere trouble of gathering it. The pulp and paper made of it seem of an excellent quality. The country paper of the North Western provinces is made from sunn (*Crotalaria junicea*). Paper is made of a species of *Hibiscus* in Japan and *H. sabdariffa* in India.

When, in 1853, the scarcity of rags in the European markets began to be felt, a friend and correspondent in Ceylon, Mr. W. C. Ondaatje, commenced experiments on various indigenous products, of which he forwarded me specimens. One of the most promising fibres he considered to be the *Gnidia eriocephala*, a plant of the same, or of an allied, genus to the *Daphne cannabina*, of which the Nepal paper is made. A small factory was set up, five miles from Badulla in the Central Province, where the material was found in abundance, and paper was made by hand labour. After spending about 200*l*., Mr. Ondaatje was obliged to abandon the manufacture, owing to the want of suitable machinery for reducing the raw material into pulp. With proper machinery the cost would be greatly reduced ; and he considers that the manufacture of paper with this new material would yield a good return. The pulp is not easily distinguishable from that made from rags; 90 grains made one sheet of paper of the size of foolscap; 12 sheets made with it weighed 2 oz. 2 drs.; 1 ream, 100 ounces. Again, 160 lbs. of the raw material, made four reams of paper; weight of one sheet of paper, 70 grains. 8 lbs. 6 oz. of pulp are required to make one ream. 1 lb. of fresh material yields $\frac{1}{4}$ lb. of paper pulp.

Mr. Ondaatje also describes the old Kandian mode of making paper, as follows:—The paper thus made was not employed for writing on—palm leaves serving for this purpose—but was used for making cartridge cases. From the tender branches of a species of Ficus, found everywhere in great abundance in the island, the whole of the bark was stripped, and afterwards the fibre, which is of great tenacity, was separated from the outer skin with the hand, put into an earthen pot, and boiled with wood ashes until it became soft, when it was removed and beaten with a wooden mallet on a stone till it assumed the consistency of dough. It was next put into water and churned with the hand, which process soon converted it to a fine homogenous emulsion. This was poured into a frame having a cloth floating in water. It was again agitated with the hand until the whole became uniformly spread over the cloth, on which it settled down smoothly. The frame being then withdrawn from the water, and allowed to drain gradually, was next put to dry in the sun. The paper thus formed was easily removed from the cloth bottom, and soon became fit for use. It was very tough and remarkable for its tenacity, and does not appear to be liable to the ravages of insects—specimens made about sixty years ago being still in excellent preservation, although no very great care seems to have been taken of them.

India abounds with grass jungles, which are, in the autumn of every year, burnt down, in order that the young blades may spring up and afford pasturage for cattle. Dr. Royle gave it as his opinion to the Board of Trade, that there are many situations where a sufficiency might be cut down before it has become perfectly dried up, and converted into half-stuff for paper-makers.

The plants of the arrowroot and ginger tribes all have annual stems and leaves, which are the refuse of the present culture, and might yield an abundant supply of half-stuff.

Some of these hints and practical details may not be without interest to the paper-maker. Very often the scientific inquirer opens up a profitable field for the manufacturer, by directing attention to some promising material which had been overlooked or not thoroughly tested. It has been only possible to skim lightly over the field of inquiry of Indian fibres; but a cursory glance of this kind in different quarters of the world may, perhaps, prove beneficial to the trade.

Scientific Notes.

THE PALM OF CHILI.—This Palm is very valuable, supplying a substitute for honey in a country where there are no bees. It grows from forty to fifty feet high ; the limbs all spring upwards from the top, and, falling over, form a graceful round head. The fruit in every respect is like the cocoa-nut, except that it is not larger than a walnut. At particular seasons of the year the trunk is bored, and the sap, by evaporation, forms a honey, which, when distilled, yields an intoxicating liquor called "guaraké," much sought after by the lower classes. The annual produce of a single tree is estimated to be worth as much as ten dollars. It is chiefly in the middle province that this palm is found. It is not a common tree, being very partially distributed, but several estates owe much of their value to the number of palms upon them ; and although the stem is useless, the leaves, sap and fruit, yield a large income to the proprietor. For thatching houses the leaves are considered better and more durable than any other material. The small cocoa-nuts, about an inch in diameter, of which every tree produces a great number, are highly esteemed, and form a considerable article of export to Peru. A curious method is employed to free the nut from the green husk in which it is enveloped, a process that was formerly attended with a very great loss of time and labour. A number of cows and oxen are driven into an enclosure, where a quantity of the fruit is spread, and being very fond of its husk, they immediately begin to feed on the fruit, only slightly masticating it in the first instance, and swallowing the whole ; afterwards, while chewing the cud, the nuts are rejected, and when the meal is finished, a heap of them is found before each of the animals, perfectly free from the husk, the cattle being thus supplied with food at a season when little grass remains on the hills, at the same time that they effectually perform a very useful operation.

THE SAGO PALM (*Cycas revoluta*, Willd.).—In Japan, the native country of this species, the Japanese, who make considerable plantations of it around their houses, are said to eat the seeds, and extract an inferior kind of sago from the pith or central part of the stem ; whence it has received the name of Sago Palm, although the true sago of the shops is the production of a very different plant, the *Sagus Rumphii*, Willd., which is a true palm. According to Dr. Hamilton (Travels in Mysore, vol. ii., p. 469), the flour used by the poorer natives of Malabar, called "Indium Podi," is prepared from the seed of a species of Cycas, dried and beaten in a mortar.

THE TECHNOLOGIST.

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THE BEECH MORELS OF THE SOUTHERN HEMISPHERE.

BY M. C. COOKE.

These singular fungi have not been known many years to scientific men, having been first brought under notice by the Rev. M. J. Berkeley, in the 'Transactions of the Linnean Society,' wherein he constituted a new genus for their reception, under the name of *Cyttaria*, and described two species, one collected by Bertero, in Chili, and afterwards by C. Darwin, Esq., who also found the species which bears his name in Tierra del Fuego, and which was the second species described in the paper above-mentioned. These were all that were then known, and they were, at the same time, ascertained to be common articles of food in the countries producing them. Since this period the number of species has been augmented, although now, as far as I am aware, it only includes five representatives, the sixth being problematic. Externally, some of these have a resemblance to the morel, and like that fungus are ascigerous, or bear their fruit enclosed in little elongated sacs (asci). Their chief interest to readers of the Technologist lies in their esculent qualities, and, hitherto, no collected account has been published of the different species constituting the genus; which must be my apology for introducing more than usual of the botanical element into this paper, which is devoted to a subject equally interesting to the botanist and the economist.

All the species hitherto found have occurred on beech trees, and with but one exception, hereafter to be noticed, a different species of *Cyttaria*, each one on a distinct species of beech. Their geographical limit is confined within a narrow zone, restricted to the southern hemisphere. The space enclosed between the parallels of 30 deg. and 60 deg. south latitude, includes all the localities in which they have hitherto been found. Four of the species are South American, two having been collected in Chili, one in Tierra del Fuego, and one at Cape Horn. One species only has at present been described from the Australasian islands, and this occurred in Tasmania, but it is exceedingly probable that others will be found when the cryptogamic flora of these important and extensive islands has been more thoroughly investigated.

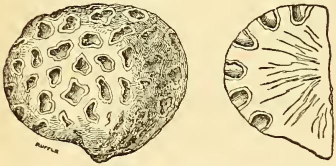
Edible fungi, belonging to other groups, are not uncommon in the localities indicated, but some of these do not seem to be at present correctly determined, and the rest do not fall within the limits of this notice.

A single specimen of a species of the present genus exists in M. Delessert's herbarium, which is stated to have been collected by Commerson, in the Isle of Bourbon, but there are doubts about the label attached being genuine, since the date given is unfortunately six years subsequent to the death of the person named thereon ; and, moreover, no true beech has yet been discovered on the island.

The following enumeration includes all that are positively known. A fungus, referred by Bonorden, in his latest work, to this genus, does not appear to me to be correctly placed.

DARWIN'S BEECH MOREL (*Cyttaria Darwinii.* Berk.)—Egg-yellow ; globose, but depressed; cups small, mouth irregular, at length open.

FIG. 1.



On *Fagus betuloides* in Tierra del Fuego, December to June, 'Berk. in Linn. Trans.'

To the Rev. M. J. Berkeley we are indebted also for a fuller and more minute description of this species.

Small specimens, half an inch in diameter, are globose, but depressed above and below, so as to resemble a little button mushroon ; strongly umbilicate below, with the edges of the umbilicus slightly puckered, and supported by a short brown stem, one and a-half line high and two lines thick, which proceeds from the umbilicus, and is granulated like shagreen, as if beset with a small black parasitic *sphæria.* Epidermis tough, very smooth and shining. A vertical section presents a brown fibrous mass springing from the stem, which gives off on every side elongated radiating fibres, divided from each other by a dark line, but which do not easily separate from one another. The divisions of the internal mass towards the circumference are more minute, but well marked, and the epidermis quite distinct. In this state there is not the slightest trace of the peripheral cups.

In a more advanced stage of growth, when the balls are from one to two inches in diameter, the cups begin to appear, the interior presenting in other respects nearly the same appearance as before, except that the divisions are larger. They are formed beneath the cuticle, and are at first covered by a portion of the matrix. The cuticle becomes depressed, though still tough and thick. The hymenium is separable in a body from the surrounding substance, except at the top, but I have not been able to detect either the toothed edge noticed by Mr. Darwin, or the gelatinous contents which had, perhaps, been dispersed by the spirits in which the specimens were preserved. The cells, or cups themselves, are ovate, lined almost to the top by the hymenium, which is, however, at present, not perfectly developed. The substance interposed between the top of the cells and the cuticle is gradually absorbed, and the cuticle itself becomes thinner and tightly stretched over the cavity, and at length bursts and forms a membranous border to the irregular orifice. The margin appears to be a little reflected, but I could not ascertain this point accurately. The hymenium is not perfect, and consists of very slender paraphyses and abundant large slightly flexuous asci, which contain eight sporidia, whose original form could not be made out, as they were contracted by the action of the alcohol. With the sporidia are a few globose granules. The asci at lenth become free, in which case they are generally slightly swollen at the base, and at last, in old specimens, there is scarcely any trace of them in the hymenium, which consists of paraphyses only. When the cups are quite formed and perforated, the cellular arrangement of the contents of the balls has wholly vanished, and there are only a few faint radiating lines in place of the regular divisions. The whole substance is composed of branched, more or less flexuous threads. Occasionally, the stem is not at all distinct, and the general form less globose, probably from the individuals having grown more deeply in the fissures of the bark. In the largest specimen there were traces of fine punctures, which had evidently arisen from the whole surface having been granulated like the stem in an early stage of growth, as some of the punctures below had still a little black granule set in them. There were, besides, other dots, which appear to indicate the position of undeveloped cups.

I have considered all the Fuegian specimens as belonging to one species. It is possible, however, that the larger specimens may prove distinct though the differences, which are not apparently important more probably arise from the period of the year at which they were gathered. ('Berk. in 'Linn. Trans').

The additional information furnished by Mr. Darwin is all that I am aware is known of this interesting fungus.

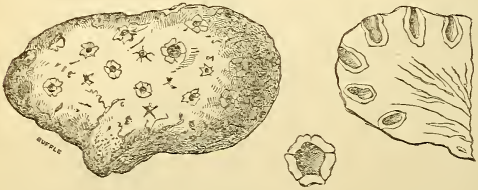
In the beech forests of Tierra del Fuego, the trees are much diseased. On the rough excrescences grow vast numbers of yellow balls. They are of the colour of the yolk of an egg, and vary in size from that of a bullet to that of a small apple, in shape they are globular, but a little produced towards the point of attachment. They grow, both on the branches and stem, in groups, when young they contain much fluid, and are tasteless, but in their older and altered state they form a very essential article of food for the Fuegian. The boys collect them, and they are eaten uncooked with fish. When we were in Good Success Bay, in December, they were then young ; in this state they are externally quite smooth, turgid, and of a bright colour, with no internal cavity. The external surface was marked with white spaces, as of a membrane covering a cell. Upon keeping one in a drawer my attention was called, after some interval, by finding it become nearly dry, the whole surface honeycombed by regular cells, and the decided smell of a fungus, with a slightly sweet mucous taste. In this state I have found them during January and February (1833), over the whole country. Upon dividing one, the centre is found partly hollow, and filled with brown fibrous matter, this, evidently, merely acts as a support to the elastic semi-transparent ligamentous substance, which forms the base and sides of the external cells. Some of these balls remain on the trees nearly the whole year. Captain Fitzroy has seen them in June.

June, 1834. Found some very turgid and highly elastic, a section of the central parts white, and the whole, under a high power looking like a vermicelli pudding, from the number of small threadlike cylinders. At about one-twentieth of an inch from the external surface there were placed at regular intervals small cup-shaped bodies, one-twelfth of an inch in diameter, of a bright Dutch orange. The cup was filled with adhesive, elastic, colourless, quite transparent matter, and hence at first appeared hollow. The upper edge of the cup was divided into conical points, about ten or twelve in number, and these terminated in an irregular bunch of the above-mentioned threads, the cup was easily detached from the surrounding white substance, excepting at the fringed superior edge. Over the cup was a slight pit in the exterior surface ; this afterwards becomes an external orifice to the cup, when the gelatinous mass has perhaps formed seeds.

A dried specimen of this fungus may be seen in the Technological Museum, at the Crystal Palace, Sydenham ; arranged with the food products.

Bertero's Beech Morel (*Cyttaria Berteröi.* Berk.)—Pallid-yellow,

Fig 2.



irregular ; base sub-elongated ; cups large ; mouths pentagonal, margins split and reflexed.

On *Fagus obliqua* in Chili, spring and summer.

Paler than *C. Darwinii*, from one inch and a half to three inches in diameter, not regularly globose, but lengthened at the base. Cups large, three-tenths of an inch, or more, broad; aperture more or less decidedly pentagonal, bordered by the revolute margin, which is split into portions corresponding with the sides of the aperture. Asci more slender, and longer than in *C. Darwinii*, sporidia elliptic, smaller, separated by a granular mass. The flesh in the full grown plant, which alone I have seen, is mottled, consisting of branched flexuous filaments. There are a few black granules about the base. (Berk. in 'Linn. Trans').

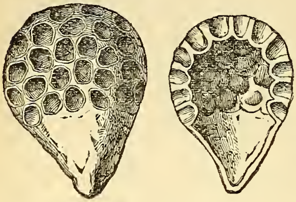
The species above described was first noticed by Bertero, and afterwards found by Mr. Charles Darwin. Like its congeners, it appears to be eaten by the inhabitants of the locality in which it is found, Bertero's account is brief, and to the following effect: "In the spring is found, on the branches of the roble, a great number of whitish tubercles, the parenchyma of which is spongy, though sufficiently consistent. At first I thought it a gall, or excrescence, produced by the wounds of some insect, as is seen in some other trees in Europe, and I gave the matter but little attention; but two days afterwards they became unglued from the branch, and I observed, with surprise, that the skin was broken, and the whole surface covered with pentagonal tubes precisely similar to the alveoli of a honeycomb, at first full of a gelatinous substance of the colour of milk, which disappeared with the maturation, afterwards throwing out from these cavities with some force an impalpable powder, when it was touched, exactly as is observed in *Peziza vesiculosa*. At the end of two days these bodies softened, lost their expulsive property and rotted. Its vulgar name is *dignenes*. Some persons eat them, but their insipid and styptic taste is disagreeable."

Mr. Darwin's account is equally brief; he writes, under date, September, 1834: "On the hills near Nancagua and San Fernando, there are large woods of roble, or the Chilian oak. I found on them a yellow fungus, very closely resembling the edible ones found on the beech of Terra del Fuego. Speaking from memory, the difference consists in these being paler coloured, but the inside of the cups of a darker orange. The greatest difference is, however, in the more irregular shape, in place of being spherical; they are also much larger. Many are three times as large as the largest of my Fuegian specimens. The footstalk appears longer; this is necessary from the roughness of the bark of the tree on which they grow. In the young state there is an internal cavity. They are occasionally eaten by the poor people."

Tasmanian Beech Morel (*Cyttaria Gunnii*, Berk.)—Common receptacle, pear-shaped; at length hollow; base attenuated; neither distinctly stalked nor scabrous. Cups small. Found on living branches of *Fagus Cunninghamii* in Tasmania, during the summer until the month of October.

It grows in tufts or clusters, on swellings of the branches; at first pear-shaped and without any distinct stem, becoming afterwards more decidedly globose and hollow. In size, this species attains from one to two inches in diameter, closely studded with the cups, which are numerous, and have broad irregular orifices. The asci are rather short and cylindrical, each containing eight broadly elliptical sporidia. The hymenium very speedily becomes obliterated.

FIG. 3.



It will be observed that in the absence of the granulations at the base of the receptacle, this species differs entirely from *C. Darwinii.*

This fungus abounds on the Tasmania myrtle tree (as the above-named species of *Fagus* is locally termed), in the dense forests to the westward, and was freely eaten by the aborigines in their wild state. It has also a reputation amongst the settlers for its esculent qualities. This species was also first described by the Rev. M. J. Berkeley, in Hooker's 'Flora Antarctica,' and afterwards figured in the 'London Journal of Botany' for 1848.

From the pages of some local journal (probably the 'Transactions of the Royal Society of Tasmania'), I some time since extracted the following paragraph, without appending the authority :—

" It is deserving of notice, that here, in the glens and ravines near the summits of a few of the high mountains between Lake St. Clair and Macquarie Harbour, a beech tree (*Fagus Gunnii,* Hook.) has been found, very closely resembling *Fagus antarctica* of the gloomy and humid forests of the southern extremity of America. A *Cyttaria* was found on this species of beech at Macquarie Harbour, by Dr. Milligan, in 1847."

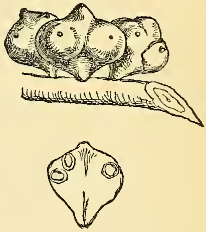
A single dried specimen of a *Cyttaria* (of which I also subjoin a figure) was presented to me by Dr. Milligan, in 1863, together with the leaves of the tree from which he obtained it. This specimen was gathered at Mount Sorell, in 1846. The leaves are considered by Dr. Hooker to be decidedly those of *Fagus Gunnii* and *not* of *Fagus Cunninghamii;* whilst the *Cyttaria*, which through the kindness of Mr. Berkeley, I have compared with a specimen of *Cyttaria Gunnii* in his herbarium, does not appear to me to offer any distinctive or specific deviations from that species. It is unsatisfactory, however, to affirm positively upon the

FIG. 4.

evidence of a single dried specimen, but there is good reason to believe that in this instance one and the same species of *Cyttaria* is found inhabiting two different species of beech. Whether this specimen collected in 1846 by Dr. Milligan, was the same as that above referred to as having been found by him in 1847 I cannot determine, not having been in communication with Dr. Milligan lately, nor am I certain that he is still in England, but I entertain no doubt that my specimen and the one alluded to in the above extract are identical. If such is not the case, it is still probable that a second species, not yet described, occurs in Tasmania.

HOOKER'S BEECH MOREL (*Cyttaria Hookeri*, Berk.)—Small; between obovate and top-shaped; obtusely papillate; pallid tawny; cups few. Found on the living branches of the deciduous beech (*Fagus antarctica*) at Hermite Island, Cape Horn.

FIG. 5.



The common receptacle in this species does not exceed an inch in height, with a diameter of from half to three quarters of an inch, attenuated at the base and obtusely papillœform at the apex, universally smooth. The cups are few in number, at first filled with a gummy matter, and at length empty. The asci are somewhat linear, intermixed with linear, sometimes forked paraphyses. The sporidia are unknown.

This is the smallest species yet discovered, and presents many points of difference from any of the others, of which its size, turbinate form, and paucity of cups are the most prominent and important. We have no other information of this fungus than that contained in the brief description in Dr. Hooker's *Flora antarctica.* It is presumed that it does not differ from its congeners in its edible qualities, but whether employed at all as an article of food has not apparently been ascertained.

CHILIAN BEECH MOREL (*Cyttaria disciformis*, Lev.)—Receptacle orbicular, convex, yellow, supported on a very short stem; cups minute and scattered. Found in Chili.

This is the smallest species of the genus which has yet been discovered, scarcely exceeding a quarter of an inch in diameter. It is flattened like a button, with a convex upper surface, on which are scattered a few point-like cells, at some distance from each other. These cells have at present only been found to contain long filaments, with a layer of compressed cellules terminating in globular swellings, each of which contains an opaque and irregular body. On the application of tincture of iodine, M. Leveille states that the filaments as well as the cellules became coloured of a yellowish brown, whilst the rest of the tissue, consisting of little polygonal cells, preserved its white colour.

Of course this species cannot be considered as of any value as an esculent on account of its very minute size, and it is only included here to render the paper complete as a record of the genus, its interest being solely botanical. I am not aware that any figure has been published, or that any specimens are to be found in Europe, except those in the Paris Museum, from which the diagnosis of the species was drawn up.

FRENCH COLONIAL PRODUCTS IN THE PALAIS DE L'INDUSTRIE, PARIS.

BY EDMUND GOEZE.

The industry of the present day represents a branch of human knowledge and action, the details of which appear so perfect that one would scarcely think it possible that its field could be so continually extended by new inventions and improvements.

England and France, undoubtedly the two most powerful nations on the sea, are of necessity at the head of all important industrial enterprises. The Great International Exhibitions of London and Paris, to which the numerous and fertile colonies of both countries so largely contributed, afforded good evidence of this. There are some economists who consider colonies rather in the light of a burden than a benefit, but their number is small; and in reading the ingenious remarks of a French writer, M. Alfred Maury, on this subject, we easily perceive the advantages, moral, political, and commercial, which their colonies offer to the European powers. No one will deny that they furnish military points and ports, and prevent over-population in the mother-country. Commercially the advantages are still more striking, and the different colonial products exhibited in the Museum I am about to pass under notice will fully prove this.

Having lived several years in Paris, I had the opportunity of paying frequent visits to this interesting and instructive exhibition, and I propose to give a short account of it for the benefit of those who take an interest in such collections. The arrangement of the specimens in the museum allows of the division of the description into two parts:

1. That which embraces the products of Algeria, undoubtedly the richest and most important of the French possessions.

2. That which treats of the productions of her other colonies, namely :—

In Africa : Senegal, Goree, Gabon, Mayotte, Nossi-bé, Sainte Marie de Madagascar, and the Island of Réunion.

In Asia : The French establishments in India, Pondicherry, Karikal, Mahé, Yanaon, and Chandernagore.

In North America and the Antilles: Martinique and Guadeloupe.

In the Atlantic: Saint Pierre and Miquelon.

In South America: French Guiana.

In Oceanica: The Marquesas Islands, Taîti, and New Caledonia.

It is not very long since the French Government and nation looked upon their Algerian possessions only in the light of a burden; now this opinion is entirely changed, a circumstance mainly attributable to the Great International Exhibition of 1851, where for the first time a very complete collection of the Algerian products was presented to the public. After this the French government purchased a private house in Paris for these collections, but only students and travellers were then admitted to it; and I have no doubt that they derive their present general importance from being united with the other colonial productions in the "Palais de l'Industrie." The Algerian products, as well as those of the other colonies, are classed in four divisions:—

1. Vegetables and vegetable productions.
2. Minerals.
3. Animals and animal products.
4. Indigenous industry and ethnography.

I intend to confine myself to a short account of the two former divisions, especially that of Botany, which study offers such rich treasures to every one who can enjoy the blessings of Nature. One of the most valuable trees of Algeria is the cork-oak (*Quercus suber*), an inhabitant of the coasts of the Mediterranean basin, where it occupies considerable plains of an extent of about 300,000 hectares, and it seems a silicious soil is that best suited for it. At the age of twenty-five its commercial importance begins. Its exterior suberous bark is first loosened, but this gives only a cork of inferior quality; nevertheless, it is used for pipes as aqueducts, for making corks, and in the preparation of lamp-black; it also serves to surround the stems of the young trees to protect them against the gnawing of certain animals, so that this first produce is necessary for the quality and abundance of later crops, which take place periodically, that is, as soon as the bark has acquired sufficient thickness, which generally occurs once in ten years. After having loosened the bark, they bring it into the work-sheds, steep it close to the fire in boiling water, and then subject it to a heavy pressure in order to flatten it. It is afterwards cut into lengths and sections of different size, according to the purpose to which it is to be applied. The annual value of the cork exported to France amounts at present to a sum of three million francs.

From Africa Rome obtained those costly tables Pliny mentions in his Natural History, and whose price amounted to upwards of 300,000 francs. The wood of which they are made is furnished by *Callitris quadrivalvis*, and we see here a beautiful variety of veins, undulations, and ramifications on a dark ground, or brown designs on a clear and brilliant ground. But its most valuable quality is its durability, in which respect it resembles the *Cupressus sempervirens*, and for this reason the ancients often confounded these two woods. Parisian industry has already employed both in cabinet maker's work, which has improved so much in the last twenty years, and different pieces of furniture made of *Callitris* and *Cupressus* can be found in the Exhibition to prove the excellent qualities which are attributed to them. I shall only refer further to the wood of the olive-tree, of the green oak, of the citron, and of the date. It would carry me too much into detail to enumerate the several woods suitable for building, &c., either indigenous or introduced, now to be met with in Algeria; I shall only observe that all the trees from the South of Europe grow well, and that the climate permits the introduction of a great many species from North America and Australia.

In a statistical table, dated 1858, I find that Algeria exported common woods of the value of 209,401fr., and exotic woods of the value of 12,208fr., but in looking at the vast extent of the Algerian forests, and considering that France imports common woods to the amount of 65,000,000fr. yearly, and foreign wood for 8,000,000fr., everybody will be surprised that Algeria contributes such a small proportion to the wants of the mother-country.

In textile plants, Algeria is excessively rich. I shall not speak of flax and hemp, nor of the giant hemp introduced from China, which, with the *Abutilon indicum*, *Corchorus textilis*, *Urtica nivea* and *argentea*, are cultivated to a considerable extent in some parts of the colony. But there are three plants especially which grow abundantly in the country, the utilisation of which promises great profit; they are the dwarf-palm (*Chamaerops humilis*) "diss" (*Ampelodesmos festucoides*), and "alfa," a name which includes several species of grasses, as the *Lygeum spartum*, *Stipa tenacissima*, *S. gigantea*, and *barbatus*.

The dwarf-palm was long considered useless, but the leaves now furnish filaments which supersede the employment of horse-hair, as it is much cheaper and not liable to be destroyed by insects. But this is not its greatest use. An Algerian journal, the *Akhbar*, is printed on paper made of the dwarf-palm diss and alfa, and there exists only one opinion concerning the excellent qualities of this paper. Among other plants cultivated for their fibres are the *Musa Paradisiaca* and *textilis*, *Agave Americana*, *fœtida*, and *ferox*, *Yucca aloifolia*, and *Typha latifolia*. French industry begins to employ the raw substances belonging to this section, and we meet here in several glass cases beautiful tissues of Algerian flax, and hemp, as well as cordage and different objects made of the fibres of the other textile plants.

Algerian cotton, which has been cultivated about twelve years, exhibits a great improvement from year to year. More than twenty varieties are to be found in the Exhibition, and each of them shows a fineness and a strength of staple which almost approaches in quality to the superior specimens coming from foreign countries.

The climate of Algeria is evidently well adapted to the production of vegetable juices ; and we find exhibited a great many specimens of oils, essences, perfumes, &c., derived from plants which grow abundantly in that country. First, the olive-tree (*Olea omnium arborum prima*) requires notice, for France expends every year 20,000,000 to 30,000,000 francs in olive oil. Algeria exported in 1858 in value nearly 4,000,000 of this.

Since that time the French government has paid a great attention to the cultivation of this tree, and Algerian olive oil has much improved from being prepared by European machinery ; so that it is now not inferior to that which comes from the south of France. The supply has increased every year, and the universal opinion is that the olive tree can be made the most valuable product of Algeria.

The *Ricinus communis*, the oil of which possesses strong purgative properties, grows well in Algeria, where it spreads spontaneously and assumes proportions unknown in Europe. A shrub belonging to the Gnetaceae, *Ephedra fragilis*, the Azeram of the Arabs, produces a juice which is used by the native women to lather and cleanse their linen instead of soap. Another shrub, having similar properties, is the soap-tree of meridional America, (*Sapindus saponaria*) which has been acclimatised in the government nursery of Algiers, and from there transplanted into the country to test its cultivation on a larger scale. In considering the essences and perfumes of Algeria, we are surprised to find them of such variety and excellence. M. Simounet is, in some respects, the creator of this branch of Algerian industry, and his products form in this section the most interesting portion of the permanent exhibition. I noticed more than twelve essences extracted from plants of the Aurantiaceae family, but even the more common plants, as *geranium*, *mentha*, *lavender*, *verbena*, *rosa*, are not neglected, and their essential oils prove all to be of the finest quality.

Passing next to dyeing and tanning substances, which are represented in great quantity, the qualities of some are highly appreciated.

The *Lawsonia inermis*, the leaves of which are used by the native women to dye their hair, nails, eyebrows, &c., is also used by the Arabs for dyeing wool and leather. It gives a yellow colour, which is said to be very durable. Mixed with a salt of iron it gives a beautiful black colour, which is stated to be excellent as a dye for silk. There is a species of Scilla in Algiers, probably *S. maritima*, growing wild abundantly, the bulbs of which afford a superior tanning matter, especially for dressing leather, and from 40 to 50 days are sufficient to perform this operation.

During my stay in Paris, I had often an opportunity of smoking Algerian cigars and tobacco, and, as far as my judgment goes, the praises bestowed upon the flavour and perfume of the tobacco are not exaggerated. In 1858 Algeria exported tobacco of the value of more than seven million francs, and I need not add that the export increases every year.

The abundance of the Algerian corn and vegetables has been alluded by Pliny, in his Natural History, 'De Fertilitate triplici in Africa.' The Algerian spirits and wines, with their peculiar strength and flavour, may be incidentally alluded to. In the exhibition there are several Herbaria, the most important having been selected and classed by M. Hardy, director of the Government nurseries. I counted in all five, the union of which will one day furnish a complete flora of Algeria.

Algeria represents, in the composition of its soil, almost all the great geological epochs ; and the numerous mines and quarries furnish a great many useful and valuable metals, stones, and earths. In the environs of Bône, Philippeville, Oran, Arzew, and Miliana, iron is found in veins and masses which are often very rich. The most celebrated copper mines are those of Mouzaia and Tenès, other silicious copper veins are found close to Blidato, Dalmatie, and Soumah. The lodes, or strata of lead, are widely diffused, and several of them were known and appreciated many centuries ago. Antimony, or stibium, is especially met with in the Province of Constantine, and lastly, we find silver, mercury, manganese, zinc, and even some traces of gold.

The coal formation is almost entirely absent, but still there is a hope that a profit may be derived from coal seams of a secondary and tertiary origin. Stone, marble, lime, parget, sea-salt, saltpetre, clay, &c., are found. The marbles of Filfila are of an excellent quality and beauty, the veins are very fine, and it is as easily worked as the celebrated marble of Carrara. On entering the rooms of the Exhibition, among the first subjects we meet with are two well-executed busts of the Emperor and Empress, which I believe are made of Algerian marble. After marble comes the granite and porphyry of Philippeville. Notwithstanding the numerous efforts and researches made in several ages to discover the quarries of the Numidian marble, so appreciated by the ancients, and which exhibit a union of purple, rose and gold ; they have not yet succeeded.

Several economic plants, cultivated throughout the greater part of France, the products of which are regarded as indispensable to the general welfare of the French people, have suffered much for some years from diseases, or atmospheric influence. Whoever will take the trouble to read the general annual reports upon this subject, will know that the fruit of the vine, and the olive, wheat, and other grains, and even the potatoe have at times failed both in quality and quantity. Whether these diseases and other unfavourable circumstances will increase or disappear, no one can predicate, but it has been a question which has engaged the consideration of the Emperor's government, as to what means might be taken to prevent these necessary products from becoming objects of scarcity. The rich soil and the beautiful climate of Algeria give the best solution to this question. In viewing the abundance and magnificence of its productions, we may justly conclude that Algeria may come to the assistance of the mother country. Another important reflection is that Algeria will become, sooner or later, the principal place from which French industry—at the present day greatly dependent upon foreign countries—will procure most of its raw materials, so that it will be enabled to compete with those foreign powers, which at present supply the French market.

Passing now to the general Colonial collection. In the first large room our eyes are arrested by a beautiful and varied assortment of woods, India, Senegal, the Antilles, and the Island of Bourbon furnishing the greater part; a simple enumeration even would be too long. These specimens exhibit a richness of shading, a fineness in the undulations, a polish and brightness which speak prominently in their favour, and the working up of the woods afford proof of these striking qualities. The precious palisander wood finds here a powerful rival in the green ebony, which is procured from a tree belonging to the Bignoniaceæ, viz., *Tecoma leucoxylon*. A piano, worked with exquisite taste, shows all the advantages which this much cheaper wood offers. Our attention is next drawn to a money-chest, made of the wood of the Manchineel, (*Hippomane Mancinella*). The mere name of this very poisonous tree of the Euphorbiaceæ frightened travellers some time ago, but it has now been discovered to be much less dangerous than was supposed. The wood is said to be well adapted for making furniture of high value. The wood of the "Avocatier," (*Persea gratissima*) of the *Acacia Lebbek*, with its beautiful blackness, the wood of several Myrtaceæ, the *Lignum vitæ*, the *Santalum*. Rosewood and mahogany also deserve to be mentioned, and recommend themselves by the specimens displayed.

The newly-opened museum in the Old Orangery in the Royal Gardens, Kew, shows a great many specimens of wood which are growing in French colonies. France imported in 1856 more than one and a half million francs worth of wood from her colonies.

In entering the second room, we make acquaintance with the different oils, fats, and soaps, as well as with the oil-seeds and fruits which produce them. We find here several productions, the consumption of which was formerly very small owing to limited supplies, but the import of which now increases every year. To this category belongs the palm-oil obtained from the west coast of Africa, as, for instance, in the districts of Gabon, Whydah, and Cazamance. It is the produce of a splendid palm, the *Elais Guineensis*, which the indigenous inhabitants call their friend; and certainly it deserves this epithet, for its produce is as various as it is copious. The oil especially renders it one of the most valuable palms. The preparation is very simple. The fruits are gathered as soon as they are quite ripe, and thrown into small troughs, which are made in the soil by casting up low dams. Negroes, armed with sticks, to the top of which sharp blades are attached, then separate the fleshy pericarp of the seeds. This done, they put the thick yellowish substance thus obtained into large earthen vessels, and place them over a fire ; vats are ready to receive it after having been boiled. This is the oil of second quality. The kernels or seeds, separately bruised and pressed, produce a proportion of 30 per cent. of fine palm-oil. The common oil is of a buttery consistence, of an orange-yellow colour, and has a very strong penetrating smell. They prepare white and yellow marbled soap of it, and in Paris it is used in making candles.

The soap possesses some peculiar properties ; it lathers in sea-water, for which reason it may be recommended to voyagers. The price is a very low one. In 1832 this production was entirely unknown in France ; at the present day 4,000 casks are yearly imported, but this import might be increased tenfold, since the shores of Western Africa are covered with forests of this palm, and only a small part of these has as yet been explored.

Besides palm-oil, the Colonies furnish a rich product in the oils of earth-nut, (*Arachis hypogœa*), *Ricinus*, *Sesame*, and cotton seed. But I must not forget to mention here the Aoura-palm of Guiana, (*Astrocaryum vulgare*), the pulp of the fruit yields an oil, which is used in many different ways. The oil of the Acajou-nut, (*Anacardium occidentale*) possesses caustic properties, which oxidise iron. The bead-tree oil, coming from Pondicherry, finds its principal use in the fabrication of soap, but the Hindoos take it as a remedy for worms, rheumatism, and open wounds. The *Bassia butyracea* of India bears a fruit with an edible pericarp. Its almonds, when placed under the press, yield a sort of fat, called Galam butter, which is employed as medicine, likewise for domestic purposes. Another species of the same genus, *Bassia gabonensis*, contains a true vegetable fat, of which two varieties are known, one, called by the natives "mounga," has the sweetness of our goose-fat, the other, named "djave," is only available in the preparation of soap. The tallow-tree is nearly related to these two plants. It produces a fat analogous to animal tallow. Vegetable wax of *Myrica cerifera* and *Corypha cerifera* closes this section. In directing attention to the balms, gums, resins and varnishes, the tropics claim here the first place. The gum Arabic, the Acajou gum, a substitute for the former, and an excellent varnish for furniture, inasmuch as it contains a large proportion of gallic acid, which prevents injury from insects, are both known and employed by the colonists. The gum of Senegal (*Acacia senegalensis*), the most valuable of all the productions of this colony, that of *Acacia Lebbek*, *Styrax benzoin*, employed in perfumes, coming from Pondicherry, and the Caoutchouc, *Hevea guianensis*, are a few of the numerous productions selected for notice from this rich collection.

The mineral substances displayed are the first things we meet with on entering another room. There are specimens of lime from Guiana, taken from a large shell-pit, the only one in the country. This lime, like most of that obtained by calcining shells, is of a peculiar fineness. Its alkaline properties are very prominent, and hence it is preferred for absorbing the acids in the sugar manufacture. Guiana possesses also rich sulphur mines, different sorts of earth, fit for excellent pottery, and for polishing metals, ferruginous kinds of sand, the melting of which gives a greyish, fine-grained, and shining mass. We would direct attention to the specimens of porcelain clay which comes from the numerous and important stone pits of Point à Pitre. In Guadaloupe it is used for different purposes, but its import in quantity to Europe yields an immense profit. At the present day the best quality is sold in Brest at 9fr. the cubic-metre, a price considerably lower than that of the porcelain clay, which comes from Auvergne and Italy. The island of Bourbon is celebrated for a beautiful red porcelain clay, but the great distance will scarcely allow of its lucrative import into Europe.

In passing, we cast a hasty glance at the mineral waters of Martinique, and on the different stones and minerals of New Caledonia. The copper mines of Ambriz and Loanda are well known, and considerable masses of copper and malachite are annually imported thence into England. Fine specimens of talc, which is found alternating with felspar, are sent from Guiana: this colony exhibits also some beautiful specimens of iron and gold, the nuggets of the latter being of considerable size. Senegal also possesses gold strata, which promise a rich profit. They are found in the province of Damhagnagney, not far from the famous cataracts of Felon, the limit of navigation on the river Senegal. This region has been but recently explored; and the knowledge we yet possess of this fertile district is not very extensive. On entering another room, we perceive specimens of fibres and textile substances, and among these a beautiful collection of cottons. A few remarks on this valuable plant may not be out of place. At the present day, when, through the American war, the scarcity of this production becomes more and more sensible, it is undoubtedly of the greatest importance that our minds should be occupied with the cultivation of this plant. In general, a cultivation so simple does not require much attention, and could open new sources of wealth to several of the French colonies. The landowners of the Antilles would certainly obtain better results from the cultivation of the cotton-plant than they do from their large sugar plantations. The most beautiful long-fibred varieties of cotton seem to be indigenous here, and Mr. Aubry-Lecomte, the intelligent curator, declares the Antilles to be the true native country of the cotton-plant, by showing us that it grows not only spontaneously upon the mountains, rocks, and sea-shores, but that the varieties cultivated here are also the most esteemed. The avarice, however, of the proprietors, the import of inferior varieties, the bad selection of seed, and divers commercial frauds, have all contributed to destroy this element of commercial welfare in its germ. At the commencement of French authority in these islands, the annual produce amounted to 1,400,000 kilogrammes, at the present time it has decreased to 16,000 kilogrammes, and even this small produce is far from being of a first-rate quality. The cotton cultivation was transplanted from here by emigrants to South Carolina and the islands of those shores, and perhaps the best variety, known as Sea Island, or Georgia long-stapled, owes its origin to this casual event, an incident which is considered at the present day one of the chief agents of the material prosperity of the Southern States of North America, the yearly produce having amounted before the civil war to four and a half million kilogrammes, a value of more than two million pounds sterling. The cottons of Guadaloupe, Martinique, Guiana, and the Senegal territory have likewise given the most satisfactory results, founded on a long series of experiments; but notwithstanding the favourable conditions of the climate and the fertility of the soil, its cultivation, despite the encouragement the Government has given to the proprietors, has not yet reached a quarter of the height which may be expected.

Among the other textile substances, one of the most important is the floss or downy silk of *Beaumontia grandiflora*; it furnishes an important material in the manufacture of artificial flowers, which are of an exquisite brilliancy and fineness. The inner down of the pods of *Ochroma lagopus*, a very common tree of the Antilles, rivals in fineness and lightness that of our eider-down; the outer one of the same plant is very useful in the manufacture of wadding and felt. According to report, large masses of the latter will shortly be imported into France. The vegetable silks and downs of *Bombax Ceiba*, *B. pentandrum* and *heptaphyllum*, of *Asclepias volubilis*, and *A. curassavica*, the fibres of the "mocou-mocou" plant of Guiana (*Caladium giganteum*) of several specimens of Bromeliaceæ, very common on the west coast of Africa, must not be overlooked. All these raw stuffs have been the object of serious examination, and they seem to recommend themselves best for the manufacture of paper, as also for making cords and ropes. The natives set us a good example; they give us, so to speak, the first hints and facilitate our experiments. The art of dyeing claims undoubtedly at the present day a high position in the industrial world, and that France especially is superior in the perfection of its products to all other European countries, everyone who has been in Paris and has visited the "Gobelins" will admit, for it is difficult to know which to admire most, the fineness of the weaving or the brilliant colours of the tapestry. I cannot forbear mentioning here the beautiful specimens of cochineal from Guadeloupe, which are much richer in carmine than that of Teneriffe, although the latter is more abundantly employed. I give here the following list of plants used in dyeing: Indian sappan, *Curcuma*, campeachy wood of Martinique; the wood of *Cytisus spinosus*, of a gold colour; the Santal-wood of Gabon, with orange and red dyeing properties; the *Mapuria guyanensis*, showing a brilliant red, but inferior to that of *Ficus tinctoria*, of Tahiti; *Inocarpus edulis*, a plant of the Sapotaceae, containing a glutinous dyeing substance; the dye lichens and mosses of the west coast of Africa, and the seeds of *Bixa Orellana*. The rich indigo plantations of Pondicherry, Senegal, Karikal, Guiana, &c., cannot be too highly appreciated. The fruits of *Aleurites triloba*, Euphorbiaceae, furnish an excellent oil for painting, and the bark of *Casuarina equisetifolia* is very caustic, and a substitute for a great many astringent substances. We find also the gamboge of the *Stalagmites gambogoides*, its brilliant yellow colour is known by everyone. Amongst the plants whose astringent properties make them important in tanning, I shall only mention a few—first of all the Areca palm or betel nut (*Areca Catechu*), the nuts of which contain much tannin; *Acacia Adansonii*, having similar but superior properties to our gall nuts, and the bark of *Rhizophora mangle*, which, by chemical processes, assumes different colours.

The only species of coffee of commercial value is *Coffea arabica*, from Arabia. A Dutchman named J. Horne brought it in 1690 to Batavia, and from thence in 1710 to Amsterdam. A few years after, in 1713, the Dutch government made a present of a plant to Louis XIX. It was cultivated in one of the stoves of the "Jardin des Plantes," in Paris, then called "Jardin du Roi," and a short time after it flowered and gave a little crop of seeds. Captain Declieux took in 1715 one small plant, raised in the garden above-mentioned, to the Antilles. During the sea voyage, the crew suffered much from want of water, and Captain Declieux was obliged to share his daily ration of water with his little coffee protegée to protect it from drought. Authentic reports assure us that from this small and weakly plant has sprung all the coffee plantations we now meet with in Martinique, the Antilles, Guadeloupe, Cayenne, St. Domingo, and the neighbouring islands. To the islands of Bourbon and France (Mauritius), the coffee plant was transplanted in a direct way from Arabia. These colonies soon produced such large quantities of coffee as not only to satisfy the requirements of France, but to leave a considerable exportation to foreign lands. The loss of St. Domingo in 1789, which island alone produced more than 80 millions of pounds of coffee, the neglect of the cultivation in Martinique and Guadaloupe, and the enormous increase in the consumption, are the principal reasons why France at the present day has become tributary to other countries for a supply.

The best variety of coffee is undoubtedly the Mocha; that of the Island of Bourbon is perhaps the next in value. Of the coffees of the West that of Cayenne enjoys a high reputation. On the Island of Bourbon people distinguish four kinds:—1. The *Mocha*, which is very delicate; the plants degenerate and often perish after a good crop. 2. The *Levoy*, much hardier than the Mocha, but vastly inferior in quality. 3. The *Myrthe*, a variety of the Mocha, which deserves to be recommended as it is very hardy and yields abundant crops. 4. The *Marron*, or wild coffee, with narcotic and bitter properties, so that it can only be used by mixing with one of the others. Numerous storms have destroyed a considerable part of the coffee plantations on this beautiful island—a reason why the reputation of Bourbon coffee has lately much deteriorated. Most of the colonies produce large quantities of cacao, the seeds of *Theobroma Cacao*. Its use is generally known, although we do not find it so extensively employed as it should be, for it is very nutritious and savoury, and certainly, as a daily beverage, much more to be recommended than tea and coffee. The cacao of the Antilles is considered of a very good quality. In Guiana 60,000 kilogrammes of cacao are obtained annually, and two different methods of preparation are known in the colony. The first consists in drying the seeds in the sun or by the wind, by which means the fine oils which they contain rests intact. The Indian mode is to smoke the seeds, but it can easily be seen that, by such a process, they lose much of their fine flavour. It is surprising that the cacao of the Island of Bourbon, notwithstanding its acknowledged excellent qualities, is considered the least valuable ; but it is too little known in Europe to banish the mistrust which in commercial circles is generally entertained against it.

Bourbon claims, however, as a compensation the first rank in sugar production, especially since 1837, when the first improved machinery was imported from Europe. Amongst all the European possessions in both the Indies, I have been told that the Island of Bourbon makes the finest raw sugar, being highly appreciated for its large crystals and easy solubility. The raw sugar of the Antilles and Mayotte is, perhaps, the next in value. In Guiana they cultivate a variety, the "Creole cane," which closely resembles the yellow cane of Batavia. The sugar cultivation in that colony is carried on without any regard to manuring, but nevertheless each hectare of soil produces annually 3,000 kilogrammes of sugar. Guiana has at the present day, fifteen large sugar factories, which employ upwards of 1,500 persons.

I must necessarily omit all mention of the medicinal substances, the farinaceous seeds, the varieties of tobacco, and the fine flavoured wines, as well as the more scientific collections, as for instance several herbaria of the colonies, but I would direct attention to forty well-executed oil paintings representing the numerous tropical fruits of the Island of Bourbon. This series of paintings deserves to be mentioned here as forming one of the most important ornaments of the Exhibition. Those who take an interest in tropical fruits will be highly gratified in viewing these fine representations ; and a very interesting and instructive paper by Dr. John Lindley "On the Tropical Fruits likely to be worth Cultivating in England" may be consulted as the best means of acquiring a further knowledge of their beauty and value.

I must not omit to mention my indebtedness to M. A. Dupuis, a French professor of Natural History, for various statements contained in this essay.

The Royal Botanical Gardens, Kew,
March, 1864.

THE TIMBER TREES OF CEYLON.

BY W. FERGUSON, F.L.S.

In addition to long-continued and extensive personal observation, the following list embodies information from Mr. Thwaites's work, "Enumerato Plantanum Zeylanicæ," from papers by Modliar Mendis, late of the Royal Engineer's Department; Mr. W. H. Wright, late of Peradenia, and the Rev. Mr. Thurstan; from the writings of Drs. Roxburgh, Wight, and Cleghorn, Major Drury, Capt. Beddome, and others, well known as botanists, or as writers on the useful plants of India. The Singhalese and Tamil names are added, marked with the letter S or T, when the trees have any that can be depended upon. An examination of a set of specimens of woods arranged according to their natural orders, will, I believe, not only convince practical men that it is the best system that can be adopted for every useful purpose; but in many cases will enable them to detect misplaced specimens.

Dilleniaceæ.

Dillenia retusa, Thunb. "Goda-para," Singhalese.—A common and useful wood, chiefly for building purposes, and more especially as rafters in the roofs of kitchens, where it is found to be the best wood for resisting the effects of smoke and heat.

Magnoliaceæ.

Michelia Nilagirica, Zenk. "Wal-Sapu," S.—A large forest tree found from 2,000 feet up to Neura-Ellia. Trees about three feet in diameter have been seen at Rangalla having a proportional height. The wood partakes of the colour and properties of the lance-wood, and therefore is used by the coachmakers in Colombo for the shafts of carriages, as it is found to be strong and elastic.

M. Champacca, or the "Rata-Sapu," cultivated and occasionally used like the above.

Anonaceæ.

Cyathocalyx Zeylanicus, H. f. et T. "Kakala" in the hills; "Eepatta" of the coast. The well-known light, lacquered Kandyan sticks are said to be made from this tree.

Flacourtiaceæ.

Phoberas Gaertneriw, Th. "Katu-Kurundo," S.—Wood hard, strong, elastic. Branches and young shoots are tied round the arms of outriggers to strengthen them.

Malvaceæ.

Paritium tiliaceum, Ad. Juss. "Belli-pata," S.—Chiefly for fences and the fibre of its bark.

Thespesia populnea, Corr. "Suriya-gas," S. "Poovarasum," T.—Called by some the tulip tree. The best known timber tree of the island. Planted from cuttings to form avenues, and such trees are generally hollow when old. Wood a shade between the colour of walnut and English elm. Felloes, naves, and panels of carriages and gun-stocks. A tough excellent wood.

STERCULIACEÆ.

Adansonia digitata, L. "Papara Pooley-maram," T.—Naturalised in Manaar and vicinity. Next in size to the *Wellingtonia gigantea.* Wood soft.

Salmalia Malabarica. "Katu-imbul-gas," S. "Elavummarum," T.—The red flowered silk cotton tree. Wood white, light, and spongy; used for small boats, floats, and models.

Cullenia excelsa, Wight. "Kattu-bodde," S. "Konjie-maram," T. —Tall straight tree, sixty to eighty feet high. Wood light, structure of longitudinal section very peculiar under the microscope.

Heritiera littoralis, Ait. "Homæderiya," S.—Looking-glass tree, found near Colombo, on the banks of lakes and rivers. Said to afford the red, strong, durable, Soondree, so well known in Bengal for house-building. It is the toughest wood that has been tested in India; when Rangoon teak broke with a weight of 873 pounds, soondree sustained 1,312 pounds. It is not a very durable wood, but stands unrivalled in strength.

Sterculia fœtida. "Telambu," S. "Peenary-maram," T.—A large tree applied to many useful purposes in India, and is supposed to produce the smaller of the Poon or Peon spars.

BYTTNERIACEÆ.

Guazuma tomentosa. "Pattipariti, Ta."—It is called the Bastard Cedar. It is naturalised in the north of the island, common in avenues in Jaffna, and there are a few trees in Colombo. Its mucilaginous bark is used to clarify sugar. Wood light and loose grained, but much used in making furniture in India, and extensively by coachmakers for panels.

Pterospermum suberifolium. "Velanga," S. "Taddeemaram," T.—A tough walnut-like wood, used for gun-stocks and many useful purposes.

Grewia tiliæfolia. "Dawaniya," S. "Thalathee-maram,"—Wood soft and easily worked, but contracts and expands much, though well-seasoned.

Berrya Ammonilla. "Hal-mililla," S. "Tericonanalay-maram, Kattamanak, and Shavandilly-maram," T.—Perhaps the most valuable timber tree in the island. Large quantities of it are exported from Batticaloa and Trincomalee to other parts of the island and to Madras, at which last place it is known as Trincomalee wood, and of which the famous Masoola boats are built. The wood resembles the English ash in colour, and is highly esteemed for its lightness and strength; is straight grained, slightly pliant, tough, and little affected by the atmosphere. Used by coachmakers, coopers, and house-builders for nearly every purpose to which a good wood can be applied. Indigenous only to Ceylon.

Kleinhovia hospita, Linn.—A very handsome flowering tree growing in Colombo, but not indigenous to Ceylon. Some young trees about eight to ten inches in diameter cut down, produced a light-coloured wood apparently of no great value, but in Java the old wood is said to be highly prized for handles of kreeses, &c.

Pterospernum Indicum, said to produce the ornamental wood known in commerce as "kyabooka." This wood is obtained from the knotty excrescences or burrs. It is sawn off in slabs two to four feet long and two to eight inches thick. It resembles the hue of the yew, and is very hard and full of curls, the colour being reddish brown varying to orange. It is very ornamental, and much esteemed in China, India, and England, where it is used for making small boxes, writing desks, and other fancy ornamental work. The wood is brought to Singapore by Eastern traders, and is sold by weight. I do not think that a tree having this botanic name exists. It is most likely the wood of the *Pterocarpus Indicus*, a handsome tree introduced from the Eastern Islands, which is deservedly becoming a popular road-side tree here. (See under Leguminoseæ.)

Dipterocarpeæ.

Dipterocarpus Zeylanicus, Th. "Hora-gaha," S.—This is a gigantic forest tree, producing one of the most common, and perhaps most despised woods in the island ; but if harder and more durable woods become too scarce for railway purposes, the wood of this tree, and of others like it of great and large growth, may well take its place if it is found that kyanizing or creosoting must be resorted to. Some trunks of this and following species measured three to four feet in diameter by fifty to sixty feet in length. Abundant up to an elevation of 3,000 feet.

D. hispidus, Th. "Boo-hora-gas," S. Saffragam.

D. glandulosus, Th. "Dorana gas," S. Putlam, Saffragam, and Ambegamoa districts. A balsamic oil called "Dorona-tel," is obtained from this tree. Wood likely to resemble that of the common "Hora" noticed above.

Doona Zeylanica, Th. "Doon-gas," S. Abundant and most excellent timber tree. Several varieties or species as regards the colour or value of the timber are known in Hewahette. The wood of the Doon is now much used for shingles for covering the roofs of buildings on new coffee estates. It is sawn into junks of the required length, and they easily split up by axes made for such purposes.

D. trapezifolia, Th. "Tukahalu-gas," S.—Common forest tree in Central and Southern Provinces up to an elevation of 1,500 feet.

D. congestiflora, Th. "Tinneya-gas," S. — Western and Southern Provinces.

D. cordifolia, Th. *Caryolobis indica*, Gartner fr. "Beraliya," S.—Ripe fruits roasted or fried are eaten by Singhalese. These three species like the above may produce resin, oil, or valuable timber.

Shorea oblongifolia, Th. and S. *stipularis*, both in the south-west of the Island, are likely to produce good timber, as do their congeners in India.

Hopea discolor.—Ambegamoa and south of the Island.—Same remarks as above, apply to this tree.

Vateria Indica, L. "Halgaha," S. "Pynie," T.—Produces the valuable *Piney* varnish, gum resin, and one of the commonest and best known woods of Ceylon for coffins, &c. Its bark is used to keep toddy from fermenting.

Isauxis Roxburghiana, Wight. "Mendora," S.—A well known and justly valued timber tree. Like most species of this order, it produces a quantity of gum resin. This is the Mendora *par excellence*, and must not be confounded with Hal or Gal-Mendora, which belongs to Leguminosæ.

Ternstromiaceæ, or Tea Tribe.

Enrya Japonica, Thunb. "Niya-dessa, S.—Small tree, very abundant in the Central Province.

Aurantiaceæ, or Orange Tribe.

Atalantia monophylla, D. C. Wild Lime. "Kat-Mamichan, T.—The wood is hard, heavy, and close grained; of a pale yellow colour, and very suitable for cabinet work. Small tree found in Kandy and northwards.

Limonia Missionis, Wall. "Gas-Pamburu," S.—Colombo to Jaffna. Generally a light-coloured wood, but when variegated, much used for furniture.

Murraya exotica, Linn. "Ætteriya," S.—A small tree, the toughest wood in the island except "Andara" (*Dicrostachys cinera*), and *Heritiera littoralis.*

Feronia elephantum, Corr. "Diwul," S.—A hard heavy wood, and yields a gum equal to gum arabic.

Ægle Marmelos, Corr. "Beli," S. "Velva maram," T.—Fruits most valuable in medicine; laxative or astringent according to circumstances, are said to contain a principle allied to opium; hence doubtless their beneficial effects in cases of chronic diarrhœa.

Guttiferæ.

Garcinia Cambogia, Desr. "Goraka-gaha."—A wood used, but not good; fruits pickled.

G. echinocarpa, Th. "Madol-gas," S.—Central and southern provinces. Large tree; wood soft.

G. morella, Desr. "Gokatu, Gothatu, and Kana Goraka," S.—This is the only tree in Ceylon that produces Gamboge. From Colombo to Batticaloa.

Terpnophyllum zeylanicum, Th.—A wood much like English oak, and well known by the Singhalese name of "Ub-beriya," but often miscalled "Ook-bairya."

Xanthocymus ovalifolius, Roxb. "Elagokatu-gas," S., "Kokatie," T.—From Jaffna to Batticaloa. Renders the jungles of Jaffna fetid when in flower.

Mesua ferrea, Linn. "Na-gaha," S.—A hard, red, heavy, and good wood. There are some six or eight iron woods known in commerce, and from different parts of the world, but this one is the iron-wood *par excellence* of Ceylon, though often confounded under this name with the "Pala," *Mimusops Indica*, D. C.

M. speciosa, Chois. "Diya-na-gaha," S.—Grows near water, and is also a useful timber. South part of the island.

M. coromandelina, Wight.—The wood of this and the above are likely to be mixed as "iron-wood."

Kayea stylosa, Th. "Suwanda-gas," S.—South of island; a timber tree.

Calophyllum inophyllum, Linn. "Tel-Domba-gaha," S., "Poonga," T. —Common; a hard, red, tough wood; for arms of outriggers and ships blocks; seeds give oil, and are largely eaten by bats, &c.

C. tomentosum, Wight. "Keena-gaha," S.—Forests of the interior; a gigantic tree and beautiful wood; seeds oil-giving.

C. Moonii, Wight. "Domba-keena" and "Wallu-keena," S.—Common in the west and southern provinces; furnishes fine long spars.

C. Burmanni, Wight. "Keena," S.—Very common small tree, used for various purposes; fruits edible.

HIPPOCRATEACEÆ.

Kookoona zeylanica, Thw., *Swietenia febrifuga*, Moon. "Kokun," S., in Saffragam, "Wannapottu," S., at Porey.—Large tree; bark and flowers medicinal.

ERYTHROXYLEÆ.

Sethia indica, D. C., Fen-tree. "Tevadanum and Semmanathy," T.—Timber flesh-coloured; considered excellent for its size; so fragrant as to be used in Mysore instead of sandal wood. Empyreumatic oil obtained from it.

SAPINDACEÆ, OR SOAP-NUT TRIBE.

Nephelium longanum, Camb. "Mora-gaha," S.—A useful timber and fruit tree.

Schleichera trijuga, Willd. "Kong-gaha," S., "Poo-maram," T.—The Ceylon oak, honey-tree, &c. Fine tree, wood dark, large size; used for mortars, for oil mills, and such purposes.

Filicium decipiens, Th. "Pihimbiya," S.—Tree; ornamental wood, well known.

Dodonœa Burmannia, D. C. "Æta-wœrœla," S.—Switch sorrel; wood not more than three to four inches in diameter, but exceedingly tough and hard. For engravings and handles of tools.

MELIACEÆ.

Melia composita, Willd. "Lunu-midella," S.—Quick growing tree; timber very light and cedar-like; for outriggers of boats and ceilings. White ants said not to attack it.

Azadirachta indica, Adr. Juss. "Telkohomba," S., "Vepumaram," T.—Wood dark coloured and tough, but curved; oil, bark, and twigs medicinal. Indigenous in forests of the north.

Walsura piscida, Roxb. "Kiri-kong," S.—Not a common timber tree.

CEDRELACEÆ.

Chickrassia tabularis, Adr. Juss. "Hulanhick-gala," S., "Aglaymarum," T.—A close-grained, elegantly-veined wood, much used in India under the name of Chittagong wood for furniture. Some of this wood, used in the palace of one of the Kandyan Kings, was known to have lasted several hundred years.

Chloroxylon swietenia, D. C. "Burutu-gas," S., "Vummary-maram," T.—Satin-wood; one of the largest and best known of Ceylon timber trees. Liable to warp and split, if not well seasoned in the shade. "Flower satin" is obtained generally from the roots, &c., of this tree.

XANTHOXYLACEÆ.

Xanthoxylon Rhetsa, D. C. "Uguraesa and Katu-keena-gas," S.—Large tree.

X. triphyllum, Juss. "Lunu-ankenda," S.—Wood soft; much used for charcoal.

Cyminosma pedunculata, D. C. "Ankenda," S.—Wood very white; for inlaying purposes and for charcoal. Tree very small.

Ailanthus malabaricus, D.C. "Walbelin-gas," S.—An enormous tree, but timber soft.

SIMARUBEÆ.

Samadera indica, Gaert. "Samadara," S.—Wood small, and, like the other members of the order, bitter.

OCHNACEÆ.

Ochna Mooni, Thw. "Mal-kaera," S.—Wood small, but very tough.

Gomphia angustifolia, Vahl. "Bo-kaera-gas," S.—Wood larger than the above; very hard and tough.

CELASTRACEÆ.

Pleurostylia Wightii, W. et A. "Pyaru," S.—Common, but not large. A white-coloured wood.

Kurrimia Ceyalnica, Arn. "Pelengas," S.—A large tree, but timber not in great request.

Zizyphus jujuba, Lam. "Maha-debara," S., "Illana," T., Masan, Portuguese.—A well-known and cultivated fruit-tree. Wood hard, tough, and heavy, but of small diameter.

TEREBINTHACEÆ.

Mangifera indica, Linn. "Aetamba-gaha," S., "Ma-marum," T.—Indigenous. One of the most gigantic of our forest trees; Colombo to Batticaloa; common; fruits size of an English plum; wood a very common one for inferior purposes.

Anacardium occidentale, Linn. "Kaju-gas," S., from its original South American name "Acajou."—Naturalised in Ceylon.

Semecarpus.—Several species, under the name of "Badula," are used as timber-trees.

Campnospernum zeylanicum, Thw. "Aridde," S.—A handsome wood, not much known.

Odina wodier, Roxb. "Hik-gas," S., "Othe-marum," T.—One of the very useful trees of the island. The heart-wood, as "Hik-karotura," when long and well-seasoned, is a dark coloured, useful, and ornamental wood.

Evia amara, Comm. "Aembarælla-gaha," S.—A quick-growing tree, often planted with the above in fences. Used in Java, whilst growing, as one of the trees to support telegraph wires.

Protium caudatum, W. et A. "Kiluvy," T.—This and another species or genus called "Mook-kiluvy" T., (*Balsamodendron?*) are the most common fence plants in Jaffna, and about the handsomest and best in the Island; wood soft.

Canarium Zeylanicum, Blume. "Kaekuna-gaha," S.—A large tree, common; produces a balsamic gum resin much sought after.

Homalineæ.

Blackwillia Ceylanica, Gardner. "Liang-gaha," S.—A common timber tree.

Liguminosæ.

Æschynomene aspera, and *Æ. Indica*, Linn. "Diya-Siembala," S., "Shola," T.—The pith hats, &c., are made from a spongy substance generated on the stems of these plants when growing in water, as they generally do.

Erythrina Indica, Lam. "Erabadu-gaha," S., "Muruku," T.—The famous Mootche-wood of India; a light, spongy, wood; models, floats, bungs, &c., made of it.

Butea frondosa, Roxb. "Gas-kaela," S.—Wood said to be hardly distinguishable from teak; flowers used for cleaning gold.

Pterocarpus marsupium, Roxb. "Gam-malu-gaha," S., "Vangay-marum," T.—A useful timber tree; one of the gum kinos obtained from it.

P. Indica, Willd.—A fast-growing and handsome tree, which produces the Lingoa and Kyabooka wood of commerce.

Pongamia glabra, Ventn. "Magul-Karandu," S., "Ponga-maruma," T.—Conflicting opinions as to the usefulness of its wood.

Fissicalyx ——— ? Bentham, *Dalbergia Mooniana*, Thw. "Naedun, or Nandu," S.—A large tree; wood dark-coloured, and valued for furniture; now scarce and dear.

Tamarindus officinalis, Hooker. "Seiambala," S., "Poolia-marum," T.—The roots and heart-wood of old trees superior in colour, &c., to Calamander wood.

Cassia Fistula, Linn. "Æhœla," S., "Koanay," T.—Wood close-grained, but small and curved; used for tom-toms, and all parts in medicine or the arts.

C. Florida, Vahl. "Waa-gas," S.—Wood extremely hard and durable.

C. Timoriensis, D. C. "Aramana," S.—Heartwood, hard and black, like ebony.

Jonesia Asoka, Roxb.—This can scarcely be a timber tree.

Dialium ovoideum, Thw. "Gal-syambala-gas," S.—Wood strong and handsome; well adapted for ornamental furniture.

Cynometra ramiflora, Linn. "Gal-Mendora-gaha," S.—A serviceable wood, but must not be confounded with *the* Mendora. See *Dipterocarpeæ*.

Bauhinia tomentosa, Linn. "Petan," S.—Wood dark and heavy, but small.

Adenanthera pavonina, Linn. "Madatiya-gaha," S., "Auny Koondumany," T.—Timber valued for its solidity; the heart-wood of old trees of a deep red colour, and called coral-wood; very hard and durable.

A. bicolor, Moon. "Mas-moru-gaha," S.—A very ornamental tree; timber smaller than the above.

Dichrostachys cinerea, W. et A. "Andara," S., "Vudutala-maram," T. —A small, crooked tree, most abundant in Jaffna; a hard, heavy, and dark-coloured wood, and, perhaps, without exception, the toughest wood in Ceylon.

Acacia eburnea, Willd.—North of the island.

A. tomentosa, Willd.—"Ani-muller," T.—North of the island.

A. leucophlea, Willd. "Katu-andara," S., "Velvaylam," T.

A. Catechu, Willd. "Rat-kihiri-gas," S., "Wodahalay," T.

All the foregoing Acacias are indigenous; and with *A. Arabica*, Willd, cultivated in Ceylon, produce hard, small, and curved timber.

Albizzia Lebbek, Benth. "Suriya-mara," S., "Vaghay-maram, T."—Wood used for bullock-bandies.

A. odoratissima, Benth. "Surre-mara," S., *A. amara*, Boivin; *A. stipulata*, Benth.; "Hulan-mara," S.; and *A. procera*, Benth.—Not indigenous; are all useful woods.

Pithecolobium bigeminum, Mart. "Kalatiya-gaha," S.—Not much used.

P. dulce, Benth. "Gorkapulli," T.—The Madras fence plant, now so common in Colombo, is a rapid-growing tree.

The plants of the fast-growing *Dalbergia Sissoo*, said to form a valuable timber tree in twenty years' time, and so freely distributed over the island in 1844, have grown well in several of the provinces; but some of those planted in the fort of Colombo fell last year from the effects of dry rot, or some other fungus which attacked their roots.

A species of *Dalbergia* produces the famous Bombay blackwood, so like rosewood, and so commonly used for furniture.

Hymenœa verrucosa.—A tree growing in Colombo, produces a gum said to be the source of copal; wood very soft and brittle.

ROSACEÆ.

Pygeum zeylanicum, Gaert. "Gal-mora-gaha," S.—It is most likely a species of *Nephelium*. The plant emits the greatest heat on being burnt, a very important fact in Ceylon, where coals are often scarce and dear.

COMBRETACEÆ.

Lumnitzera racemosa, Willd. "Beriya," S.—Affects the same places as the mangroves, where the sea generally has access. Timber small, wood solid and heavy, remarkably strong and durable, and much used for posts and other parts of houses of natives.

Conocarpus latifolia, Roxb. "Dawu-gas," S., "Veckalie," T.—One of the largest timber trees on the Circar mountains; wood universally esteemed for almost every economical purpose. Towards the centre it is of a chocolate colour, and is then exceedingly durable. For house and ship-building, the natives reckon it superior to every other sort, Kumbuk and Teak excepted. A variegated, hard, close-grained wood. Found in open grassy places, and to the north of Kandy, up to an elevation of 1,500 feet.

Terminalia Belerica, Roxb. "Bulu-gaha," S., "Tanikai," T.—From the sea-coast to the open Patenas of the interior, where it is a very common tree. Wood used for coffee-casks, packing-cases, catamarans, grain measures, &c. Its dried fruits (Myrobalans), like those of *Ægle Marmelos*, are both astringent and laxative, as rhubarb is.

T. Chebula, Retz. "Aralu-gaha," S, "Kadukai-marum," and "Pilla-murdah-marum," T.—Wood dark-coloured, heavy, and hard; heart-part used for superior furniture, &c., but cross-grained and difficult to work. Fruits (also Myrobalans), the ink-nuts of the bazaars.

T. parviflora, Thw., *Combretium decandrum*, Moon. "Hampalanda," S.—Abundant in Ambegamoa and in margins of woods in the Central Province up to 4,000 feet. Also common near Colombo. The wood is very hard and heavy.

PENTAPTERA.

T. glabra, W. et A., *T. alata*, Moon. "Kumbuk," S.—A majestic tree, from Belligam northwards to Jaffna, and from thence to Batticaloa, as well as in the central parts of the island. Wood dark-coloured, very hard, heavy and strong, inch bars bearing 430 to 450 lbs.; used in house building, for boats, canoes, &c.

MELASTOMACEÆ.

Memecylon capitellatum, Linn., "Welli-kaha," S., and *M. umbellatum*, Burm, "Kora-kaha," S.—Wood small but very tough, and in great request as switches by bullock-drivers, hence the origin of the Tamil "Suatche."

Myrtaceæ.

Eugenia Willdenovii, D. C. "Tambeleya and Kotala-gas," S., "Kyan and Pandy-kyan," T.—At Trincomalie, where it is one of the useful timber trees.

E. Mooniana, Wight. "Pini-baru," S.—A small but hard and very tough wood, for handles of hammers, for stone-breakers, &c.

Jambosa aquea, D. C. "Wal-jambu," S.—A small tree, wood white and soft.

Syzigium carophyllifolium, D. C. "Madan," S., "Navel-marum," T. —The black fruits, which are about the size of English damsons, are sold in the bazaars. A very common tree from Jaffna to Colombo, but wood small and curved. Used for knees of boats, and various useful purposes.

S. polyanthum, Th. "Batta-Domba," S.—An ordinary wood, but not so plentiful as the above.

S. androsæmoides, *Eug. Cordifolia*, Wight.—A middle-sized but very handsome tree. Too scarce for the wood to be generally serviceable.

S. sylvestre, Wight. "Alubo-gaha," S.—A large common tree, used in house building.

S. neesianum, Arnott. "Panu-kaera," S.—A small timber tree found in the western province. The "Damba," S., a good-sized tree, producing a fragrant gum and useful timber, is a species of this genus, if it be not *S. Gardneri* of Thwaites. The other species are also likely to produce a good timber.

Acmena zeylanica, Thw. "Goda-maranda," S.—A small myrtle-like tree, very ornamental, but timber, though tough, small and curved.

Barringtoniaceæ.

Barringtonia speciosa, Linn. "Moodilla," S.—An umbrageous fine tree, affectiug the mouths of rivers, but too scarce to be generally useful. Wood red, equivalent to mahogany.

B. acutangulum, Gaert. "Ela-midella," S.—Wood small, but described as similar to the above.

Careya arborea, Roxb. "Kahata-gaha," S., "Pailae-marum," T.—A common tree from the coast up to the Pattenas. Bark very astringent as its Singhalese name implies, and used for slow matches and cordage in India. Its flowers and calcyces are a famous drug of the bazaars, under the name "Wagapul." Its wood is described as useless in India, while in Pegu it is said to form, with the *Barringtonias* above, the chief materials of which the carts of the country are made. Red, and like mahogany.

Anisophyllea zeylanica, Benth. "Wellipyana," S.—For common house-buildings.

Rhizophoraceæ.

Of this order, the genera Rhizophora, Bruguiera, Kanilla, and Ceriops, form the chief plants composing the Mangroves, which affect the sides of marshes all round the island. The timber of some is used in common house-building, and the barks of others are the chief ingredients in tanning and dyeing country leather.

Carallia integerrima, D. C. "Dawata-gaha," S.—A common and shady tree, like the "Goraka," or Gamboge tree; from the coast to 3,000 feet. Timber strong and ornamental.

Anstrutheria zeylanica, Gardner.—Galle and Trincomalie. No use of its known.

LYTHRARIACEÆ.

Lawsonia alba, Lam. "Marithondi," T. and S.—Country mignonette. Tree small, but wood tough; a good fence plant; the "Camphire" of the "Song of Solomon."

Lagerstrœmia reginæ, Roxb. "Muru-tu-gaha," S., "Kadali-pua," T.—Timber used for casks, and various useful purposes.

Sonneratia acida, Linn. "Gedi-kilala," S.—Ceylon cork-tree, found in swamps, common. Wood light and white; used for models of boats, &c.; said to be a better substitute for coal in steamers than any other kind of wood. The curious white, spongy, spindle-like columns, which are thrown up from the roots of this tree, are used as corks for the tart-fruit bottles, &c., for models, and for lining the inside of insect cases. It is adhesive, and easily pierced by a pin.

ARALIACEÆ, OR IVY-FAMILY.

Hederà exaltata, Thw. "Goda-Itta," S.—A large tree of the mountains, with handsome digitate leaves. Wood soft.

Aralia papyrifera, Hooker.—The famous rice-paper plant of China; has been introduced into Ceylon, and several plants of it are growing in the Fort Garden.

ALANGIACEÆ.

Alamgium Lanarkii, Thw. "Eepetta," (?) S., "Alangi-maram," T.—A small tree. Wood tough and elastic, but scarce.

RUBIACEÆ, OR THE COFFEE AND CINCHONA FAMILY.

Nàuclea coadunata, Roxb. "Bak-mee-gaha," S.—A common tree. Wood light and tough; used for sandals, common almirahs, doors, &c.

N. Cadamba, Roxb. "Halamba," S., and *N. cordifolia*, Roxb., "Kolong-gaha," S.—produce timber which is used for house-building and common purposes.

Uncaria Gambier, Hunter.—Is quite a common plant, near Colombo and Galle, Deltotte, and Doombera. The extract from it is the Gambier or Terra Japonica of commerce, found to be an excellent preservative for timber, especially against the attacks of the Teredo.

Morinda bracteata, Roxb. "Ahoo-gaha," S., and *M. exersta*, Roxb. "Manja-woenna," T.—Roots of both used as a dye.

M. umbellata, Linn. "Maha-kiri-wael," S.—The long scandent stems of it used for ropes and to tie fences.

Serissa Ceylanica, Thw.—*Dysodidendron*, of Gardner, is a fetid wood, but must not be confounded with the "Guraenda" elsewhere given.

Canthium didymum, Gaert. "Poruwa-mara," S.—A common, but small and curved tree.

Timonius Jambosella, Thw.—A common tree, likely to be a useful timber.

Of the genus *Coffea* we have two species, and a doubtful one, indigenous to Ceylon, and I have seen trees of the real coffee plant in the forests of Deltotte, upwards of 20 feet high, and 3 to 4 inches in diameter, with a hard, white, close-grained wood. These were escapes from the coffee estates of course.

Ixora parviflora, Vahl. "Maha-ratambala," S. "Soowen-dee Cuttay, and Karan Cuttay," T.—A small sized tree, wood employed for beams and posts, but its chief use is for "chules" or torches, as it burns readily, and is thus used by travellers at night in India—it is hence called the torch-tree.

Scgphostachys coffeoides, Thw. "Wat-kopec," S.—Produces a close grained white wood, used at Galle for inlaying.

Stylocoryne Webera, A. Rich. "Tarana," S.—Produces an exceedingly hard and tough wood, much used for fences, hurdles, &c.

Griffithia Gardneri, Thw. "Atu-kaetiya," S.—A small, handsome, flowering tree, produces an ordinary timber.

Gardenia latifolia, Ait. "Gallis-gas or Lakada-tarana," S.—A small tree, with wood nearly equal to box-wood.

Wendlandia Notoniana, Wall. "Rawan or Rawen Iddala," S.—A tall shrub or very small tree; used for common house buildings; very durable under ground. The sticks make excellent fences.

(To be continued.)

THE EXTENSION OF TEA PLANTATIONS IN INDIA.

There is no culture, perhaps, that is occupying more attention just now amongst European capitalists in India than tea.

A very useful report was addressed to the Madras Government in 1860, by Dr. Cleghorn, the Conservator of Forests, on the suitability of various places in that Presidency to the growth of the tea plant, from which we make the following extracts:

"I have found it impossible, owing to my other engagements, to visit the tea plantations at Caldoorty and Udagiri. I regret this, as the vegetation of that part of the Travancore territory is most luxuriant, and the lofty ranges stretching towards the Pulnies have been less explored than any other part of the Malabar Ghats.

"I have collected from my journal a few notes made during my tours upon the tea plants seen in different districts of the Presidency.

"Shevaroy Hills, 4,000 feet high.—There are several well grown trees at Yercaud, introduced by G. Fischer, Esq.; these have not been picked or pruned, and, indeed, have been left to nature, but are growing vigorously nevertheless.

"Coorg, 4,500 high; rainfall, 120 inches; mean temp., 68 degrees. —A case of plants was brought from China by Colonel (Lieutenant General) Dyce in 1843; these (now trees) appear to me over luxuriant, producing a rapid growth of leaves, and not bearing seed with regularity

"Nundidroog, 4,800 feet high.—A number of plants have lately been sent to this hill sanatarium; they were beginning to droop in the Lál Bágh garden, Bangalore, but there is hope of their thriving in their new location. 'The mean temperature of Bangalore is 75°, and the average rainfall 35 inches.' The climate being too dry and too hot, the plants necessarily become dwarfed.

"Bababooden Hills, 5,600 feet high; rainfall and mean temp. not known.—Four plants from General Dyce's stock were received from Mercara in 1847; these grew well without care. A packet of fresh China seeds was sent last year. Colonel Porter, Superintendent of Nuggur, raised twenty-three plants above Ghât near the Sicar bungalow; and a number of seedlings have been planted out about a thousand feet lower by Mr. Denton, coffee planter.

"Nilgiri Hills.—*a.* Coonoor, 6,000 feet high; rainfall, 55 inches. —A full report of Captain Mann's plantation is recorded in 'Proceedings of Government,' No. 1272, dated 21st September, 1859.

"Besides this, there are a few plants at the undermentioned places—

"*b.* Ootacamund, 7,300 feet high; rainfall, 60 inches; mean temp., 58 degrees.—Introduced or raised by Mr. M'Ivor, Government gardens, from Saharunpoor seed, and by General F. C. Cotton, at Woodcote.

"*c.* Kaity.—Introduced or raised by Sir S. Lushington and Lord Elphinstone.

"*d.* Kulhutty.—Introduced or raised by Mr. Rae.

"Pulni Hills, 7,100 feet high.—Major Hamilton reported that a considerable number of tea plants at Kudaikarnal were an inch or two above ground, and appeared fresh and healthy.

"Curtallam, 1,200 feet high.—I have received flowering specimens from the old spice gardens, which corresponds with the standard figures of *Thea Chinensis.* The shrubs are 20 years old, 12 to 15 feet high, and where the seed came from is not known.

"Travancore (Caldoorty: altitude, 6,700 feet; rainfall, 150 to 200 inches. Vallymallay, near Udagiri: altitude, 1,800 feet; rainfall, 150 to 80 inches. Athaboo, near Tinnevelly: altitude, 3,200 feet; rainfall, 150 to 40 inches).—Tea trees grow luxuriantly in Messrs. Binny and

Co.'s plantations (formerly Mr. Huxham's), 40 miles east of Quilon on the road to Curtallam, and from whence some plants were procured 10 or 12 years ago, which were planted at Vellymallay near Udagiri, 1,800 feet; and at Athaboo, near Tinnevelly frontier, 3,200. At both places they are growing luxuriantly.

"These facts are taken from General Cullen's letter to the Madras Government, and I may state that some seeds received from him were planted and throve on the Nílgiris at an elevation of 5,500 feet.

"In tea, as in all cultivated plants, there are variations, the discrimination of which is of the utmost importance commercially, and also in an economical point of view, but I have not materials for attempting a precise definition of these differences. This, however, is known that the seed having been obtained from different parts of China, the introduced plant varies in stature exceedingly, from a bushy shrub of 3½ feet to a ramous tree, 25 feet high. There is a vast difference also between the narrow-leaved forms and broad-leaved specimens in some of the localities mentioned.

"At present the leaves are taken indifferently from several sorts, which should not be done, when preparing tea for commercial purposes; and the means of manufacture are of the rudest description.

"The tea shrub of commerce, though long confined to Eastern Asia, is now cultivated far beyond the limits of China and Japan, in Java (under the Equator) in Assam, the North West Provinces of Hindustan, on the banks of the Rio Janeiro, and recently in North America. From the published reports of Mr. Fortune and Dr. Jamieson, it appears to prefer a climate probably of 67° to 73° mean temperature. Such is nearly the mean temperature of the hill slopes near Núnúr, Kotagiri, and of many of the valleys in the eastern and northern slopes of the Pulni and Nílgiri Hills, and also of the Bababooden range in Mysore, and of Kudra Muka in South Canara.

"It ought also to be observed, as illustrative of the hardiness of the tea shrub, that the cultivation extends over a great breadth of latitude (from the banks of the Rio Janeiro, 22½° south latitude, to the province of Shan-ting in China, 36½° north latitude), and that as we recede from the equator, the lower latitude compensates for the difference of altitude. The Chinese cultivate on the lower slopes of the hills, whilst, in the North-West Provinces, the culture is carried on between 2,000 and 6,000 feet."

Dr. M'Pherson, Inspector General of Hospitals, writes, under date 13th June, 1862:—

"I have gone over extensive fields of tea in the Dutch colony of Java, and witnessed its manufacture there on a large scale, and in company with Dr. Jamieson, the Government Superintendent in Upper India, I have gone over the Government tea plantations and others, in the Deyra Doon, paying much attention to the manufacture of the leaf, and I am persuaded that it is worse than useless for inexperienced hands to attempt to produce a marketable article from tea grown on the Neilgherries and Shevaroy Hills.

"I am acquainted with Mr. Mann's and Mr. Fischer's plantations at these places, and am persuaded that a correct system of manufacture is alone necessary to render the former equal, if not superior, to that grown on the lower ranges of the Himalayas.

"I send specimens of both, from which the Board will observe the imperfect manufacture of the one, compared with the other. The leaf of Mr. Mann's tea has evidently not passed through that essential early process, without which, every other part of its delicate manipulations, before it becomes a marketable article, is futile, and the acridity perceptible in its infusion, is another proof that the first process of triturating and rolling the leaf, after its first scorching has been neglected.

"The tea otherwise excels either Himalaya or Assam, and judging from what I have observed elsewhere, on both the ranges mentioned above in Coorg, on the Pulneys, and on Gallikonda also, there are vast spaces where the plant may be propagated successfully.

"A tea plantation is a far more certain return to the planter than any coffee concern can be; for with tea, grass lands on slopes shaded by fruit trees, or capable of irrigation, are available for its cultivation, whereby the destruction and expense of removing forests as in coffee is avoided, and the leaf, which is alone consumed in tea, is a much more certain return than the coffee berry.

"It is utterly impossible, however, satisfactorily to carry out the several parts of the process of preparing the tea for the market, by description alone. Everything relating to it is simple when acquired. The character of our hills for the growth of the plant will be injured, if an article such as Mr. Mann has manufactured be sent to market in Europe.

"Mr. Mann's tea plantation at Coonoor was commenced about 11 or 12 years ago. It was formed from seedlings brought in Wardian cases from China, and seeds from the same, all these having been selected (I believe) by Mr. Fortune in some of the best tea districts of the country.

"The present state of the plantation, as far as I can ascertain, is this:—

2,400	plants,	age about	11	years.
4,000	,,	,,	8	,,
2,000	,,	,,	2	,,
12,000	,,	,,	1	,,
20,400	say at 1,208 per acre, 17 acres.			

"The later cultivation has been from seeds produced by the early trees.

"From February to June (the crop season) of this year, tea has been prepared from the crop of leaves picked, to the amount of 2,000 lbs. weight.

"It has thus been established, that the real tea plant of commerce will grow fruit, mature seed, and supply a crop of leaves, at Coonoor. At Ootacamund the shrub also grows, and seeds; and, thus succeeding in these two climates of the hills, their general surface, in suitable soil and situation, may be deemed equally adapted to the favourable growth of the plant. I may observe that I believe Mr. Mann was induced to select Coonoor for his experimental cultivation, because it had been pointed out by the late Dr. Turnbull Christie, an eminent naturalist, as the most likely climate for its success.

"With all the conditions of its favourable growth as a plant established, there has still remained to be determined, whether its produce was really a merchantable article; whether, in fact, the climate of the Neilgherries admitted of the tea leaf carrying the flavour of good consumable tea. Repeated rough trials seemed to speak unfavourably on this point. About 25 years ago, Mr. Sullivan, then collector of Coimbatore, sent some prepared tea leaves, taken from a shrub at Ootacamund to Madras, but the infusion from them was pronounced execrable. Subsequent trials had pretty much the same result, and even when the leaves were taken from the better plants of Mr. Mann's plantation, and prepared with more care and a little more knowledge, the least unfavourable opinion that could be pronounced upon the tea by Dr. Cleghorn was, that it was 'not palatable.' Such results have sufficed to deter others from embarking in the adventure, Mr. H. Rae alone having had sufficient confidence in his own judgment to engage (in 1861) in tea cultivation at Sholoor. Mr. H. Mann had left Coonoor to settle in Coorg almost immediately after the outset of his tea plantation, he considering that what he met with from local authority was the reverse of encouragement to his costly experiment.

"But there seems much reason to believe that the tea prepared from plants growing on the Neilgherries has been thus unpalatable because of its defective manipulation; that the acrid taste so constantly complained of, even when the proper leaves have been selected for the manufacture, has resulted from the want of a right manufacturing apparatus, and from an ignorance of the necessity of every particle of moisture being removed from the leaves, and of how to effect it. Mr. Mann's native overseer, Ponnambalum, though he has shown a good deal of skill in his mode of treatment, has been unavoidably ignorant of the correct style of manipulation, and generally his tea has had a musty smell and an acrid flavour. But, on the other hand, when accident (perhaps) has caused one picking to be better prepared than ano her, tasters have found this passable; his tea, moreover, has for the past two years, found a ready sale at a fair price in the bazaar, and partially in a shop ot Ootacamund; it has shown decided improvement by being kept; and last year (of which I can speak from personal knowledge, my friend Mr. Mann having asked me to direct matters at his tea garden for him, on his departure for England at the beginning of the year), the result of partial experiments, made in pursuance of instruction gathered from books was, that some parcels of tea were so good in flavour and perfume, that I found a pinch added to the ordinary China tea sold in the Ootacamund market, impart to the latter a most agreeable flavour. This apparent strength in the tea, if found to be really present, would give it a similarity to those of Assam, whose value consists in their imparting a flavour to, and improving other and ordinary teas. There is in all this great encouragement to expect that tea cultivation on the Neilgherries may yet prove an extended and profitable industry.

"I may, in conclusion, draw attention to the fact that the 2,000 lbs. of tea picked this year from Mr. Mann's garden, were so from scarcely over five acres of cultivation, and that there would probably have been much more, but for the failure of rain at a particular time. The quantity actually picked, however, averages 400 lbs. per acre, which is a very favourable return if the tea prove of the quality that there seems some show of reason in anticipating. And I may mention that I know visitors from Bengal in late years, civilians, military officers, and merchants, officially connected with tea cultivation or directly interested in it, to have expressed strong and decided opinions as to various parts of the Neilgherry hills being well adapted and very promising for the same cultivation.

"This valuable plant has been found wild in Upper Assam and Cachar, whilst its congeners abound on the Nilgiri and other mountain ranges of the Presidency. In the case of Captain Mann's plantation near Kunur, we have the opinion of four competent judges that the experiment had entirely succeeded as regards the growth of the plant.

"It now only remains to prove the merchantable character of the leaf, and this I hope will soon be tested.

"So far as I can judge, the aid of a few practised manipulators is all that is required to conduct the manufacturing processes.

"Much useful information will be obtained from Fortune's works, especially his 'Visit to the Tea Districts of China,' and 'A Short Guide to Planters cultivating Teas in the Himalayas and Kohistan of the Punjab,' by Dr. Jamieson. Intending tea planters ought also to study carefully Mr. Ball's excellent work on the 'Cultivation and Manufacture of Tea,' and the 'Theory of Horticulture,' by Professor Lindley, a knowledge of the principles of culture being indispensable to success."

Sir Emerson Tennent, in his work on 'Ceylon,' says:—"The tea plant has been raised with entire success on the estate of Messrs. Worms, at Rothchild, in Pusilawa, but the want of any skilful manipulators to collect and prepare the dry leaves, renders it hopeless to attempt any experiment on a large scale until assistance can be procured from China, to conduct the preparation."—Volume I, page 90.

"The plants thrive surprisingly, and when I saw them they were covered with bloom. But the experiment was defeated by the impossibility of finding skilled labour to dry and manipulate the leaves. Should it ever be thought expedient to cultivate tea in addition to coffee in Ceylon, the adaptation of the soil and climate has thus been established, and it only remains to introduce artizans from China to conduct the subsequent processes."—Volume II, page 252.

In an official reply, dated 31st October, 1860, the Secretary to the Government states :—"I have perused with much interest the reports by Dr. Cleghorn, the Conservator of Forests, on the growth of the tea plant in the Neilgherries and other parts of the Madras Presidency, which accompany your letter of the 24th August last, No. 90.

"It is satisfactorily established that tea plants will thrive in several different localities, but no attempt appears yet to have been made to convert the produce into a marketable article of commerce. I agree with you that, as a general rule, it is undesirable for Government to step out of its way to aid the efforts of private adventurers. Considering, however, the great success which has attended this branch of culture in Assam, and in the Himalayas, and which it can scarcely be expected would have been attained, at any rate to the same extent or in the same time, if the initiatory proceedings had not been taken by the Government, I shall not object, if it should appear that there is little chance of the matter being taken up by private enterprise, to your acting on the recommendation of Dr. Cleghorn, and obtaining the services for a limited period of a few skilled tea manufacturers from the North Western Provinces, which it appears from the information supplied by Dr. Jamieson, might be procured at a very moderate cost.

"I presume that under the rules now in force, the difficulties which were apparently experienced by Captain Mann in obtaining land in the Neilgherries suitable for his tea plantation, will no longer exist."

The Conservator of Forests, Madras, in his report, dated the 31st of August, 1860, further remarks :—"Southern India promises well to afford favourable sites for the growth of tea.

"Numerous experiments have been made, and attended in several instances with marked success, as regards the healthy growth of the plant. In order, however, to complete the experiment, and allow the tea grown in the Presidency to occupy its proper place in the market, it is necessary that the art of manufacturing it should be introduced either direct from China or from Government plantations in the North Western Provinces. Unless something of this kind be done, tea grown in Southern India cannot attain that commercial value which it might probably acquire, were it generously taken up. The tea shrub is remarkable for its hardiness, the cultivation extending over a great breadth of latitude. It prefers a climate where the mean temperature is from 67 deg. to 73 deg. This valuable plant may be seen at several places on the Nilgiri and Pulni hills, in Coorg, on the hill sanatarium of Nundidroog, on the Shervaroy and Bababooden hills, at Curtallum, and in various parts of Travancore. Although tea plants have been introduced, and are growing at each of these localities, they are not all equally promising ; and the place in the market which any of them is to occupy has not yet been ascertained, and cannot be so until the introduction of competent manipulation completes the experiment."

North West Provinces.—Dr. William Jamieson, Superintendent of the Botanical Gardens, North Western Provinces, writes from Seharunpore, dated 12th May, 1862 :—

"I have the honour to lay before you, for the information of the Honourable the Lieutenant-Governor, a detailed statement showing the manner in which the Government tea plantations have been worked, and the results obtained during the last season.

"The out-turn of tea during the last season shows a decrease on that of the former year, caused by the great drought during the cold weather and months of April and May. The grain crops throughout the upper part of the Doab were a failure. It ought not, therefore, to be a matter of surprise that the yield of tea shows a decrease, particularly as the chief or first crop of leaf almost entirely failed. Considering this, the decrease may be considered small, and showing how admirably the plant is fitted for the Kohistan of the North Western Provinces and Punjab.

"The quantity of tea prepared in the factories was as follows :—

Kowlaghir Factory, Dehra Dhoon.

	lbs.	lbs.
Green Teas.		
Gunpowder	199	
Imperial Gunpowder	182	
Hyson	150	
Young Hyson	386	
Hyson Skin	817	
	——	1,734
Samples sent to Exhibition		21
Black Teas.		
Souchong	4,846	
Fine Souchong	1,853	
	——	6,699
Pouchong	3,244	
	——	3,244
Bohea		3,284
Total		14,982

Paoree Factory in Gurhwal.

Black Teas.	lbs.	lbs.
Souchong	2,697	
Pouchong	2,850	
Bohea	4,700	
		10,247

Bhimtal Factory in Kumaon.

Black Teas.		
Souchong	1,129	
Pouchong	64	
Bohea	75	
		1,269
Total		26,498

Hawul Baugh Factory in Kumaon.

Green Teas.		
Fine green tea	521	
Hyson skin	880	
		1,401
Black Teas.		
Souchong	2,707	
Bohea	2,952	
		5,660

Ayar Toli Factory in Kumaon.

Souchong	7,103	
Bohea	856	
		7,960
Total		41,519
Showing a grand total of		41,519

"But if there has been a small decrease in the quantity of tea, it has been met by an increase in the produce of seeds, the yield being 2,220 maunds, or 79 tons; thus:—

Kowlaghir Plantation	Mds.	860
Paoree "	"	260
Ayar Toli "	"	370
Hawul Baugh "	"	480
Bhimtal "	"	250
	Mds.	2,220
"Add to this produce of the Khangra Plantation	"	1,416
	Mds.	3,636

and we have an out-turn of 3,636 maunds, or 130 tons.

"This immense produce has enabled me to give great assistance to private planters throughout the Kohistan of Kumaon, Gurhwal, Dehra Dhoon, and Punjab. The large quantity of 2,513 maunds, or 89 tons of seeds, have been distributed gratis to them.

"In addition to this large quantity of seeds, large numbers of seedling tea plants, amounting to two millions four hundred thousand, have been, or are being distributed.

"But, though the amount of seeds and plants at my disposal for distribution is immense, it comes far short of the indents received, new parties seeking other fields than those of the Kohistan of the North-West Provinces and Punjaub to carry on tea cultivation. Thus, last season a company established themselves at Hazareebaugh, and to them fifteen maunds of seeds were given. To the Neilgherries, too, considerable quantities of seeds have been sent, through Dr. Cleghorn, superintendent of forests, and by him I have been informed that Her Majesty's Right Honourable Secretary of State for India has sanctioned the engagement of some skilled native tea makers from the government factories, North-West Provinces, in order to assist tea planters in the Madras Presidency to prepare tea.

"Financially, the tea plantations may be thus considered:—

	Rs.
To 41,519 lbs. 15 oz. at Rs. 1. 8. per lb. . .	62,279
2,200 maunds of seeds, at 20 rupees per maund .	44,000
Total . . Rs.	1,06,279
To expense of working the plantations . .	48,000
Balance . . Rs.	58,279
"To this must be added the value of tea seedlings distributed,—viz.	
800,000 seedlings at 3 per 100	24,000
Total balance . . Rs.	82,279

"Of the teas prepared, 16,000 lbs. are being packed for transmission to London for sale in the London market, and the remainder will be sold by auction at Almorah and Dehra Dhoon, in compliance with the orders of government. Some delay in packing the teas has occurred, owing to the limited establishment of carpenters, which, however, is being remedied.

"By private planters the demand for skilled tea makers and native overseers to superintend their factories and plantation operations is great, and to many, such as Messrs. Dick, Berkeley, Troup, Smith, Knyvett, Mohur Singh, Ramnath, &c., skilled native workmen have been given.

"Some of the Chinese tea makers, whose time of service had expired, have left government employ, and entered that of private parties, being tempted by a much higher rate of pay, and it has been found necessary to give an increase to the remaining tea makers. This, however, has been done without any increase to the establishment, the increased pay being more than met by that of the men who have resigned.

"From the Kalee in Kumaon to the Ravee in the Kohistan of the Punjaub, the cultivation is being actively and energetically carried on both by European and native capitalists ; and the day is not far distant when we may expect to see tea exported from the British Himalayas as its staple article of produce, and the hills made lucrative, instead of as at present a drag on the revenues of the country.

"In a few years the Dehra Dhoon, the most attractive spot in the North West Provinces to the European settler, will become a great tea garden. In every direction in it tea plantations are springing up, and the two things wanted to make them there universal are, in the eastern Dhoon drainage, and the western Dhoon water for drinking purposes and irrigation.

Early in 1856, the tea plant was discovered wild in the province of Cachar, and a reward of 5*l.* was given to the native who made the discovery. Mr. G. Williamson, (who had already a tea plantation in Assam) undertook the experimental culture in Cachar, and obtained a grant of 742 acres, rent free, for sixteen years, being one year longer than the period granted by the rules of Assam waste lands, in consideration of his being the first applicant. The subsequent rent was to be 10 guineas for the next ten years, and 20 guineas for seventy-three years.

The following tracts of thea lands are officially reported to have been granted as early as the spring of 1858, to companies and individuals in Cachar ; had we the latest official returns at command, the progress shown would have been much more extensive.

	Acres.
Bengal Tea Company	10,510
Silchar Tea Company	13,102
Cachar Company	27,000
Assam Company	7,464
Equitable Tea Company	2,817
Messrs. Borrodaile and Co.	9,549
Mr. Foley	4,809
Messrs. Wyse and Co.	3,708
,, Moran and Co.	3,031
,, Pogose and Thomas	1,500
Mr. Francis Tydd	2,836
,, R. Wright	500
,, G. Williamson	742
,, Parker	139
	87,707

THE MANUFACTURE OF VEGETABLE OILS.

Whether considered as a medium for the application of colour in works of art, or of utility as the principal source of illuminating power where gas is unattainable, or as the lubricator without which all machinery, from the simple clock of the cottager to the most complicated and powerful engine, would be all but useless, the value of oil is incalculable ; and a few words on its manufacture and the process of refining it cannot be uninteresting. To furnish these we were favoured with a visit to the extensive works of Messrs. Pinchin and Johnson, who have two sets of premises, one for the manufacture of oil, called Albert Works, on the Middlesex bank of the Thames, near Hammersmith, the other for refining purposes, in Cable-street, St. George's-in-the-East. The oils they manufacture are rape and linseed only, but their refining operations extend to the animal as well as the vegetable oils. The Albert Works have a river frontage of about 200 feet, and recede from the bank about the same distance, thus covering an area of more than three-quarters of an acre. The building consists of four storeys ; the manufacture is carried on in the lowest, the others being used as storage for the grain, which is hoisted from the barges by means of cranes worked by steam power. The first object which arrests the visitor's attention is the engine, which is a small but beautiful piece of machinery of forty-five horse power. With the exception of the workmen's meal-times and Sundays, it is always at work night and day. From the engine-room the visitor is conducted to the manufactory, where, as soon as he can recover from the irritation in the eyes produced by the volatile oil escaping from the heated and bruised seed, the whole process presents itself before him.

The grain is received from the upper floor into a *hopper*, in which is a screen, the agitating of which removes all foreign substances and suffers the seed alone to pass through its meshes. This falls between two faced, hollow, iron cylindrical rollers, which are heated by steam, and which as they revolve crush, or, as it is termed, *open the grain.* Thus opened it is thrown on to a *steel plate calf*, fixed on a bed of solid masonry, which is constantly traversed by a pair of edge-runners, weighing from eight to nine tons, and travelling at the rate of sixteen revolutions per minute. They revolve in a strong framework attached to a vertical axis, which also, by means of a large cog-wheel at the top, which engages a wheel upon the main shaft, revolves slowly. A double motion is thus given to the grinders or edge-runners, one on their own axis and one on the iron plate, which we may consider the nether millstone. A raised border or rim prevents the seed from escaping from the plate, and the paste is brought regularly under the stones by means of rakes or sweeps attached to the vertical framework, and revolving with the runners on the surface of the plate. When the grain has been sufficiently ground, the paste is brought to an open portion of the rim-and falls over into perforated troughs placed to receive it. Through the perforations a considerable quantity of oil oozes, and this, being considered purer than that which is obtained by expression, is conveyed to a cistern set apart for the purpose. The paste is next put into a jacketted kettle, that is, one surrounded by a hollow chamber into which steam is injected for the purpose of heating it. Within this kettle is an agitator or stirrer, so that all the paste is in turn brought to the heated surface and raised to an even temperature. Having remained in the kettle six minutes, it is collected in woollen bags, about eighteen inches long and six inches wide, each bag is placed between four layers of press hairs (a kind of horse-hair mat), and eight of them being thus prepared, they are ranged in two perpendicular rows between four grooved shelves of a hydraulic press. The pumps worked by the steam-engine are set in motion, and a pressure of 400 tons is speedily realized. The oil being expressed, runs into an underground tank, the bags are then withdrawn, and on being removed the residue presents itself in the form of what is known as linseed cake. These cakes are placed in a rack to cool, when they become so hard as not to be easily broken; they are then orderly stacked, and from time to time sent away in waggons or barges to supply the cattle-food market, for which purpose the cake is in great request.

A quarter of linseed, which only undergoes one pressure, yields an average of 120lbs. of oil and 35 cakes of nutritious food, each weighing 8lbs., or an aggregate of two hundred weight and a half. Rape seed, which is twice ground and pressed, yields per quarter from 88lbs. to 90lbs. of oil at the first, and from 60lbs. to 70lbs. at the second pressure. Of those two kinds of oil-producing seeds upwards of 600,000 quarters are annually imported, and this mill alone works up 35,000 quarters per annum. Calcutta, Bombay, and Kurrachee are the great emporia for these seeds, and it is a remarkable fact that, whereas the last-named place, when it fell into the hands of the British, in 1839, consisted of only about fifty wretched huts, inhabited by fishermen; it is now a thriving port, and one of the principal outlets for the oil-producing seeds of India.

After the oil has remained a few days in the receiving cistern the parenchymous matter subsides; it is then pumped into vats for a second settling, after which it is barrelled and conveyed to the Refinery. This is situated about a quarter of a mile down the Blackwall line, of which property it occupies nine arches in its rear. The premises are very large, and are used not only for refining vegetable but also animal oils. The casks of unrefined oil are hoisted to the upper floor by means of a crane worked by steam. Along this floor a large vat, capable of holding ten tons, is extended. It is lined with copper; is fitted with a horizontal agitator or fan; and is called the reception vat. Into this receptacle five tons of rape oil are decanted, an equal quantity of water is added, and the whole treated by chemical process. The agitator is set in motion, and after four or five hours the oil becomes thoroughly washed, its impurities having been removed. The agitation is then stopped and the water and bleaching ingredients are allowed to subside. The oil is next drawn off into the boiling vat on the next story. This vat also is lined with copper, fitted with fans or agitators, and a coiled perforated tube; steam is admitted into the tube until a uniform temperature of 212 deg. is obtained. It is kept in this condition and continually agitated for about four hours, when all impurities having been thrown off it is allowed to cool, assisted by the fans, which bring every portion in turn into contact with the air. At the end of eight or ten hours, it is sufficiently cool to be drawn off into the filters, which are on the lower story. Each filter contains five tons. Having passed through the filter, the oil fully refined, is pumped into appropriate tanks to be ready for barrelling; and receives the name of Colza oil, on account of its illuminating properties, the true Colza being an oil expressed from the *Brassica oleracea*, a variety of the cabbage plant, from whose seeds an oil much used on the Continent is expressed.

Some idea may be formed of the vast quantity of purified rape oil consumed for lubricating and illuminating purposes, when this refinery alone sends out upwards of two thousand tons per annum. A single railway company consumes three hundred tons a year, and the Great Eastern requires one thousand gallons for the single voyage to New York. Whale, seal, and sperm oils are refined by a more simple process. They are simply filtered through flannel bags; the residue of the common kinds is called foots, and is one of the ingredients used in the manufacture of soap. The deposit produced in the filtration of sperm oil is called spermaceti, and is very valuable, commanding a ready sale at 90*l.* per ton. These oils are used for the purpose of illumination only, with the exception of sperm, which is employed in the cotton districts for the lubrication of spindles. Large quantities of olive oil are imported from Spain for lubricating machinery, and immense quantities of American lard are imported, pressed and filtered for obtaining the oil known as lard oil, which is considered a good lubricator, and certainly has the quality of cheapness to recommend it.—'Mechanics' Magazine.'

WOODS OF THE PHILIPPINE ISLANDS.

1. Bolongita, *Diospyros* (Guayacanac).—Wood resembling the alintatao (See No. 5), of which some varieties are light red, others darker, regularly spotted with black, solid texture, and of very good use for wheel works and constructions, shavings fine, flexible, and waved. Abounds in various provinces, and particularly in Bulucani, Tayabas, Pangsnau, and Nueva Ecija.

2. Calamansanay, *Gimbernalia catamansanay* (Combretac.).—A tree of 20 or 30 metres in height, and 0·8 to 1m. in diameter at the trunk, Wood reddish, strong texture, compressed fibres, shavings rather fine, smooth, somewhat twisted. Abounds in Calaban and Angat, splits in long splinters ;—used for sheathing—planking, ceiling—and constructions.

3. Calantas, or Cedro, the well-known *Cedrela odorata*, a variety much resembling it is called *tara-tara*.

4. Calumbit—*Terminalia edulis*—(Combretac.), a tree of second order wood of a cloudy yellow, spotted with ash colour parts, texture weak, fibre longitudinal, somewhat glassy. Abounds in Angat ; splits in long splinters ; the shaving is rough and twisted, or smooth ; used for buildings, and particularly for those pieces that have to resist by the strain of the fibre.

5. Camagon, a variety of *Diospyros pilosanthera* (Alintatao). This precious wood, yellow-red with great veins or spots of black, is much employed for fine cabinet work ; texture solid, fibres longitudinal and compressed ; pores large, long and narrow ; polished with facility ; splits nearly from the trunk, and shaving somewhat rough, compact, and not at all twisted or contorted.

6. Camayuan (*Diospyros*), a tree of 15 to 20 metres in height, abundant in the provinces of Bataan and Mindore ; wood violet red—mulberry colour ; texture strong and soft, fibres longitudinal and compressed, pores hardly visible. Splits nearly from the trunk, shavings fine, smooth, and a little twisted ; employed in constructions.

7. Dongon, variety of *Sterculia ambiformis* (Malvac). This tree arrives to first rank, wood red violet, texture solid, fibres compressed and crossed, smells like tanned leather, pores scarcely any, splits from the trunk, and in long fibres. Abounds in Misamis, Leyte, Bataan, Eueva, Ecija, and other provinces ; shaving smooth, rough, and somewhat twisted ; used for building.

8. Ebano, variety of *Japoti negro—Diospyros nigra*—(Ebenac.), small tree abounding in Angat, la Pampanga, and Cavite. Wood black, somewhat spotted with yellow and white, takes readily a fine polish, texture solid and fine, splits from the trunk, shaving fine, twisted, and smooth ; specially used for fine cabinet work.

9. Guijo—*Dipterocarpus quiso*—(Guttif.). A tree of second rank, wood of wavy fibre, strong reddish colour, much esteemed in civil and naval construction for futtock-timbers, keels, masts. The Manga-chapuy is another specimen of *Dipterocarpus* used with this. The wood is also used by wheelwrights, abounds in the mountains of San Mateo, Pangasinan, Nueva Ecija, Mindora, Cavite, and Bataan, splits in large splinters, shavings rough and twisted.

10. Laneti—*Ansera luneti* (Apocina.)—A tree of middle height, wood white, texture soft and compact, pores imperceptible, much esteemed for furniture and other uses where elasticity is required ; frequently

found in Laguna, Bataan, Cavite, and Pangasinan, splits in large splinters, shaving fine, smooth, and twisted.

The following woods are used in Cuba for railway sleepers. GUYACAN (*Guiaacum officinale*). GUYACANCILLO (same kind but smaller). QUIEBRAHACHA, a very hard wood that breaks the axe. AZARO (this name signified anciently *sarcocolle*). JIQUI and JIGUELETE (must be a leguminous plant, Jiqui is a name given in Spanish America to the *indigo*). *Guama* de costa and *Jucaro* negro.

LABORATORY NOTES.

MUSEUM OF IRISH INDUSTRY, DUBLIN.

EXAMINATION OF THE COALS EMPLOYED IN THE MANUFACTURE OF GAS. By JAMES DUNNE, Student in the Evening Class for Practical Chemistry.

I.—BOGHEAD CANNEL COAL.

Specific gravity of the coal	1·184
Proximate Composition of the Coal.	
Water	1·55
Volatile matter	62·09
Fixed carbon (coke)	18·20
Ash	18·16
	100·00
Amount of sulphur in volatile portion	0·616
Amount of sulphur in non-volatile portion	0·133
Total Amount of sulphur in 100 parts	0·749
Percentage of Nitrogen	0·84

II.—MICKLEY COAL (Newcastle).

Specific gravity of the coal	1·26
Proximate Composition of the Coal.	
Water	0·59
Volatile matter	35·86
Fixed carbon (coke)	61·42
Ash	2·13
	100·00
Amount of sulphur in volatile portion	0·352
Amount in non-volatile portion	0·314
Total amount of sulphur in 100 parts	0·666
Percentage of nitrogen	1·48

III.—NEWCASTLE PELTON MAIN.

Specific gravity of the Coal	1·243

Proximate Composition of the Coal.

Water	0·89
Volatile matter	29·87
Fixed carbon (coke)	68·67
Ash	0·47
	100·00
Amount of sulphur in volatile portion	0·615
Amount in non-volatile portion	0·976
Total amount of sulphur in 100 parts	1·592
Percentage of nitrogen	1·77

IV.—Carlisle Coal.

Specific gravity of the coal	1·273

Proximate Composition of the Coal.

Water	0·76
Volatile matter	35·97
Fixed carbon (coke)	57·11
Ash	6.16
	100·00
Amount of sulphur in volatile portion	3·026
Amount in non-volatile portion	2·288
Total amount of sulphur in 100 parts	5·314
Percentage of Nitrogen	0·43

V.—Wigan Cannel Coal.

Specific gravity of the coal	1·284

Proximate Composition of the Coal.

Water	0·82
Volatile matter	36'09
Fixed carbon (coke)	61·02
Ash	2·07
	100·00
Amount of sulphur in volatile portion	0·543
Amount of sulphur in non-volatile portion	0·639
Total amount of sulphur in 100 parts	1·182
Percentage of Nitrogen	1·42

Determination of the Absolute Heating Power of the Coal from Different Irish Coal-Fields.—Mr. Lewis Thomson's apparatus was employed for determining the absolute heating power.

Coal (Fourpenny Vein) from the Lisnacore Colliery, Kenturk, co. Cork. By Charles W. Bateman, LL.B.

Absolute Heating Power of the Coal.

9·9 lbs. water, at 212 deg. F. converted into steam by 1 lb. of the coal.
872·44 lbs. water, at 212 deg. F. converted into steam by 1 cubic foot of water.

Proximate Composition of the Coal.

Water	2·89
Volatile matter	7·59
Fixed carbon (coke)	80·63
Ash	8·89
	100·00
Amount of sulphur in volatile portion	4·550
Amount of sulphur in non-volatile portion	1·512
Total amount of sulphur in 100 parts	6·062
Percentage of Nitrogen	0·278
Specific gravity	1·44

COAL (third seam) from the detached field north of the Arigua Valley, Seltannaskeagh Colliery, Co. Leitrim. By WM. J. WONFOR.

Absolute Heating Power of the Coal.

13·47 tons of water at 212 deg. F. converted into steam by 1 lb. of the coal.

1246·0 lbs. of water at 212 deg. F. converted into steam by 1 cubic foot of the coal.

Proximate Composition of the Coal.

Water	1·08
Volatile matter	20·16
Fixed carbon (coke)	74·66
Ash	4·10
	100·00
Amount of sulphur in volatile portion	0·596
Amount of sulphur in non-volatile portion	0·531
Total amount of sulphur in 100 parts	1·127
Percentage of nitrogen	1·36
Specific gravity	1·48

(To be continued.)

AMOUNT OF TANNIN IN SOME ASTRINGENT SUBSTANCES.—By M. HANRATTY and T. H. FLETCHER, Students in the Laboratory of the Museum of Irish Industry, Dublin.

The following estimations of Tannin were made in a manner similar to that pursued by our late fellow students, Messrs. Mulligam and Dowling :—

	Per Centage of Tannin.
Rizophora Mangle (*Rizophoraceæ*), Tropics	8·27
Crabwood, *Xilocarpus Carapa*, (*Meliaceæ*,) Brazil	3·65
Bark of the Greenheart, *Nectandra Rodiëi*, (*Lauraceæ*,) Demerara	10·17
Birch Bark (*Betula*)	4·33
Bark of the *Blakea triplinervis* (*Melastomaceæ*) Guiana	1·32
Gaub fruit of *Diospyros embryopteris*	17·82
Wild Pomegranate Buds (*Balaustines*)	45·58
Sodom Apple Galls	47·20

Scientific Note.

PYROLIGNITE.—A company has been formed in Tasmania, the object of which is to procure by dry distillation from the hardwoods of the colony several products of considerable value in Europe, and for which the demand is practically unlimited. These are Acetate of Lime, which is the basis of most of the dyes used in Calico Printing. It is also the material in the form of Pyroligneous Acid, from which White Lead and Sugar of Lead are made ; and almost entirely supersedes the use of Vinegar in the wholesale manufacture of Pickles, being, when properly prepared, purer, stronger, and a far better preservative—Wood Naphtha, which, on account of its far lower price, has been of late almost entirely substituted for spirits of wine in the preparation of spirit varnishes—and kreasote, which is now used in preference to any other article for the preservation of timber. In Europe these substances are prepared from oak and beech, of which the supply is far from sufficient to meet the demands of the manufacturer, while the great value of the timber only leaves the refuse at his disposal. The hardwoods of Tasmania have been proved by careful and repeated trials to afford, at least, as much of these products as oak and beech ; while the supply is, as every one knows, unlimited, and the cost nominal ; whereas in England the price is from 18s. to 22s. 6d. a ton. The superior facility of preparing the whole trees of this colony more than compensating the difference in the price of labour. The value of these products is as follows :—From each ton of wood is procured—Acetate of Lime, from 80 to 120lbs., worth from 8*l.* to 15*l.* per ton, according to quality—Wood Naphtha, from 1 gallon to 1½ gallons, worth 3s. 6d. per gallon—and Kreasote, about two gallons, worth 2s. per gallon. Each ton of wood also yields about 15 gallons of Tar, equal to Stockholm before the Kreasote is extracted ; and six cwt. of Charcoal, which may, in consequence of the low price at which it can be sold, come into general use as a domestic fuel, especially for culinary purposes ; or, if not, can be easily formed into artificial fuel, far exceeding the best coal for steam purposes, and much cheaper. The quantity of wood which could be worked up, by an expenditure of capital less than that required for the Company, would be thirty tons a day. The returns from which may be roughly stated as follows—

	£	s.	d.
3,000 lbs. Acetate of Lime, at say 12s. 6d. per cwt.	16	14	10
30 galls. Naphtha, at 3s. 6d. per gall	5	5	0
60 galls. Kreasote, at 2s. per gall	6	0	0
9 tons of Charcoal, at 20s. per ton . . .	9	0	0
	£37	19	10

Or, in round numbers, 37*l.* In England, the products from a ton of wood are valued at 1*l.* 11s., but they are here stated at a much lower average.

THE TECHNOLOGIST.

ON GRANITE AND ITS USES.

BY THE LATE PROFESSOR GEORGE WILSON.

Granite looked at from a technological point of view, it is paradoxically remarkable as at once the most enduring and the most perishable of rocks. One half of its industrial applications depends upon its enduringness ; the other depends upon its perishableness.

No hills are more grand and picturesque than hills of granite. They lift their stately heads, as we see in the mountain-peaks of Arran, high up into the clear, cold air, and fear neither lightning nor storm. No hills better deserve the name which the Hebrew poets loved to give to mighty mountains—the everlasting hills. They are everlasting in the sense of enduring as compared with the duration of man or his works. In the lapse of 4000 years, nation after nation has been spoiled of the earthly immortality which it promised itself, and only relics more mournful than oblivion, reveal that it ever existed. Babylon has fallen, Nineveh is a heap of ruins, Thebes a city of mummies, Athens an eyeless skeleton, Rome an inhabited sepulchre, Jerusalem a thrice-ruined temple: all, so far as man is concerned in the making of them, are but the spectral shadows of what they were ; but if a map of Arran had been made 4,000 years ago, it would in all its great features represent what Arran is now. Nay, I think it not unlikely that if Noah could return among us, he might show us the very valley in Mount Ararat where the Ark rested. However that may be, if we look to Palestine, Greece, Italy, or Egypt, so far as their natural features are concerned, and compare the descriptions of them which have come down to us from remote times with the present condition of their best known regions, such as the Cataracts of the Nile, the mountains round Jerusalem, the hills about Athens or the neighbourhood of Rome, the difference is scarcely appreciable, provided we always exclude from consideration the effect of earthquakes and volcanoes, which is in truth exceptional, and that of man, which, after all, goes for very little.

The granite hills are everlasting also, as tried by standards which can find no place for a thing so fleeting as a generation of men. Napoleon told his soldiers in the plains of Egypt that forty centuries looked down on them from the summits of the Pyramids; but the stones of the Pyramids, which are older by uncounted centuries than Adam, were not born when there were granite mountains hoary with age. And we may possibly form a faintly imperfect conception of the antiquity of some of those rocks, if we consider that in all probability more than one of the stars are younger than they. At all events, during incalculable periods they have gazed into the abysses of space; and the mightiest, perhaps, of the events of the universe were not transacted till millions of years after those ancient monarchs first wore upon their brows their crowns of snow.

They are everlasting, finally, in the sense of renewing themselves in the only way created things can, namely, by the birth of successive generations; so that, whilst certain of the granite hills are unimaginably old, others have arisen from the fertile depths below within geologically recent times, and have witnessed at least the dawn of the historic period, and the last stages through which the earth passed before it was made ready for man.

But what have those relations of granite rocks to do with technology and industrial science? They affect it thus. The enduringness of the granite mountains belongs to the blocks cut out of them, down even to the smallest fragments. No material, accordingly, is so suitable for buildings or erections which are to be very lasting. The air can rust nothing out of granite blocks; rain can dissolve nothing out of them; rivers even may flow in granite-beds for miles without ceasing to be soft —*i. e.*, unimpregnated with saline matter. Frost has little power to split them; their component particles are bound together by a strong cohesion; plants do not readily grow on them; they remain undiscoloured for ages. In proof of this, we have the obelisks of the ancient Egyptians, still standing like detached peaks of granite hills. Those obelisks, not only beneath the serene atmosphere of Egypt, but after transference to the capitals of Western and Northern Europe, display, uneffaced, unblunted even, the hieroglyphics which were cut upon them three thousand years ago. In the British Museum most readers have probably seen granite sarcophagi and colossal figures, which might have come from the sculptor's hand yesterday. Those good qualities, however, are necessarily accompanied by a corresponding difficulty in quarrying and carving the stone, and thus a large demand is made on the ingenuity, skill, and patience of the stone-cutter. Into this I will not minutely enter; but you can readily understand that the employment of gunpowder to blast granite rocks; the slow process of boring holes in them; the tedious driving of wedges into these holes; the rougher dressings by heavy hammers; the sawings into slabs by great iron saws driven by steam; the protracted polishing by moving the slabs over each other; the employment of swift turning-lathes, and special iron tools, to give the last touches to curved surfaces—include a great technological domain, and involve a multitude of applications of science to art. The stone-mason of this country, the hewer and carver of these rugged, intractable stubborn rocks, is, as Hugh Miller as shown us by precept and example, a very noble specimen of the industrial man, and all the more so that he too often falls a sacrifice to his hard labour, and dies young in years, having lived only long enough to carve his own tombstone. Let him be thoughtfully regarded as one of the hardest-wrought of hard-working men, whom industrial science hopes yet to save, by the substitution of machinery for bodily labour, from that slow self-murder which is too often inseparable from his calling. What the nature of his work is you will best appreciate by the records of our lighthouses. Our works on lighthouses are all delightful reading such as Smeaton's 'Record of the Building of the Eddystone Lighthouse,' the elder Stevenson's 'Record of the Building of the Bell Rock Light,' and his son Alan's very dramatic and picturesque description of the 'Lighthouse of Skerryvore.' It is largely built of granite, and the modes of quarrying and fashioning that stone are incidentally but fully given in his work, and connected with the striking story of the building of the great northern beacon.

Turning aside from granite as a rock which we speak of as if it were uniform in structure, we have now to look at it as an aggregate of minerals. Its name signifies that it is. The word 'granite' implies made up of separate grains. There is no stone to which the name, as a name, might not be given; but it is specially applied to the one rock, because its component grains are very different in colour and lustre, and catch the eye of even the most casual observer. In the best known, the most typical, and, as it were, leading granite (of which there are many varieties), the component grains are of three different kinds. There are never fewer than two; in reality there are always more than even three, but beyond three we find only rarely disseminated and irregularly scattered grains.

The first of the three grains which concern us most now are transparent, often quite colourless, and very like glass. They consist of rock-crystal, otherwise called quartz.

The second are to appearance opaque, black, or rather dark-brown, and possess a peculiar silvery or pearly glitter (in Latin, *micare*), from which power to glisten their constituent is named mica

The third grains are opaque, resemble white marble, and are white, cream-coloured, buff, flesh-coloured, or red. Their material is called felspar; *i.e.*, feld (German), or field spar, a spar abounding in the fields. On the felspar the colour of granite depends.

As regards size, they may be no larger than grains of sand or sugar, or as large as currants. All may be about the same size, or one kind of grain larger than the others. Any one may be in crystals many inches, or even feet in length. In 1725, a cave opened at Zinkenberg, on the Grimsel, contained five tons of crystal, among which were columns, clear as water, from 500 to 800 lbs. In 1770, in Hagdorn, near Fischbach, a column weighing 14 cwt., one 8 cwt., and one 6 cwt., were found, of the greatest purity.

As for the shape of the grains, they are generally squeezed together in the rock, which was once probably liquid. But they often shoot into crystals, that is, solids with plane or flat sides or faces, bounded or circumscribed by definite angles. Rock-crystal or quartz appears as a six-sided prism and pyramid ; mica as a rhomboid, solid or with six lozenge faces ; felspar occurs as an oblique prism.

Rock-crystal is the characteristic ingredient of glass ; felspar, the characteristic source of the constituent of earthenware and porcelain ; mica is of much less importance.

Rock-crystal is called also silica, from the Latin word for a flint, which has the same composition as quartz. It is known as a crystalline solid ; as a white, glistering, gritty powder, and as a soft impalpable one. An intense heat melts it, but no heat can volatilise it, and it is insoluble in all ordinary fluids. It consists of oxygen, and a combustible body, in some respects like charcoal, in others like a metal, called silicon or silicium.

A beautiful and most interesting department of technology is connected with rock-crystal, as one of the precious stones or gems. It is the chief element of glass, and the largest constituent of porcelain, and we shall look at it again in its relation to these ; but before we consider it as transformed by man in the course of his industrial doings into marvellous things, it must be looked at in connection with an art which perhaps some may be jealous of hearing called utilitarian. Rock-crystal is one of the precious stones or gems, and is pre-eminent among them in a threefold way—1. It is itself ranked among ‘ the stones most precious.’ 2. It is the chief ingredient of many of those most highly prized which contain other things besides itself. 3. It is associated with the larger number of the gems as these are with granite. I wish to refer specially to the precious stones, that, in connection with them as famous and familiar things, I may dispose of two weighty objections to technology, and may urge an important argument in defence of its study and practice.

Mankind in all ages have looked upon those few minerals, which they have called precious stones, gems, or jewels, with delight and wonder. Their origin has been ascribed to supernatural causes, and they have been invested with the most mysterious powers. They could render their wearer invisible ; they could banish drunkenness (especially the amethyst), cure madness, and make certain the passionate love of those who were objects of affection. They could detect poison, and were its best antidotes ; they could heal, indeed, all diseases. In darkness they shone with a light of their own, bright as that of the sun, but bright, nevertheless, with an unearthly splendour. By all nations they were accounted as things regal and sacred, to be employed in the adornment of great kings and queens, and dedicated to the service of God. And if their employment was not restricted to such purpose, they were at least kept apart from ordinary uses. The songs and legends and fairy tales of all peoples are full of references to them, and the poets never wearied of comparing them to the rainbow and the azure sky, to flowers, and to stars. Even in these utilitarian and technological days, how much poetry lurks under the word "gem." We call a precious stone a gem. The word signifies literally a "bud or flower," and most happily denotes those crystals which shoot up and bud forth from their stony beds with forms as graceful, though of a different type of symmetry, and with colours as varied and as gorgeous as those of flowers. The amethysts, emeralds, garnets, and topazes are the true flowers of the granite, not the insignificant lichens which the botanist alone counts as belonging to the granitic Flora. Well, then, could not technology spare those unfading flowers to the poet? Has any but a jeweller an interest in knowing how diamonds are cut with lead wheels by patient Dutchmen? or how ingenious Germans convert, by chemical processes, common pebbles into choise carnelians and onyxes, or how clever Brazilians change yellow into red topazes? Because, in these later days, there has arisen a Sir Humphry Davy with a wonderful lamp, are we to forget Aladdin, and his more wonderful lamp, and the trees he saw loaded thick with emeralds and rubies? or because the Queen had to send a great army and take a mighty Indian fort before she could get her Koh-i-noor diamond, are we to lose sight of the simple way in which Sinbad's friends the merchants procured their sackfuls of the biggest gems from the Valley of Diamonds? Accepting the protest which we have heard against the flowers of the crystal world being regarded as mere substitutes for money, or useful because they can be converted into pretty studs and buttons, or clasps and brooches, and the heads of pins; and remembering that the same protest is made against every branch of industrial science, I wish to consider the two cardinal objections that are made to the modern zealous encouragement of utilitarian art as compared with the ancient mere sufferance of it. The one objection is, that our modern utilitarianism is stealing from us our imaginations; the other and more serious objection, is, that it is killing our consciences.

It is contended, then, that in these days the spirit of utilitarianism has so possessed the minds of the people that all interest is likely to be lost in imaginative art. The true object of technology, it is said, if you translate the word into plain English, is how to answer most sumptuously the questions, "What shall we eat?" and "What shall we drink?" and "Wherewithal shall we be clothed?" and the only fine arts it fosters are those which increase the sensual comforts and gratify the vanity of that luxurious animal man. The spirit, too, of its teaching is affirmed to be, that the money-value of an object is the true criterion of its worth to the world. A diamond is worth much gold, and therefore to be esteemed. It is also a good thing for cutting glass with, and indispensable to window-makers, but it may be left to fantastic Orientals to call it a Mountain of Light. Now, it is not to be denied that there is in our day a disposition among ourselves and the other active nations of the world to encourage utilitarianism as a thing most deserving encouragement, and that, though this may not be done in the spirit of depreciating other things worthy of being fostered, these suffer by its exaltation. But who is to blame for this ? Not the utilitarian, I think ! It is assumed in the argument against him, that the world in former ages paid sufficient attention to utilitarianism, but that now it is paying too much. But this is begging the entire question in dispute ; for when was the world too industrial, and when did the fine arts gain by men being idle and miserable ? The utilitarian does no more than declare that bread for the hungry, water for the thirsty, clothing for the naked, and homes for the houseless can be furnished to all, if men will but wisely use their faculties, and conquer that physical world which was given them to conquer. If it be desirable, as assuredly it is, that after being fed, and clothed, and housed, they should cultivate their imaginations, let the poet and his brother artists look to that. Hungry, thirsty, ragged wretches are not the audiences who weep over Tennyson's "Maud," or crowd to hear Jenny Lind sing, or make pilgrimages to London to visit the picture galleries. To feed, to clothe, to house the needy, are surely not acts which involve any invasion of their imaginations. If the poet, and the painter, and the sculptor, and the musician, will go before and go beside, and follow after the utilitarian, they will find him in no case an enemy, and in most cases a friend ; and if they will not do their work, they should not complain that it is left undone.

In reality, the question whether utilitarianism shall or shall not prevail against non-utilitarian fine art, depends upon a matter beyond human control, namely, whether there shall be more great artists or great utilitarians given to the world within a particular epoch. Let a Shskespere be born, and he will make his nation imaginative, and keep it so for centuries after his death. Let a Bacon be born, and he will make his uation utilitarian, and keep it so for centuries after his death. Let both adorn the same epoch, and that epoch will reflect the spirit of both, as the last two hundred years have done. And so long as a Shakspere and a Bacon, a Milton and a Newton, a James Watt and a Walter Scott, a Davy and a Byron, a John Herschel and a Thomas Campbell, a Faraday and a Tennyson, are given us together, the world will find no difficulty in being at the same time utilitarian and poetical. If it shall ever please Providence to send us no poets, then we must grow unpoetical, and the faster the better. And if it shall ever please Providence to send us no utilitarians, then we must at least grow non-utilitarian, though perhaps not become more poetical, only this time the slower the better. Let no one, then, quarrel with utilitarianism for being utilitarian. You might as well quarrel with a ball for being round. If poetry threatens to suffer, let the poets defend it from wrong.

There is one respect, however, in which I think too great a devotion to utilitarianism is doing mischief. An endeavour is being made to indoctrinate children with what is called useful knowledge, to the exclusion of fairy tales and other so-called useless imaginative literature. I have no sympathy with this. It is wrong in principle, and wrong in policy. The childhood of an infant, like the childhood of a nation, is a time when the imagination is the great inlet to knowledge, and it should be allowed to remain so. The poet is entitled to the childhood of every man and woman. The utilitarian may touch the finger tips of the youth, and often may entirely clasp the hand of the man; but the child is as useless to him as his knowledge is useless to the child. I count it, for example, an unwise and even a cruel thing to tell a wondering child that a diamond is not a fairy marvel, but only so much black soot or charcoal. The fact has no interest for a child. It is, indeed, beyond its comprehension, and to the small extent that it is apprehended it can only occasion perplexity. Tell a child, if it must be spoken to on the matter, that a diamond is so much sunlight condensed and crystallised, and you may enlarge its conception of that exquisite gem without misleading it. For, in a sense which the greatest philosophers would acknowledge to be a just one, a diamond is so much imprisoned sun-light; and if you burn the diamond you can set the light free again. On such a conception a child's mind can lay hold, and grasp it as it grows older better and better, till by-and-bye it learns to qualify it by the added idea of a ponderable solid embodying the imponderable light, and so gives wings to the chrysalis thought. I am not objecting to teaching children utilitarian facts, but to teaching such facts so as to cripple the imagination and morbidly develop or distract the intellect. A dwarfed and chilled imagination will help no one to study or to work. The boy who is greatly interested in "Aladdin s Wonderful Lamp" is sure, by-and-bye, to be greatly interested in all the wonderful safety lamps, electric lamps, and self-lighting lamps of Davy and his successors; and I have noticed that all my schoolfellows who have since distinguished themselves as men of thought or action, were great story-readers in their early days.

I wash my hands free, as Professor of Technology, of any approval of the so-called intellectual style of teaching. I have listened, on occasion, by request, to the uttered wisdom of little girls, who told me that the specific gravity of gold is 19.5; that the proper name of salt is chloride of sodium, and that the animal kingdom is divided into Mammalia, Aves, Reptilia, and Pisces: all which I heard with suppressed groans. The knowledge was good of its kind, but did the child no good.

It was furnished as mental fuel, and had been shovelled into the child's head with intent that it should take fire, and warm and light up its whole being; and it would have done so, had it been laid on the hearth of its imagination, where a fire is ever burning; but instead thereof, it had been cast into the unlighted furnace of the intellect, which it had only choked. So far is it from being the intention of scientific utilitarianism or technology to encourage such a style of teaching, to rob children of their imaginations and distract their intellects, that one of its great aims—an aim with which personally I sympathise deeply—is by lessening the toil and trouble which the great majority of mankind are compelled to spend, even from their earliest years, in gaining their bread, to give them leisure and opportunity to feed their imaginations and cultivate their intellects as God intended they should do. Let no poet or painter, then, or artist of any other kind, or friend or lover of these or of the arts, think unkindly of utilitarian technology. It can do them no harm, if they are true to themselves, and it will be their fault if it do not render them service.

I will not affirm that there are no grounds for the charge that utilitarianism has made men sordid and worldly. Great discoveries of gold diggings; ready access through the medium of swift steamers and railways to the choicest regions of the earth; the command which the telegraph gives over the markets of the world; the immense improvements in machinery; the new, and newer, and newest applications of chemistry to the useful arts; the great advances of agriculture, of navigation, of the art of war, and the wide diffusion of knowledge among the people, have unquestionably a strong tendency to fix men's thoughts too much upon this world, and make them forget how soon they must leave it.

All this is true; but for the evil, industrialism is not to blame. We are at best but narrow-minded creatures, troubled to carry more than one idea in our heads at a time, and but partially able to keep hold of two worlds at once. By all means let moralists and Christian divines, and every good man and woman, warn their brethren against mistaking this little passing world for the great eternal one. But to abolish industrialism would not cure the evil, and industrialism has many evils to cure. Its vocation far more is to relieve the wants of the poor than to minister to the luxuries of the rich; and we have the poor with us always.

Think how many thousands of starving men there are in our country at this moment for whom there is bread enough and to spare in this God's world of ours, if wisdom and and patience were allowed their perfect work! Think how many women crowd our streets, forlorn outcasts, for whom no man cares, who have been driven to perdition of soul and body by those vulnerable demons—Cold and Hunger! And think, lastly, how many stalwart working men and patient house mothers there are who, though not starving, are yet so overworked, so insufficiently fed and clothed, that they will be aged at fifty, and retain only vitality sufficient to rot slowly away in workhouses till they fall into their graves.

Think of this woeful multitude of sufferers and sinners whom the miseries of their bodies daily drive into the commission of terrible crimes, and judge whether industrial science can wrong religion by feeding, and clothing, and healing, and employing so inglorious an army of unwilling martyrs to the cause of imperfect civilisation!

Wealth and luxury are assuredly not less fruitful parents of crime than poverty and hunger, and if the criminals are fewer, they are often all the blacker, and they are few only because riches and leisure cannot be the endowment of many. But industrial science is as little responsible for the crimes of the rich as for the crimes of the poor. The fault of both is, that they are not industrial. The poor cannot work; the rich will not work; and both pay the penalty of idleness, which, whether voluntary or involuntary, is always punished in a world of which the law is Labour.

I think, then, that industrialism is no enemy of religion. I believe that it is most ready to be its handmaid. But let me add that, in itself industrial science is neither religious nor irreligious. It is simply embodied power, innocent of either good or evil intentions; as ready to make gunpowder as to make chloroform; as willing to cast iron into bomb-shells as into household grates; and no more interested in distilling an elixir of life than in concentrating the most subtle poison.

The often-quoted declaration of Bacon, that "knowledge is power," is especially true in reference to industrial science, if you take the aphorism without any qualification. Knowledge is power, and only power. It is not love; it is not hate; it is not virtue; it is not vice; it is not mercy; it is not justice; and least of all is it revenge. It has not a soft touch or a gentle look, a kind heart or a pitying ear. It has only a clear eye and a strong hand. Its symbol is the steam-hammer, to which it is equally indifferent, whether it is forging shapeless iron into goodly merchant ships, or crushing goodly merchant ships into shapeless iron. Industrial science is thus as free to the religious as to the irreligious, and is alike the blind instrument of both. Whether it shall produce evil or good depends on those by whom it is guided, and the business of the Christian is not to flee from it, as Moses fled at first from his wonder-working rod, because it put on the aspect of the subtle, terrible, malignant serpent, but to stretch forth his hand and take it, and hold it up before men as a sceptre which, wisely used, will compel the earth to obey the will of God.

I would compare industrial technology to one of the tribes of Israel, among which the Land of Promise was divided. I would not compare it to the lion-like Judah, or to Benjamin the ravening wolf, or to Napthali, the hind let loose, or to Dan the biting serpent, or to Joseph the fruitful bough, but to the lowliest of them all, who, you will remember, is thus described :—"Issachar is a strong ass couching down between two burdens : and he saw that rest was good and the land that it was pleasant ; and bowed his shoulder to bear, and became a servant unto tribute." This Issachar, the strong and patient, peaceful bearer of burdens, and servant of his brethren, is the very symbol of industrial science, and he can bear two burdens, so that you need not be afraid to lay one upon him.

And now, having in a long digression disposed of two grave questions affecting my subject, let me announce the positive truth which I seek to connect with the topic before us :—I was referring to rock crystal as connected with a peculiarly interesting department of technology. 1. As itself a precious stone. 2. As a prominent ingredient of those gems which contain other things besides itself. 3. As occurring along with those most prized.

There are two famous gems, indeed, perhaps the most famous of all, which are not included among the children of the granite. The one is a choice gift to us from the plant world, viz., the diamond. The flowers have kept the secret of their production to themselves, but they have whispered enough to let it appear that to them we are indebted for that rare crystal, most akin to the light, without which no plant can open its buds or perfect its flowers. The other exceptional gem, the pearl, comes to us from the animal world, and its subdued moon-like splendour, as contrasted with the sun-like diamond, is no unbefitting symbol of the smaller dependence of animals than of plants on the light of day.

The remaining precious stones are literally stones, the offspring of the rock, and of the earth, earthy. Take for example those mentioned in the Bible, without stopping to question whether or not the names are rightly rendered by our translators, seeing that it is only with the names we have at present to do.

In Aaron's breastplate there were twelve stones, namely, a sardius (or ruby), a topaz, and a carbuncle ; an emerald, a sapphire, and a diamond ; a ligure (or opal), an agate, and an amethyst ; a beryl, and an onyx, and a jasper.—(Exod. xxviii, 17, 20.)

In St. John's description of the Heavenly City we read of twelve foundations—jasper, sapphire, chalcedony, emerald, sardonyx, sardius (or ruby), chrysolite, beryl, topaz, chrysoprasus, jacinth, and amethyst ; "and the twelve gates were twelve pearls, every several gate was of one pearl."—(Rev. xxi. 19-21.)

Now, omitting the diamond and pearl, and counting no stone twice, we have sixteen gems. But of these, no fewer than one half, namely, agate, amethyst, chalcedony, chrysoprasus, jasper, onyx, opal (ligure), and sardonyx, are slight modifications of silica. Some, like the amethyst, are coloured crystallised rock crystal ; the others more resemble silica in the form of flint ; but all agree in consisting almost entirely of that most abundant and common earthy or mineral matter, which, as forming the smooth milk-white pebbles of our Highland brooks, we distinguish in our vernacular by the contemptuous name of chucky-stones (stones to be chucked about); which, as forming the sand upon our sea shores, we count the very type of useless barrenness; and of which, in its shape of sandstone, we build our rudest walls and meanest erections.

The whole of the precious stones in question are, in truth, only coloured sandstones. Nor is there anything rare in the source of their colour. A little iron rust, a little manganese, a little coaly matter, or a few scales of mica, are sufficient to give them their beautiful tints. And the most beautiful, perhaps, of all the siliceous gems, the precious opal (of which there exists a piece at Vienna, weighing 1 lb., valued at 40,000*l.*), if it owe its splendid blaze of colours to anything but its structure, owes it only to the presence of a little water.

Of the other eight stones, three—the ruby, the carbuncle, and the sapphire—are identical. The ruby and the carbuncle are exactly so, and the sapphire differs only in colour from them. A ruby or carbuncle may be called a red sapphire or a sapphire may be called a blue ruby. They consist of the same thing as the emery powder with which we clean rusty needles, and it is the same thing as the earth of clay, alumina. The rarest azure-blue sapphire, or blazing ruby, is only crystallised coloured clay-earth.

Of the remaining five stones, two—the emerald and the beryl—are but different names for one thing. They are largely made up of flint-earth (silica), and clay-earth (alumina), and their colour is owing to an abundant metal, chromium. They do contain, however, one comparatively rare body called glucina, the oxide of an unfamiliar metal. Yet there is nothing remarkable in the appearance of this body, which is a white powder resembling closely flint-earth and clay-earth, and only occasionally found forming a gem. For it is only a few among the beryls that are sufficiently beautiful to be counted among precious stones, and fine emeralds are so rare that a single one (no doubt a large one) at Vienna is valued at 50,000*l.*

The last three stones are the chrysolite, the topaz, and the jacinth. The chrysolite is made up largely of the continually recurring flint-earth, silica; its rather unattractive yellowish or olive-green colour results from the presence of a little iron rust; and what is not siliceous or ferruginous in it is the uncostly substance magnesia. The topaz is, again, clay-earth and flint-earth, with the addition of a common body, fluorine.

At length, however, in the last of the sacred gems, we encounter one constituted of very rare materials. The jacinth is composed of the least common materials of all the gems. It has in it an earth called zirconia, the oxide of a metal which occurs very sparingly in any part of the crust of the globe. This forms two-thirds of it, the other third is silica. Of all the gems it is probably the least known, and the least prized. It is a brown stone, of no remarkable beauty, resembling a red brown garnet, which is often sold as a jacinth or hyacinth. The rarest of the gems is thus the least prized of them all.

There are other precious stones besides those which I have named; but they all consist of common things. The garnet, for example, the spinelle-ruby, and lapis-lazuli or ultramarine, are compounds of the ever re-appearing silica, alumina, magnesia, and iron oxide; the splendid colour of ultramarine (which we are able to imitate artificially), depending, in addition to these materials, on the presence of sulphur and soda.

The turquoise is clay-earth united with bone-earth (phosphate of lime), coloured by oxide of copper. Many turquoises are the fragments of fossil bones stained with copper. Malachite is a very common copper ore. Satin spar and Derbyshire spar, besides other prized spars, consist chiefly of lime. Jet is coal, and amber is petrified rosin. In short, with the exception of the dull brown jacinth and the emerald, the great majority of precious stones are only coloured sand, flint, clay-earth, or clay, whilst the diamond is charcoal, and the pearl chalk.

If any of my readers hear this for the first time, I can well imagine them saying, "for us hitherto a diamond was a diamond, and a pearl a pearl; the sapphire the embodied azure of the sky; and the emerald the green which the earth loves in spring. But now, much apparently to your contentment, they are turned into soot and chalk, and clay, and iron rust!"

Now, I sympathise greatly with the feeling which leads to this protest. I have pleaded that children should not too early be despoiled of their romantic beliefs. And there are grown-up children of the best sort, who keep the hearts of children, in manly or womanly breasts, even to extreme old age, and who, I should be glad, could believe all their days, that diamonds were crystallised May-dew, and pearls the tears of mermaids, and sapphires chips from the vault of heaven, and emeralds leaves of the trees that grew in Eden. But to most of us, as even to a Wordsworth, the time irrevocably comes, when the fairy gleams of childhood fade into the light of common day; and we are all the descendants of her who ate of the fruit of the tree of knowledge of good and of evil, and must taste, like her, the bitter as well as the sweet; but the bitter here is a wholesome one. Why should we admire a diamond the less because a chemist can roast it into a cinder or burn it into choke-damp? Why should a pearl be pronounced unbeautiful because any one can rival the wanton Cleopatra, who changed one into a hateful draught by dissolving it in vinegar?

There is something unconsciously atheistic, materialistic, and barbaric in the notion that the rarity of its material is the chief element in the beauty of a beautiful object. All that the marble contributes to the beauty of the Apollo Belvidere, or the Medicean Venus, or any of the other statues that enchant the world, may be subtracted, without subtracting more than a fraction of their beauty; and that fraction makes the marble statue more beautiful than the plaster cast or the clay model, not because marble is rarer than plaster or clay, but simply because it is more beautiful. If the diamond had organised itself out of some unique and precious kind of matter, which alone, of all kinds of matter in the universe, could form it, then all praise to the self-made diamond! But if omnipotent hands carved it out of the most common, most unlikely, and most intractable materials, then, whilst the diamond is none the less beautiful, all the more honour redounds to its wonderful Carver. It might have been the law of nature that graceful shapes and gorgeous colours should have been found attached only to the rarest materials; as gold, for example, is a rare thing, as well as a very beautiful thing. But the law of nature is exactly the opposite. There is not, I am sure, a more beautiful object than a soap-bubble, none which a youthful Shakspere or Milton is more likely to have tried his creative hand at producing. No flower or precious stone excels it in symmetry. None equal it in colour, and yet it is but a distended drop of muddy water. The secret of its beauty lies in its workmanship, and the same law applies to all created things.

This is the lesson I am anxious to enforce. It is, I will not say, a childish, but it is a childlike fancy to expect to find beautiful objects constructed out of a rare material, which by its very nature confers beauty upon all that is made of it. When we become men, and put away childish things, what we do find in the physical universe, are materials the most common, but workmanship the most rare. Herein lies a great argument, little appreciated, for man being a worker. Herein lies a justification of Industrial Museums, and a divine warrant for Chairs of Technology. Thus the material of the gems is the cheapest and rudest. To judge from the condition of the mass of this material at the earth's surface, its tendency is to assume ungraceful and dull-coloured forms. The clay or flint, or chalk or charcoal, does not help the artist, but must be subdued into beauty, and etherealised by him. It is susceptible of being made beautiful, and does not refuse to be beautified; but it is shy and coy, and reluctantly submits to be glorified. Not till it is touched by the finger of God does it start into shapes and hues of beauty; but how surpassingly beautiful they are! The crystallised gems are modelled into figures so perfect, that the mathematician wonders at their almost ideal symmetry. Some, like Sal-Gem, are exquisitely-squared cubes. The jacinth rises in four-angled campanile-like towers; the emerald in stately six-sided obelisks; the amethyst in twelve-sided cathedral-like spires; the diamond assumes a most symmetrical shape, like that of a double Egyptian pyramid; the topaz inclines obliquely, like the leaning Tower of Pisa; the garnet, the most many-sided of them all, shows twelve or twenty-four polished facets; and the pearl (which is not, however, a crystal) as it were, rounds these off, and grows into a perfect sphere. Each assume many shapes but all related, all beautiful, and so unaltering that their bounding angles do not vary.

Those crystals in virtue of their structure, not their material, can influence nearly all the great forces of nature. They can transmit rays of light, and reflect them, bend them aside, break them in two, make them visible or invisible, and strangely change all their properties. They can similarly affect the rays of heat. They develop and modify electrical agencies. They act, and are acted on, like magnets, and when traversed by light, heat, electricity, and magnetism, display inner marvels of structure unsuspected until these marvels revealed them.

I will say nothing of their colours, for these are familiar, nor enumerate further their characters. Enough has been said to show that they are among the most perfectly beautiful things that God has given us to delight our senses and imaginations, and to quicken our intellects; and yet they are made of the most common, the most vulgar, and most worthless ingredients, and owe their graces solely to the exquisite skill with which those despised ingredients have been moulded, and carved, and tinctured with the choicest dyes. And they are bright with a lesson as heaven-born as themselves.

We are placed in a world where all are commanded to live by labour, the labour of head or hand, or heart or brain, or of all together. And lest we should be discouraged by the apparent intractability and meanness of the dull physical materials with which we must work, and should complain that we have to deal with a hard taskmaster, who sets us to make bricks but gives us no straw, behold He has stooped like a benignant father to His wilful children, and with His own Almighty hands has wrought into shapes of beauty the clay and sand and trodden dust beneath our feet. We are too apt to regard it as altogether exceptional that God should have shown to Moses on the mount patterns of all the things he should make for the service of the Tabernacle; we forget that He has in all ages given to men patterns of the way in which they should fashion the materials he has placed in their hands. And do not forget that it is not merely a few beadlike gems that show this. The everlasting mountains, the plains, the valleys, the river-beds, and the caverns of the sea, are built up or hewn out of the same common things. All the might and grandeur of the ocean, whether as shown in its waves or in its ice-bergs, those mightiest of emeralds, sapphires, and diamonds, depend upon the most common of material things. All the splendours of the sky have a similar origin. All the trees of the forest, the meadow-grasses, and every fruit and flower, are but new forms of the same endlessly alterable materials; and the creatures of the whole animal kingdom, up to the highest models of manly and womanly beauty, are only the same things in other shapes. On every side we hear one great truth uttered from earth, and air, and sea, and sky, and plant, and animal—*The material is nothing, the workmanship is everything.* On their testimony I rest my case. They are the justifiers of industrial science, they furnish an argument for cheerful, hearty work. To two alone of its aspects I will now refer.

In the first place, the infinite susceptibility of useful and beautiful modifications which the most common things possess, assures us that, though we are not omnipotent, and cannot avail ourselves to more than a small extent of this susceptibility, yet we can largely turn it to account in our capacity as workmen ; neither need we fear that all the generations of men to the end of time will exhaust the latent properties of even one kind of matter.

In the second place, as if not to deter us from work by showing us unapproachable examples of His power, it has pleased the Almighty worker to restrain His skill, if I may use such language, and whilst He has made all material things beautiful, to make none perfect.

Exquisitely graceful, for example, as crystals are, perfect crystals never occur. A faultless cube we do not see. Equilateral triangles or right angles, rigidly such, as tested mathematically, are not found, or facets unerringly plane. Poets speak of entire and perfect chrysolites, but crystallographers never saw them, and mathematicians never measured them.

It shows, as has been most justly urged by a profound thinker, how much greater man's intellect is than his senses, that we should have an unfaltering belief in the existence of such things as cubes and triangles, and circles, although we never saw them (*i. e.* perfect) and cannot produce them. But the conclusion I wish to draw from this curious fact is simply that on our globe the beauty of everything is as it were veiled and subdued, and for this among other reasons, that we may not be disheartened in working, by seeing the Divine ideal too perfectly realised before us.

And so, if our work never contents us, and, least of all, our best work, let us not seek a lower ideal, or be too despondent, still less throw our tools away in despair.

The workman's song, whether successful or not, should ever be, "Excelsior!" the motto, 'Higher! higher!" We must postpone the thought of perfection till we stand before Him who can make us perfect, and our work too.

ON THE STRAW PLAIT TRADE.

BY A. J. TANSLEY.

Bedfordshire has long been celebrated for the production of beautiful wheat straws, suitable for the purposes of plaiting. The first straws used for the making of plait in this country were grown in the neighbourhood of Luton. Straw-growing now extends throughout the southern part of the country, in the valleys and along the slopes of the Chiltern Hills, and also in parts of Hertfordshire, Buckinghamshire, Oxfordshire, and Berkshire. The best soils are light but rich; the stiff clays, being unsuitable, will not produce good straws. Some soils that would produce good straws, but not yield a fair crop of wheat, are only cultivated for the latter, but those yielding both, prove very advantageous to the farmer. The seed used is either that known as red lammas or white chittim wheat, according to soil and aspect; and is sown broadcast or drilled, according to circumstances, and cultivation is carried on in the usual manner. When harvest draws nigh, great care is required by the grower, it being necessary to commence cutting before the flag of the straw falls. If very wet and stormy weather sets in, the straws become rusted or spotted; or, if opposite weather, dry and hot, and the crop remains uncut, the straws change to red, and become harsh. The first favourable opportunity is taken, extra hands are set on, the crop is rapidly cut, laid out to dry before being tied into sheaves, carted and stacked with all despatch as soon as ready. The result of this attention is in general seen in obtaining bright and clear straws that will repay the farmer for all his trouble. An acre of wheat will yield in a good season five to eight loads of wheat, of five bushels to the load, and from fifteen cwt. to a ton of cut straws, of the value of six to eight pounds sterling the ton, clear of all expenses.

The farmer disposes of his straw to men known as straw factors; these draw and cut the straws in his barn. Each sheaf is taken between the knees, and the straws are drawn out a handful at a time; the ears are then cut off, and carefully laid together on one side. After a sufficient number has been drawn and cut, large bundles are formed, weighing 20 to 25lbs., and these are carted to the home of the factor, to undergo another "cutting" process, which is generally performed by boys, who earn from 2s. to 5s. per week. In the act of cutting each straw, the sheath in which it is encased is taken off. Two joints of the straw are preserved for plaiting, the other, or root joint, being cast away.

Straws thus cut are next subjected to the fumes of sulphur in a close chest, "steamed," as it is termed, and afterwards sorted by hand into proper sizes. Of late years sorting is performed by a hand-machine, similar to a sieve; the straws, being held in an upright position, fall through holes of a uniform size. A final sorting takes place, when discoloured or spotted straws are thrown out, which, however, are not altogether wasted, as they answer for dyeing in some cases. Marketable bunches are formed of the various sizes and qualities, the bundles so made up fetching one halfpenny to one shilling per bunch ; they are afterwards sold to the plaiters at the various markets of the districts, or in the immediate neighbourhood, the factors always residing within the plaiting districts.

There are straw-growing districts in Essex, but as the soil is unfavourable for the growth of good straws, great quantities are sent there to be made into plait from Bedfordshire and the other districts.

The growth and preparation of straws are most important branches of the "straw trade," and to the attention given to them during the last fifty years, much of the excellence of English-made plait is to be attributed. The districts were originally limited, but the advantages of straw-growing have led to the present large extension of the districts in the counties enumerated ; the possibility of obtaining a good crop of wheat, with a good crop of straws, having led on many a farmer to their successful cultivation.

The art of making plaits from wheat straw was first introduced into England about two and half centuries ago. In Agnes Strickland's "Lives of the Queens of Scotland," we read that Mary Queen of Scots, when travelling in Lorraine, in France, noticed that women and children were employed in the plaiting and making of straw hats, and in the districts where this light and pleasant handicraft was practised, the peasantry were much better off than in other parts where it was not. It is said that the thought struck her that the introduction of this useful art into Scotland would be attended with much benefit to her own subjects. She therefore prevailed upon some plaiters to return with her to Scotland ; this was about the year 1562. The troubles in which she was afterwards involved prevented her fully accomplishing her object ; but her son, James I., took a lively interest in his mother's plaiters, and transplanted them to Luton, in Bedfordshire. While, however, they remained in Scotland, they taught their art, and plaiting still survives to the present day in the Orkney Islands, though the quantity now made there is very limited.

These plaiters are supposed to have arrived in England about the year 1603, and must have taught the peasantry the art of making whole-straw plait. About a century after this, it is stated in "Oldmixon's History of England," that plaiting had, in 1724, greatly extended, and that several thousand plaiters found profitable employment both in Bedfordshire and Hertfordshire. In the reign of Queen Anne, large quantities of hats were made from the whole-straw plait, a taste for hats having sprung up at Court, as shown in the costumes of that reign in the milkmaid hat, and, later, in the succeeding reigns of the Georges, in the gipsy hat. The heaviness of the article, however, led to efforts for improvement, in order to produce a lighter description. At first the contrivances for the splitting of straws were of a clumsy character. Some plaiters, indeed, cut the whole straw with a knife, and made a kind of split plait, which realised as much as a shilling per yard, or 20s. per score (at the present time it would be about 4d. per score). A considerable quantity of fancy work was made about this period at Dunstable by straws, so cut, being made into what was called "laid-work." It consisted of the split straws being flattened, and afterwards pasted on wood or other firm substances; various pretty and useful articles in the shape of baskets, work-boxes, mats, &c., were thus made. Dyed straws were introduced, forming variegated patterns, and many other ingenious devices, and these were sold to the passengers passing through that ancient thoroughfare in the days of coaching. Many hats were made at the same period, and, together with the fancy work, brought Dunstable into notoriety in connection with the straw trade; hence the names of Dunstable plait, Dunstable hat, Dunstable bonnet.

The efforts at splitting straws made at Dunstable in the "laid-work," and around Luton, were not successful in discovering a proper instrument. Who it was that at last succeeded in the invention of that most important and useful little "machine," as it was named, the straw splitter, cannot now be traced, but it is generally supposed that the French prisoners at Yoxley Barracks, near Stilton, first made it in bone, between the years 1803 and 1806. It was about two inches long, brought to a point, behind which a set of cutters was arranged in a circle; the point entered the straw pipe, the cutters separating it into so many equal-sized splints. Some were arranged to cut a straw into four parts, others five, and so on up to nine. This instrument was soon imitated, and being of such surprising utility, numbers were speedily made, and fetched as much as from one to two guineas each. A blacksmith, at Dunstable, named Janes, made them in iron, and turned the end downwards at right angles with the stem, the cutters being placed immediately above the point. This soon after became the general form in which it was made, with the same varieties of cutters as at first in bone. A few years afterwards, about 1815, others were made like wheels, and inserted in a frame, the points projecting in front of each; by this arrangement four or five splitters could be fixed in one frame. As these instruments became common, and were made in brass, the price being about sixpence each, the making of split plaits with facility was placed within easy reach of the plaiters. To this invention may be attributed the success which, in later times, has attended the manufacture of straw plait in England.

The first split plait was made of seven straws, and it fetched as much as 12s. per score. Many amusing accounts have been handed down of persons called "dealers," collecting it of the plaiters five yards at a time, meeting them on their way to market as early as three or four o'clock in the morning, and making great efforts to obtain it. Prices continued high for many years. Other kinds were also invented, called rustic pearl, Italian (made of eleven straws) diamond plait, and other fancy kinds. Much plait was also made by the French prisoners at Stilton, about the year 1810. The plait they made was purchased by persons from Luton, who, at much risk, succeeded in holding communication with them.

Bonnets made of split straw succeeded rapidly in displacing the whole-straw Dunstable hat, and continued a favourite article of fashionable wear for a long time, but Leghorn hats eventually interfered with them. Chips also had a considerable sale. About the year 1820, Leghorns were largely imported into England from Italy, by Mr. Thomas Vyse, of London, and their sale was very great for many years, the prices varying from two to four guineas each.

The great demand for Leghorns led to many attempts being made to produce an article resembling them in England. Correspondence was carried on by the Society of Arts with certain persons who were attempting to accomplish the object, and every encouragement was offered by the Society to parties trying to grow straws like those in Italy, and then making a similar article to the Leghorn hat, in order to increase the manufacture. A Mr. Parry received the Society's large silver medal in 1822, for his method of manufacturing Leghorn plait from straw imported from Italy. No person succeeded so well, however, as the late Mr. Thomas Waller, of Luton, in his efforts to find employment for the population of his native town. This gentleman at first imported seeds of the Italian wheat, and endeavoured to raise straws from it in the neighbourhood of Luton, but though not in the end successful, being beaten by the uncertainty of our climate, and the want of sufficient heat in our atmosphere, he hit upon the expedient of using straws, which he imported from Italy, in making eleven straw plaits in the English style. The plaiting of eleven Tuscan straws, with the straws set out evenly at the lower edge, and not in the middle as Leghorn plait, was the new feature of his peculiar manufacture; the plait so made was a great success, and through his invention he obtained a patent for a bonnet, called by him the "Tuscan Grass Bonnet," which was afterwards patronised by Queen Adelaide, and great numbers were sold all over the kingdom at prices from 30s. to 50s. each.

Large importations of Italian straws were made by him, and many thousand persons in a few years were employed on the new plait. Eventually, the same kind of plait from Italy much interfered with the home-made; but, notwithstanding this, English-made Tuscan employed many thousand of plaiters, both in Bedfordshire and Hertfordshire, for many following years.

From the time of making the first single plait, called split, at the commencement of the present century, many fancy kinds of plait were invented in the split straw; the plait called "corkscrew" was one, and a bonnet made from it was worn by Lady Bridgwater. Similar fancy plaits and trimmings followed. About 1820, a new kind of plait, more durable, and with a surface more glossy, was invented, and it may be said to have been the parent of most of the numerous kinds that afterwards came up. This new sort was formed of seven double straws, two splints with their pithy or inner sides being laid together, after having been flattened, and thus a "double" straw was made, forming a smaller and lighter thing than the whole pipe, however fine. Seven of these double straws, being plaited, formed the new plait, termed "Patent Dunstable." This invention was followed by another and broader, and termed "improved." Another, formed of eleven double straws, from a fine splitter, was named "Bedford Leghorn," and one with fifteen doubled straws was named "Rutland." All these plaits realised very high prices when they first came up. These four kinds were soon after made into rice-straw plait. This novel kind differed in this important particular, that the straw was reversed, the inner or pithy side being worked outwards, and the natural or bright side worked inwards. This kind, in after years, had an immense sale, and some of the finest, which resembles chip to a degree, was made up for wedding bonnets. About this time, 1820 to 1830, much broad single plait was made, called "Italian," "Devon," and broad pearl or rustic, from which the cheapest straw bonnets of the day were formed. The making of these varieties found employment for great numbers of plaiters, and being more profitable than lace-making, many of the children of lace-makers were taught this more valuable art.

Between the years 1844 and 1850, other and more important plaits were invented. An idea occurred to a straw-plaiter of turning the straw on the upper edge in such a manner as to form a bead or pearl, and by working each pearl along the edge at every other straw, the plainness of the edge was broken, and a new plait was formed, of a pleasing appearance. This plait was found, when made into bonnets, to give quite a new feature to them, and led to the general making of this plait wherever plaiters had sufficient skill. The pearls were afterwards doubled, two being formed one next the other. A third, with three pearls, was soon after invented, and these plaits were respectively named one-pearl, or China pearl, two-pearl, and three-pearl ; the last named, three-pearl or rock edge, having proved most useful ; it was afterwards called Cobourg. These same descriptions were subsequently made in eleven straws. Some had the straw worked over a wire, and were named moss-edged plaits. One most useful sort was worked every straw over a wire, and was named satin-piping, or Vienna. Others had their edges worked so as to imitate a feather, and hence were named feather-edged. Another sort was made of eleven straws, open in the middle, like lattice work, and was named Brussels. Another, similar in some respects to the last, was called birds-eye. Much plait in seven and eight straws had been made, composed of coloured and white straws mixed together, and made in a variety of patterns. These plaits being cheap, and bonnets made from them of economical wear, great quantities of plait were used, and employed numbers of children in the plaiting districts. But the most important of double plaits is that termed twist edge, and made within the past fourteen years. This plait was also named whip-cord edge, from the fact of the straw being whipped over as it were. It is also made in whole-pipe seven and eleven straws, and is a staple article of English wear, forming the true straw bonnet, by exhibiting English straw to the best advantage. The discovery of this valuable plait has been attended with happy results, as it is a description capable of being used in almost every kind of hat or bonnet.

These various descriptions of straw plaits have enabled the trade to produce so many novelties that Tuscan plaits for bonnets declined as articles of wear, the beauty of English straw plaits, as displayed by these new patterns, leading the public to give them the preference; and although the lowering and subsequent abolition of the duties on foreign Tuscan brought that article into competition with the English straw manufacture, no injury has been sustained by the straw trade. Tuscan is chiefly confined to girls' hats at the present time, and its low price since the removal of the duty has completely abolished the making of Tuscan plait in England from Italian straws.

The plaits now enumerated of English make from the wheat straw were those shown at the Great Exhibition in 1851. At that concentration of the best productions of the plaiting districts, the skill of the English plaiter was fully shown. From that date plaiting has continued to progress, not so much in the invention of a number of new plaits, as in the superior quality and extent of the manufacture. The newest feature is the production of various coloured plaits of excellent patterns, suitable for ladies' hats, the last and popular colours being produced in mixed and dyed plaits, as mauve, magenta, &c. Many valuable patterns have been made by mixing rice straw with dyed straw, as rice and black, rice and mauve, rice, black, and brown, and similar patterns.

The progress made in English plaiting up to the present time has been thus remarkable in the varieties produced to meet the public taste and the necessities of the million. And although foreign straw plaits from Belgium, Germany, and Switzerland, have been brought to compete with them, they have nearly all failed in this respect. A few single plaits of a choice character are used for white goods, but the greater portion, from the inferiority of their colour, are only suitable for use when dyed.

Straw plait is a domestic manufacture, carried on in the cottages of the agricultural labourers of the three counties of Bedfordshire, Hertfordshire, and Buckinghamshire, and portions of Essex and Suffolk. The plaiters are generally the wives and children of the labourers ; a few are men. No plait is made in factories.

Children are taught usually in schools, and are sent at the early age of four years ; besides plaiting, they are taught the simple elements of spelling and reading. In most villages there is a plaiting school, which is generally conducted by an elderly dame, who receives from each scholar 2d. or 3d. per week. The children are some time before they can plait so as to earn anything, but after a year or two they contrive to obtain 6d. to 1s. 6d. per week, after their plait is disposed of by their parents. They remain at school the usual school-hours; afterwards, during the time they do not play, they plait a little till sent to rest. They continue working at school till they can plait sufficiently well, and when they are above eight or nine years they earn 2s. to 3s. per week. On leaving school, they earn 4s. to 5s. if expert plaiters, and after they become skilful they may obtain as much as 7s. Many learn to sew if near Luton or Dunstable, and then leave their cottage-home for the greater attraction of hat and bonnet sewing, a sewer being considered a step above a plaiter, and one who may exhibit an amount of personal adornment, to which a simple plaiter would not dare to aspire in her village-home.

Plait is made all the year round, except during the interruption of harvest time. The plaiters do but little then, especially when the time of gleaning arrives. In winter plait is made indoors, and as the splints have to be worked in a partially wet condition, it is cold work for the fingers. When plaiting near the fire, the straws are liable to injury; winter-made plait is never so good as when it is done in spring and summer, away from the fire or in the open air, at the cottage door, or along the green lane.

The earnings of plaiters vary much according to the time devoted to it. Unmarried women, who are skilful and quick, earn the most, but some married women contrive to do pretty well; and a well-ordered family will obtain as much or more than the husband who is at work on the neighbouring farm; in this respect plaiting far exceeds lace-making. The earnings of a good plaiter, after the straws are deducted, will be from 5s. to 7s. 7d. per week, in a good state of trade.

The plaiting districts are now wide spread; each district has a plait market as its centre. The chief markets are Luton, Dunstable, Hemel Hempstead, and Hitchin. There are nine lesser markets, and they all begin at a fixed hour in the morning, a bell being rung to announce the commencement. The districts do not all produce the same descriptions, plain plaits being the product of one locality or district, fancy of another.

It is computed that the number of females engaged in plaiting, and boys up to eight years of age, would now be near to 50,000, and the number of yards annually made 200,000,000, or 10,000,000 scores of plait of every description.

Plait is sold by the score of 20 yards, at from 2d. to 3s. per score, and is done up in double links of 17 inches in length,* 20 such forming the score. One week's work is generally disposed of at a time by the

* An additional inch at each end is taken up in the bend, making 36 inches in all.

plaiters, either at market or to dealers living near to them. In some cases several weeks' work is kept before being disposed of.

The measure of plait till very recently was very deficient, being frequently but 17 or 18 yards, or even less to the score. Of late years an association for the suppression of this evil has been established, which has been attended with most beneficial results, the measure being now very near the just standard.

The number of towns, villages, and hamlets embraced by the districts is computed to be between 150 and 200. Of the towns, there are Luton, Dunstable, St. Albans, Hemel Hempstead, Chesham, Tring, Leighton Buzzard, Ivinghoe, Toddington, Ampthill, Shefford, Baldock, and Hitchin. At each of these towns there is a plait market, to which the plaiters come from distances varying from one to six miles. The plait is sold in the open market, beginning at 8 o'clock in the summer and 9 o'clock in the winter. At these markets straw dealers attend, and from them the plaiters obtain their straws when they do not purchase them nearer home.

Plait, after being collected by the dealers (of whom there are from 150 to 200), is brought for sale to two markets, Luton and Dunstable, but chiefly to the former town. Luton market is held on each Monday throughout the year, and as such large quantities of plait are disposed of, it is attended by almost all the trade; from 150,000 to 200,000 score are sold in busy times on a single market day. Marketing extends in general over three hours.

Plait, after being purchased of the dealers, is either bleached or dyed. Till within the last eight years it was chiefly bleached, but owing to the immense sale of black, brown, and other self-colour hats, the quantity that is dyed is at some parts of the year greater than that bleached. The dyeing of plait is now a most important branch of the trade, and to the first dyer of plait the trade is greatly indebted. This person was a Mr. Thomas Randall, of Sundon, near Luton. Pipe straws were dyed by him, and by Mr. Wright, of Hemel Hempstead, many years before plait was dyed a self-colour, but the honour of the application of dyeing to plait belongs wholly to Randall. Had he secured it by patent he would have secured it for a long time in his own hands, but as he did not, plait-dyeing in a few years was practised by other persons, who now employ many men and boys, who otherwise could hardly have found employment in the trade in other occupations.

Plait dyed or bleached is chiefly sewn into hats or bonnets at Luton or Dunstable, or is exported; the greater portion is, however, required for home consumption. Very little was formerly sewn up at Luton or Dunstable. Up to the year 1835, the Luton trade consisted in plait more than in bonnets, which plait was sold all over the United Kingdom for bonnet making. But the cheapness of Luton bonnets, and their superiority over others made by the bonnet milliners, gave rise to the present trade. The best manufacturer who gave a start to the Luton bonnet trade was the late much-respected Mr. Edward Waller, who, by his enterprise, laid its foundation. His brother, Mr. Thomas Waller, helped much in this direction by the excellency of his productions in Tuscan bonnets. About the same period, 1830 to 1840, branch establishments were opened in Luton by London firms, as Vyse and Sons, Gregory and Cubitt, Welch and Sons, Munt and Brown, the first-named firm especially helping to bring Luton manufacture into reputation. A good deal was being done at Dunstable in bonnet and hat making about the same time. At the early period of bonnet making in Luton, other materials were used in their construction besides straw, as chip and sewn willows, the latter having first been woven in a loom, afterwards dyed black, and then the cut strips were sewn into bonnets and carefully pressed; hence the cheap willow bonnet. The making of Tuscan bonnets was a very important branch also.

Further improvements in shape, superiority of colour and finish, continuing throughout a series of years, brought the Luton trade to its present perfection, and have been the causes of the present extensive English and foreign business. Luton was described by Boswell, in 1781, after his visit to Lord Bute's, at Luton Hoo, as a "village," by after writers as "a small dirty town in Bedfordshire." In 1801, the census showed 3,095 inhabitants; in 1841, 7,740. In 1851, it had risen to 12,783; at the present time it is well drained and paved, and is supposed to contain about 18,000, and will in another year or two amount to 20,000, if its trade still keeps enlarging. As would be supposed, the females out-number the males, but not quite to the extent some imagine.

The sewers of Luton are divided into two classes, those employed in the rooms of the manufacturers, or who are employed directly by them out of doors working at home, all of whom are under direct control; and those who are employed on "sale work" on their own account, and who are their own masters. More are employed on "sale work" than in rooms. There are many persons of respectability who employ 10 to 20 or 30 sewers, and dispose of their goods likewise to the warehouses. Of the whole population, 12,000 are supposed to be occupied directly in the trade, the remainder being chiefly dependent upon it indirectly.

Of the class of sewers employed by the manufacturers the most skilful are the room hands. Their earnings are excellent, and superior to any similar class in the kingdom; some two thousand or more are engaged in the room work, and their hours commence at 9 o'clock in the morning, and in general terminate at the same hour in the evening; they are all employed upon piece-work, and have to sew up the plait or other material to a given shape and size of hat or bonnet. They are not strictly confined to the rooms when at work, as in the cotton factories of the North. The rooms are in general provided with every comfort and convenience for carrying on their work and for preserving health, some masters taking especial care in this respect. Their earnings in the season vary from 8s. to 12s. for the medium hands; 12s. to 15s. is obtained by those employed upon the best plain goods ; and best fancy hands can obtain from 16s. to 20s. per week ; these earnings are subject to variation with the fluctuations of the trade.

Many of this class return home in July and August for a holiday, coming to work again in September. Numbers come from considerable distances, as far as 30 to 60 miles. The other and larger class of sewers are those engaged upon "sale work," and as this is the commonest description, their earnings are in proportion. The goods are in general sold by them to the warehouses at the end of the week. Almost every poor family is employed upon this kind of work, and their earnings vary very considerably ; but, on the whole, more is obtained than by plaiting families of the surrounding districts. As this class of the population is very numerous, they are subject more suddenly to the changes of trade, their productions frequently being in excess of the demand. In good seasons their earnings are excellent. The industry of the mass of the population is great, as may be seen when it is considered that the "sale work" amounts to nearly five millions of bonnets and hats within a twelvemonth. So vast has the trade become, and so industrious are the fingers that ply the needle, that articles of cheapness and utility are the result of their industrial occupation, such as no other town, unaided by machinery, in the kingdom can exhibit.

The earnings of those employed upon sale work vary much. Children earn 2s. to 3s. per week ; girls and women 5s. to 8s. per week. Boys in some cases also sew, and some men in the winter season, when other employment is scarce.

The male part of the population engaged in the trade are boys and lads, employed in bleaching, dyeing, and brushing plait, earning 5s. to 8s. per week ; men at the same earning 12s. to 15s., and the large and important class of blockers or pressers earning 20s. to 30s. per week.

The Luton productions of the superior descriptions are manufactured in the work-rooms, and amount to from two to three millions of bonnets and hats annually.

Of late years much valuable material has been worked up at Luton, either alone or with English straw. These materials consist of foreign and St. Albans' wove trimmings, and that most important article from Switzerland, hair braids or embroidered hair braids and trimmings, commonly known as crinoline. Similar hats and bonnets are made up at Dunstable ; and the two towns, now connected with each other by railway, and at so short a distance, may be considered as one in the superiority of their manufactures ; though "sale work" is produced at Dunstable, in a very small degree.

The "straw trade," in all its numerous ramifications, is most extensive, and when the bonnets and hats now made in London from Bedfordshire and other straw plait are added, the annual returns will not fall short of one and a quarter millions sterling.

During the past 15 years a large shipping trade has been carried on chiefly, in the first instance, with the United States of America; later, in addition to this, large quantities of English straw goods have been shipped to Canada, Australia, the West India Islands, India, Brazil, and the Continent; and while France supplies England with the newest fashions in bonnets, she in return is supplied with the latest fashions in hats from England.

Before closing the subject, it is necessary to notice the novel but useful invention of mixing white cotton braids, now made chiefly at Manchester, with straw plait. In the first instance the white braid was made up alone, as is still done for some descriptions of bonnets. The introduction of this new material is referred to the Messrs. Woolley, Sanders, and Co., of London and Dunstable. The bonnets made of the braid are whiter by far than those of chip, and are often preferred for wedding bonnets. The finest braids are named chip braids.

From the foregoing statements the trade of Luton, and the straw trade generally in England, is exhibited as assuming greater importance every year. Luton is now in direct communication with the metropolis by means of the Great Northern line, the Luton branch railway joining the main line near to Hatfield. This important advantage is likely to develop still more the straw trade of Bedfordshire, by placing the emporium of it, Luton, within easy reach of all travellers. It is in communication with the North by means of the railway to Dunstable and Leighton. In addition to the straw trade of Bedfordshire, there is the Brazilian hat trade of St. Albans, which employs about 1,800 persons in the town and neighbourhood, and in other branches of hat-making, forming the staple trade of that town.

Although in the mere popular view of the subject it may, in its various details, be considered more interesting to ladies, who are the principal purchasers and wearers of bonnets, yet it is not without general interest to the male sex, who sometimes wear straw-hats in boating, cricketing, &c., and are also interested in it as relating to home and export trade. It is much to be wished that a little more boldness was manifested by men, in wearing, at suitable seasons, a lighter covering for the head than the silk, felt, and cloth hats usually worn. Such a practice, while helping on an important home manufacture, would likewise conduce to the preservation of the hair and lessen the number of bald heads. The due ventilation of the head and the more free exposure of the hair greatly conduces to its healthy preservation among the ladies. Our ever-changing fashions and variable climate have much to do with the progress and prosperity of the straw plait manufacture. Looking at the strong contrasts in fashions, and the recurrence from time to time to old and obsolete styles of articles of dress, it is by no means improbable that the cottage bonnets and milk-maid and gipsy hats worn half a century or more ago, now looked on as such curiosities, may, after all, be again seen in the shops and on ladies' heads. The subject of the working-up of grasses and plait of various kinds into coverings for the head, ornaments, matting, and fancy work, is not of interest alone to ourselves. The details and information connected therewith, hitherto of the most meagre character, are of great importance to numbers in Europe and America, as well as in Asia and our colonies. Some of their manufactures come occasionally into trade here, and several are of a most expensive character, realising exceedingly high prices. Such, for instance, as the fine Panama hats, so common an article of wear in Central America, the Southern States, and the West Indies. The sinnet hats, plaited by seamen, are made from the fronds of a species of palm; the cabbage-tree hats of Australia are from another palm, so are those made in Brazil, and the palmetto hats of the United States. In the Philippines hats are made of a very fine kind of rush, and formed of two hats, one within the other. At Ningpo, China, straw hats are made to a large extent, for as many as 40,000 are sent annually to Shanghai from thence. Indeed, every country has its peculiar light hats in use, and most of them made of indigenous fibres. We may glance at the particulars of some few of these, which are of interest by way of comparison with our own growing trade and manufacture in straw plait. Florence long enjoyed a monopoly in straw work for hats and bonnets of great fineness and remarkable beauty, insomuch that bonnets have been made there that sold for as much as 70*l.* The Swiss hats are made in Venetian Lombardy, and, if less fine than those of Florence, are at least cheaper. The straw plait industry is of great importance in Tuscany, occupying about 35,000 workpeople. The attempts made in other countries to produce the peculiar kind of straw used has hitherto entirely failed. The seed from which the straw for plaiting is grown is a small round grain of wheat, called *Grano marzolano.* It is an error to suppose that hats are made from rye or any other grain in Tuscany. This marzolano straw is cultivated for the sole purpose of being made into hats, and is grown chiefly in the vicinity of Florence, and on the hills on both sides of the valley of the Arno. Tuscan women have settled themselves in various places, such as Vienna, St. Petersburg, &c, where they carry on the manufacture with straw grown in Tuscany. Fine plait is not accounted good unless much drawn together, for which end it is worked very wet. After being soaked and pressed, the plait is made up into hats by women who do nothing else; it is put together by the edges, not overlapped. On the operation of pressing a great deal depends. From a consular return, we find that in the five years, from 1851 to 1855 inclusive, the exportation of straw work from Tuscany had progressively increased, as follows:—

1851	. . . . . Liri.	9,832,292
1852	. . . .	11,628,490
1853	. . . .	16,772,314
1854	. . . .	13,213,756
1855	. . . .	23,186,820
	Total . .	75,633,672

The diminution observable in the returns for the year 1854 was not real. The crop of straw was most abundant in that year, and the quantity of straw work manufactured very considerable, but a great part was exported in the following year. The value of straw work exported, classed under different heads, gave the following results :—

	Hats.	Plait.	Straw.
	Liri.	Liri.	Liri.
1851	5,204,093	3,804,600	138,471
1852	7,875,475	4,064,604	335,331
1853	10,811,865	5,183,352	199,898
1854	6,956,620	5,278,824	95,012
1855	15,834,507	7,158,060	30,553
Total . .	46,682,560	25,489,440	799,265

It is clearly proved by this table, that the greater part of the straw is manufactured into plait in Tuscany, and the popular belief that the liberty to export straw would ruin the native industry is shown to be unfounded. The value of straw-work exported during the above period constituted 28½ per cent. of the whole exportation of Tuscany.

In Italy the trade represented by bonnet-making and other articles from straw, whether for home use or export, is a source of wealth of a fluctuating character, depending upon fashion.

The wheat used for straw plait in Italy is a summer variety of the *Triticum hybernum*, cultivated expressly in Tuscany in poor, arid, and strong soils, in order that the stalks may be as thin as possible, and they seldom exceed 18 inches in height. They are gathered by rooting out the plant altogether. These are dried and blanched by gentle watering, much the same as flax; the upper portion is then cut off, and arranged in different sizes, and bleached with sulphur, &c. It is important to keep the ends of the straw air-tight, in order to retain the pith, and prevent its gummy particles from passing off by evaporation.

In the barn, or other appropriate place, the part for making hats, &c., is selected, which is the straw between the ear and first joint, no other part being serviceable for the purpose.

On selecting the part on which the spike grows, it is classed or stapled like wool, the coarse and fine straw separately. The coarse or thick is given out to children, or inferior hands, while the fine or best straw is worked by good hands only.

One peculiarity in this manufacture of the so-called Leghorn hat is, that the straws are not split, as is the case with the kind known as the Dunstable, manufactured in England. The plait is always worked with thirteen straws, which, by the peculiar manner of plaiting, are not sewn together at the edges, nor overlapped. The straws are worked when very wet, for which purpose each person is furnished with a jar, which is filled with cold water, in which the bundles of straw are put, as required; it softens the straw and assists the workers to plait fine, and makes it appear as if drawn together, without which quality it is not considered good.

To obtain the whiteness so much required, it is smoked with sulphur, previous to being worked, also after being worked; and lastly, after being formed into the hat or bonnet. It is done by placing a chafing dish, filled with sulphur and set fire to in a large box, or small close room; sometimes the bleaching requires repeating two or three times. The mode of plaiting is as follows:—The straws being picked and put into separate bundles, according to their quality, let thirteen of them be taken and tied first together by the seed ends; attach them to anything, such as the back of a chair, to keep them steady; then take hold of the loose end of the bundle, putting six straws into the one hand, and seven in the other. Take the outermost and with it cross over two, then carry it behind the next two, and lastly, before the remaining two. After which, lay the straws into the other parcel of six. The first parcel of six being now made seven, take the outermost straw of it, and carry it across the bundle by two, as in the former case, laying at last this seventh straw into the outer parcel, as before. It will be understood that this outermost straw of each parcel is always made the acting straw, and that in the progress of the operation, each of the straws of both parcels are thus employed in its turn.

Besides bonnets, the straw is made into many articles, cigar cases, &c., and plumes, and other ornaments and trimmings for females, and it also has combined with it chenille, horsehair, and aloe fibre. Bonnets at a more moderate price than those of wheaten straw are made of barley straw, in Italy, but not being so durable, they are less esteemed, although they are of finer texture, and have a larger number of turns in a given width, which constitutes the standard of fineness.

Straw may be bleached by a solution of chloride of lime. The straw, after being aired and softened by spreading it upon the grass for a night is ready to be split, preparatory to dyeing. Blue is given by a boiling-hot solution of indigo in sulphuric acid, called Saxon blue, diluted to the desired shade; yellow by decoction of turmeric; red by boiling hanks of coarse scarlet wool in a bath of weak alum water, containing the straw; or directly by cochineal, salt of tin, and tartar. Brazil wood and archil are also employed for dyeing straw.

In the Duchy of Baden, considerable attention is given to the manufacture of straw hats. Those, particularly, from the districts of Neustadt, Freiburg, and Schonau, fear no competition save that of Italy. The superiority of these districts of the Black Forest is due, first, to the excellent quality of the straw, and, secondly, to the numerous schools which the government has carefully established there for teaching this particular branch of trade. It is worthy of remark that, in the Wurtemberg part of the Black Forest adjoining these districts, the straw does not possess those qualities which distinguish that grown on its southern side. It is clearly, then, the climate which here favours the Grand Duchy. This industry is a most popular one; and everywhere in the forest the women may be seen twisting, in their agile fingers, the plaits of straw destined to adorn the pretty heads of their fair country-women of the towns.

The straw trade of Switzerland in 1852 occupied about 40,000 persons; a portion worked at the factories, but the greater number at home. The straw is of home production, embroidered or mixed with silk, thread, horsehair, &c. The more important factories of this material are in the Cantons of Argovie, Thurgovie, Appenzell, and St. Gall. The Canton of Fribourg is more especially confined to the manufacture of straw hats and bonnets. They export to almost every country, and the articles of this manufacture are highly appreciated for their beauty and low price.

Upwards of 70,000 persons are now employed on straw plaiting and hats. The Canton of Fribourg exports goods to the value of 60,000*l.* or 70,000*l.*, and that of Argovie more than half a million sterling. France has a large trade, principally for local use, in straw hats and bonnets, at wholesale prices, ranging from 4s. to 15s. per dozen. At the Paris Exhibition of 1855, where there was an excellent display of straw plait manufactures from Tuscany, Switzerland, Belgium, Saxony, and France, Great Britain in this class was quite unrepresented, although, as the Jury Reports observed, "she occupies a distinguished rank" in this particular manufacture.

General Imports into the United Kingdom.

	1854.	1855.	1856.	1857.	1858.
Plaiting of straw chip or other material, lb.	207,755	135,864	155,524	203,128	172,333
Cordonnet . lbs.	18,057	6,310	7,292	6,834	4,177
Plaiting of chip less in value than 6d. the piece of 60 yds. lbs.	9,850	9,219	10,409	3,969	4,044
Willow squares . cwts.	200	287	218	219	242
Hats and bonnets of straw, &c. . lbs.	...	37,901	36,852	67,454	35,272
Straw or grass for plaiting . . cwts.	...	478	504	165	84

Computed Total Value of the Imports into the United Kingdom.

	Plaiting.	Hats and Bonnets.
1854	£209,454	£168,543
1856	158,023	86,155
1858	156,369	93,588
1860	194,561	100,071
1862	118,877	99,640

The duty on imports was, from 1853, 2s. 6d. per lb. on hats or bonnets of straw; 2s. per lb. on plaiting, and 6d. per lb. on inferior chip; whilst willow squares paid 10s. per cwt., and formerly paid as much as 20s. a pound; but all are now free of duty.

Quantities and Values of Straw Plait and Hats imported from

		France.		Tuscany.	
		Quantity.	Value.	Quantity.	Value.
		lbs.	£	lbs.	£
1854	............Hats.	37,399	112,197	5,940	17,820
”	............Plait.	176,926	171,766	20,856	20,248
1855	............Hats.	14,699	44,098	7,078	21,233
”	............Plait.	125,425	120,757	3,007	3,007
1856	............Hats.	19,354	58,062	4,519	13,558
”	............Plait.	148,220	137,830	4,745	4,745
1857	............Hats.	24,953	74,860	2,983	8,948
”	............Plait.	144,398	136,418	4,853	4,853
1858	............Hats.	12,147	34,616	2,991	8,434
”	....Plait.	110,994	105,785	12,569	12,569
1860	............Hats.	13,404	46,417	1,027	3,596
”	............Plait.	121,564	182,348	13,190	7,914
1862	............Hats.	24,062	60,155	1,348	4,044
”	............Plait.	75,805	45,718	4,025	2,133

Exports of Plaiting of Straw.

	Weight.	Val. of Brit.	Val. of For.	Total.
	lbs.	£	£	£
1854 . . .	138,713	40,515	17,472	57,987
1855 . . .	101,831	41,145	10,280	51,425
1856 . . .	112,285	58,972	7,306	66,277
1857 . . .	126,968	46,804	25,455	72,259
1858 . . .	82,114	29,810	20,507	50,317
1860 . . .	97,369	44,230	3,485	47,715
1862 . . .	116,761	49,085	817	49,902

A VISIT TO THE WORKS OF THE PATENT PLUMBAGO CRUCIBLE COMPANY.

BY J. C. BROUGH.

Crucibles have been in use for melting and refining metals from that distant point of time when man exchanged his stone hatchet and bone chisel for implements of bronze. The earliest melting-pots were doubtless made of the plastic and infusible substance clay, and there is no reason to suppose that they differed essentially from the earthen crucibles now commonly used in our foundries.

As an instrument of scientific research the crucible has held an important position for at least a thousand years. It was constantly used by the first alchemists, and may, indeed, be truly styled the cradle of experimental chemistry.*

At the present time crucibles of one form or another are extensively employed by the refiner of gold and silver, the brass-founder, the melters of copper, zinc, and malleable iron, the manufacturer of cast-steel, the assayer, and the practical chemist. They are made in many different shapes and sizes, and of many materials, according to the purposes for which they are intended. For certain chemical experiments requiring high temperature vessels of platinum, porcelain, and lime are adopted; but for ordinary metallurgical operations "clay crucibles" and "plumbago crucibles" are exclusively employed. We have now to confine our remarks to these two important classes of crucibles.

On examining a clay or plumbago crucible we find nothing to excite our surprise. It seems to be merely a rough specimen of pottery that might be easily imitated. Yet the successful makers of crucibles are so few that they might almost be counted on the fingers of two hands. When we take into consideration the qualities which are required in a crucible to enable it to pass victoriously through the ordeal by fire, the paucity of good makers becomes intelligible. The crucible should resist a high temperature without fusing or softening in a sensible degree; it should not be liable to break or crumble when grasped with the tongs; and it ought to be but little affected by the chemical action of the ashes of the fuel. Again, it might be required to withstand the corrosion and permeation of such matters as melted oxide of lead. In some cases crucibles should resist very sudden and great alternations of temperature so that they may be plunged, while cold, into a furnace nearly white-hot without cracking. In other cases, they are required to resist a high temperature after having been gradually heated. Some crucibles are specially remarkable for one quality, and others for another, so that in selecting them the conditions to which they will be exposed must be

* The word "crucible," from the Latin *crux—crucis,* recalls the alchemical practice of making the vessel with the protective sign of the Cross.

kept in view. The crucibles which present the finest combination of good qualities are those from which the Patent Plumbago Crucible Company takes its name. They support, even when of the largest size, the greatest and most sudden alternations of temperature without cracking; they can be used repeatedly, and their inner surface can be made so smooth that there is no fear of the particles of metal hanging about their sides. Their first cost is necessarily high, as plumbago is an expensive raw material; but the fact that they may be used for a great number of meltings makes them, in reality, cheaper than the ordinary clay pots. As fire-clay contracts considerably when exposed to a high temperature, it cannot be used alone for large crucibles. The so-called " clay crucibles" are made of a mixture of the plastic clay and some other substance, such as highly-burnt fire-clay, silica, or coke, which counteracts in a measure the evil due to contraction, and so lessens the tendency of the vessels to crack. The large Stourbridge clay crucibles so extensively employed by the brass-founders of Birmingham contain both burnt clay and coke. The Cornish and Hessian crucibles are made of peculiar kinds of clay, in admixture with sand. The great superiority of the plumbago crucibles over these can be easily accounted for by the fact that graphite or plumbago is the most infusible of all substances known, and at the same time a material that can be thoroughly incorporated with the clay without impairing its plasticity.

The works of the Patent Plumbago Crucible Company cover a large space of ground at Battersea, and have a good river frontage. As we proceed along the lane which leads from near Battersea Bridge, we find that the ground gets blacker and blacker, and before we reach the threshold of the office we notice the familiar black-lead polish beneath our feet. Passing a regiment of clerks, we enter the private office of the manager of the works, where we put on a very large coat and a very old hat, which are kept for the use of clean visitors. There are many things in this office which attract our attention. The walls are covered with testimonials from British and foreign mints respecting the excellence of the Company's manufactures, with here and there a prize medal. The International Exhibition of 1862 is recalled, not merely by the Prize Medals awarded to the Company for crucibles and black-leads, but also by the splendid samples of plumbago, which formed such a striking feature in Class I. In this collection every quality of plumbago is represented by specimens from all the most celebrated mines, particularly those of Ceylon, Germany, Spain, Siberia, Canada, Finland, and Borrowdale. We learn from the manager that some of the samples would not be adapted for the manufactures of the Company. The Siberian plumbago, for instance, contains too much iron, and although this could be entirely removed by the Company's patented process for purifying plumbago, it is found cheaper to work with the Ceylon plumbago, which contains but little iron.

Before we leave this snug office for the busy factory, we will jot down a few notes on plumbago, or, to use its more correct name,—graphite. The old mineralogists, misled by its remarkable metallic lustre, placed graphite among the metals, and at the present time there are doubtless many persons who accept "black-lead" as an appropriate name for this substance. In most dictionaries graphite is defined as "carburet of iron," in accordance with the opinion formerly held by most chemists that it was a compound of carbon and iron. This definition is now known to be incorrect, for, although iron is generally present in graphite, it must not be regarded as an essential constituent, any more than the silica or alumina which usually accompanies it. The iron, silica, and alumina, when present, are simply in a state of mixture, and not chemically combined. Graphite is one of the forms of *carbon*, that Protean element which also occurs native as the sparkling diamond and the black and lustrous anthracite, and which also appears in the familiar shapes of charcoal, coke, and lamp-black. According to Dr. Wood's analysis of a sample of the graphite used at these works, it contained upwards of 98 per cent. of pure carbon, the remainder being silica with mere traces of iron and alumina. Few samples have been found to contain less than 95 per cent. The variform character of carbon is exhibited by graphite itself, for it is sometimes crystalline and sometimes amorphous. The crystallised, or foliated graphite, is found occasionally in six-sided tabular crystals, but commonly in foliated or granular masses. It is chiefly obtained from Ceylon, where it is found imbedded in quartz. It is also found near Moreton Bay, in Australia; in the States of New York and Massachusets, and in Siberia. The amorphous graphite is that variety to which the terms "plumbago" and "black-lead" are ordinarily applied. It is much softer than the crystalline graphite, and makes a blacker streak on paper. Formerly it was obtained almost exclusively from Borrowdale, in Cumberland, but the mine there is nearly exhausted, and we believe is no longer worked. The bulk of that used at present comes from Germany, principally from Griesbach, near Passau. Both varieties are used in the manufactures of the Company; the crystalline for crucibles, and the amorphous for polishing powders.

The consumption of Ceylon graphite at the Battersea Works has had an extraordinary effect upon the price of the article. When the Company commenced business it cost about 10*l.* per ton, but now it cannot be bought at double that price. In Ceylon we hear that applications to dig graphite are daily on the increase, notwithstanding the rate of 14s. per ton which has to be paid as royalty at the Colombo Cutcherry. The following figures, giving the amount of revenue collected at Colombo and Galle, on account of royalty, in 1862 and 1863, clearly show the extraordinary increase in the demand for Ceylon graphite:—

	1862.			1863.			Increase.		
	£	s.	d.	£	s.	d.	£	s.	d.
Western Province.....	472	4	4	1,272	10	2	800	5	10
Southern Province....	112	2	8	282	8	5	170	5	9

The total quantity of graphite exported from Ceylon in 1862 was 40,895 cwt., of which no less than 34,730 cwt. was shipped to Great Britain. The Customs' returns for last year have not reached us. We do not wish it to be understood that the Patent Plumbago Crucible Company use up all the Ceylon graphite brought to the United Kingdom, but it is well-known that they are the principal consumers. We must now take leave of chemistry and statistics, and see what there is to be seen at the Black Potteries.

We commence our tour of inspection at the Receiving Stores, where we are shown the stock of raw material, which comprises at present about 2,000 casks of graphite, each one holding from four to five cwt. The heads of a couple of casks are broken open, in order that we may compare the hard iron-grey fragments of the Ceylon graphite with the black, dull, friable lumps of the German variety. A piece of the latter pressed between the finger and thumb feels pleasantly soft, and flattens readily into a lustrous cake. From the stores we pass to the engine-house, to take a peep at the prime mover of the machinery employed on the factory. One horizontal engine of 25-horse power serves to do all the work that does not require skilled hands.

The grinding-room contains several mills of different construction for grinding and mixing the materials of which the crucibles are formed. In one corner we see two huge stones chasing one another round a shaft, and pitilessly crushing the hard lumps of dried clay that are thrown in their path. Here we see a powerful mill for grinding the graphite, and an ordinary pug-mill for incorporating the graphite with the clays. The noise made by these machines is almost unbearable, but it is not only the noise we have to put up with. A brisk rattle is maintained by a number of workmen, who are occupied in sorting the pieces of graphite into different sizes and qualities by the aid of metallic sieves. When the graphite is reduced to powder, it is conveyed to the upper floor by an endless band-lift, and sifted by a contrivance similar to an ordinary flour-dressing machine. One of these machines is provided with a silk-gauze drum of remarkable fineness, and is reserved for the preparation of plumbago for anti-friction purposes.

Following the graphite to the upper floor, we enter the mixing-room, where the most important operation in the crucible manufacture is performed. A number of large bins, each containing a distinct variety of clay in powder, or a certain quality of plumbago, are ranged round the room. Upon the proportions of these several ingredients taken to form the mixture, or "metal" as it is technically termed, the quality of the crucibles depends. The actual proportions of Stourbridge and other clays used are of course kept secret. The ground graphite having been mixed with the clays, the whole is wetted with a sufficient quantity of water, and allowed to soak for some time. Having been "pugged" in the mill, the tempered "metal" is formed into blocks, and then placed in a store-room, where it is allowed to remain for several weeks.

We now enter the potter's room, where the crucibles are fashioned. This room might be a part of any large pottery were it not for the funereal hue of everything around. On each side are ranged the lathes or wheels, all driven by steam-power, but resembling in other respects the potter's wheel of the earliest ages. Let us watch the growth of one large crucible. The "thrower" takes the necessary quantity of "metal" and submits it to the operation of "wedging," which consists in tearing or cutting it into two pieces, and striking them together again with great force. This he repeats until the metal becomes perfectly tractable. He then dashes the mass upon the revolving disc of his lathe, and presses it with his wet hands till it assumes an irregular conical form. He then makes it take a variety of forms, with the object of getting rid of all air bubbles. It is impossible to follow the mass through its numerous changes, but suddenly, when we least expect it, it takes the shape of the crucible. This shape is very rude at first, but under the skilful hands of the thrower it soon becomes beautifully symmetrical. A wire guide is fixed at a certain height above, and at a certain distance from, the revolving mass, and to this the thrower gradually brings the edge of the crucible. With this simple guide he can make a dozen pots resembling each other so perfectly in shape and size, that the most experienced eye can hardly detect any variation in them. The skittle pots are made in precisely the same way, but are contracted at the mouth, after the inside has been properly shaped. Many of the fire-resisting goods manufactured by the Company are shaped by moulds, or by the aid of modelling tools. One of these miscellaneous articles which we see in course of construction is a large bath, five feet long by a foot and a half wide, intended to hold molten zinc. This we are told is for a French order.

We now follow the pots to the drying-room. Through the centre of this room the upper part of one of the kilns passes, and the heat which would otherwise be wasted is thus applied to a useful purpose. Here we find regiments of pots undergoing the drying process. Many of them have the graceful form of the once-celebrated Picardy pots, and are intended for the French mints. Though unbaked, each article that has remained sufficiently long in the room gives a clear metallic ring when struck.

The kilns are large conical chambers like those of ordinary potteries. The goods to be "fired" are packed in cylindrical cases of fire-clay called "seggars," and these are piled one above the other in the kiln like the basaltic columns of Staffa, and are luted closely together. These seggars protect the goods from the action of the air, which at a high temperature would have the effect of whitening their external surfaces, and so rendering them unsightly. We have the good fortune to be present as the workmen are engaged in emptying a kiln. We see that the crucibles come from their fire-clay cases exactly as they are sent out from the works. The absurd practice of giving plumbago crucibles a factitious polish and smoothness generally followed by Continental makers is not adopted by the Company.

From the kiln the goods are conveyed to the store-room, or to the packing-room if they have to be shipped at once. The goods are nearly always packed in old sugar hogsheads, which are strong, large, cheap, and plentiful. Turning out on to the wharf we see thirty of these hogsheads packed ready to be shipped for Vienna; and lying alongside, 150 cases containing crucibles for the Italian Government. These orders, not by any means unusual in magnitude, will enable our readers to form an idea of the scale upon which the operations of the Company are conducted.

We now cross the yard to the workshops of the Clay department, where various descriptions of crucibles are manufactured. The larger sizes, as in the case of plumbago crucibles, are made at the potter's wheel, but the smaller, in which the Company can successfully compete with the best French makers, are fashioned by beating the clay upon boxwood mandrils. The so-called "white-fluxing pots" are really beautiful specimens of earthenware, and are acknowledged by the best authorities on metallurgy to be very refractory, and to withstand the action of fluxes in a most remarkable manner. Every pot is made by gauge, and each moulder is consequently provided with a great number of pattern ribs cut from boxwood and ebony. The little crucibles used in assaying almost equal the German porcelain crucibles in thinness and smoothness. The smallest are not much more than an inch high. Besides crucibles, all kinds of clay instruments used in assaying are here manufactured, such as scorifiers, roasting dishes, and muffles. The convenient clay furnaces used by assayers, dentists, and experimental chemists, are also made in great numbers.

Let us now turn back to the store-rooms and look at a few of the curiosities that are to be found there. We have just been speaking of a crucible about an inch high. We notice one, of the pattern supplied to the Royal Mints, intended for melting 600 pounds' weight of silver. Here again is another plumbago pot, made specially for zincing the Armstrong shot, and which will hold 800 lbs. of molten zinc. The medium-sized plumbago pots now so extensively employed for melting silver, gold, copper, brass, and malleable iron, are, of course, the most important products of the works. All the pots are numbered according to their contents, each number standing for one kilogramme, or a little over two pounds; thus—a No. 2 crucible contains two kilogrammes; a No. 3, three kilogrammes, and so on. Covers, stands, and stirrers of plumbago are kept in stock with every conceivable article of fire-clay, from the huge glass pot down to the humble fire-ball for the parlour grate.

The graphite imported by the Company is not used solely in the manufacture of melting-pots and metallurgical apparatus. A good proportion of this valuable raw material is prepared for domestic purposes, and sent from the Battersea Works in the form of ordinary "black-lead." As this article is used wherever there is a grate or stove to be kept bright, its annual consumption must be very large. There is no substitute for it—nothing that can be employed in the same way to polish and protect the ironwork of common fire-places. Without the factitious lustre produced by the action of "elbow-grease" on black-lead, the most elaborate kitchen range would soon become unsightly, the trim parlour grate would blush with rust, and the cottager's "wee bit ingle" would leave off "blinkin' bonnily."

The various qualities of black lead which the Company sends into the market under different fanciful names are all prepared from graphite or plumbago, and nothing else. The higher qualities are distinguished from the lower by their superior fineness, softness, and lustre; but chemically they are identical. The article sold under the sentimental name of "Servants' Friend" at 28s. per cwt. is quite as pure as the "Prize Medal Lustre," which fetches double the price, or "Halse's Roman Lustre," the best quality of black lead manufactured by the Company. Again, the analytical chemist would fail to detect any essential difference between either of the above-named products and the article labelled "carburet of iron," in remembrance of the exploded opinion respecting the nature of graphite. How comes it, then, that one quality is so much superior to another? The explanation is simple enough. The differences in the manufactured article may be traced to certain variations in the physical properties of the raw material. Thus one sample of graphite may be soft and lustrous, while another, equally pure, may be hard and dull. These variations are subordinate to the distinction between amorphous and crystallized graphite, to which we have already referred. For making domestic black lead, the amorphous or soft graphite is almost exclusively used.

The separation of the different qualities of graphite is a labour which demands great experience and judgment, and can only be successfully performed by the old hands. The best pieces are soft and unctious, perfectly free from grit, and capable of receiving a very high polish. The worst pieces, technically called "gruffs," are, on the contrary, harsh, gritty, and deficient in lustre. The latter are only employed for making "leads" of the lowest brands. The numerous intermediate qualities are distinguished one from another by characters which are only apparent to the experienced eye.

The manufacture of black leads includes three distinct operations—grinding, sifting, and packing. At the Battersea Works, the first operation is performed by means of a large mill driven by steam power. The ground "lead" is conveyed to an upper floor by an endless-band elevator, and is then sifted through the finest silk in the simple dressing machine already noticed. The packing is chiefly done by boys, who work with marvellous rapidity. The powdered black leads are done up in neat packets in quantities from two ounces upwards; they are also packed in 1-lb. tin canisters and in wood boxes. Papers of various colours are used to form the small packets, so that the different qualities may be readily distinguished. A paper covered on one side with burnished black lead is employed for wrapping up some of the higher qualities.

Two descriptions of "blocked black lead" are manufactured by the Company. The blocks are formed by pressing the powdered and sifted graphite into suitable moulds by the aid of machinery, very similar in construction to that employed for making bricks, though, of course, on a much smaller scale. There are two blocking-machines constantly at work, and the number of little bricks they turn out annually would amply suffice for the building of a Lilliputian city.

The organization of labour is thoroughly understood at the Battersea Works. There is a place for every man and every man is in his place. A strict code of rules is enforced by fines ; but these fines are paid over to the Fund of the Workmen's Provident Club. We have been over many great industrial establishments, but have not seen any better managed than this Crucible factory.

A few days after writing the above we paid a visit to the establishment of Messrs. Brown and Wingrove, the refiners to the Bank of England, where we saw a hundred ounces of silver poured out from a plumbago crucible which had been used again and again. Here, indeed, as at many other great establishments, the Patent Plumbago Crucibles are alone used. We were informed by the courteous manager of the refinery, that the pots never cracked, but gradually became thinner until a point was reached, when it would be unsafe to trust a charge in them. He assured us that 50,000 ounces of silver and upwards had been melted in one 1000-oz. pot. We were glad to receive such good testimony to the value of the plumbago crucibles, for all that we saw at Battersea gave us a most favourable impression of the manufactures of the Company.

NOTES ON SOME AFRICAN VEGETABLE PRODUCTS.

BY JOHN R. JACKSON.

That a nation's wealth is derived from its natural resources is a truism more or less truthful according to the geographical disposition of the nation referred to. The natural productions of one land tend to alleviate the wants and necessities of another not so highly favoured, thereby establishing a system of exchange and communication known to us in this busy world by the short, but comprehensive word, *Commerce*, and every day fulfilling with greater truthfulness the words of

Cowper, so significantly set forth in the year 1862, that "Each climate needs what other climes produce." Though the products of each nation or country may be vast and extensive in itself, it is alone by the system of freedom in trade and navigation from one port to another that the prosperity of a nation greatly depends. The British Colonies and dependencies furnish us directly with many of our most valuable and indispensable requisites, and continental and other countries receive from us, indirectly, the same kind of valuable commodities. Though in this age of research and enterprise much has been said upon utilising and economising substances and products which men have hitherto passed over unheeded, little good has yet been practically effected. The duty has been thoroughly performed, by a few thoughtful minds, of bringing such substances prominently before the notice of those who have capital to test their worth, and the effects, though not apparent now, will no doubt show themselves in the days of a future generation. Much has been done in another field, that of geographical exploration, the results of which, in some cases, have been advantageous, in others but doubtful, though they are the means alone whereby we can obtain a knowledge of the natural productions of obscure countries, and determine the probability of their future application in the arts and manufactures of civilised nations. In the vegetable world much, even in our own land, lies hidden from the eye of application, and this is more or less the case, in every country, in proportion as the resources are small or great.

In the following notes upon African products, some of which have recently come under my notice, I am not led into the belief that all may become great commercial speculations; indeed, many of them are already known. The difficulty of opening a free communication with the interior of Africa is not a new fact. The power of the Portuguese on the Eastern Coast, and the difficulty of obtaining labour, which is so great a drawback in many countries (even in the Australian colonies), as well as the difficulty attending the transit, all militate strongly against the prospect of the interior of Africa opening in our day a free trading communication. Some of the products here enumerated are only known to be in use amongst the natives, but their economic value is very apparent. They produce some of their brightest and best colours for dyeing their mats, &c., from woods, barks, seeds, roots, &c., and these colours are mostly fixed without the aid of mordants (the knowledge of the use of which is quite unknown to them). One of the best dye-woods found on the Zambesi is a species of *Cudrania*, a plant closely allied to the Fustic of Commerce. This is a common climbing shrub. The colouring principle seems to be as fully developed as in the wood of *Maclura*. It is the heart wood from which the dye is obtained, though the bark is of a very bright yellow, and of a considerable thickness, running in deep ridges in a slightly spiral direction. The external covering is of a dusky brown colour, very thin, which, upon peeling off, exposes a very bright yellow bark, and this appears to be composed of thin layers of a papery nature similar to birch bark. These are of the brightest yellow, but no colour can be extracted from them; that which is contained in the wood itself would seem to be in the form of a resinous secretion. By the use of alum as a mordant, a good durable colour can be obtained. What is a most singular fact is, that having this dye-wood so easily accessible, they get the bulk of their yellow dye from other sources. The pretty baskets, hats, and ornamental articles in the manufacture of which they are so clever, and which are plaited with the leaves of the native date palm (*Phœnix spinosa*), are always composed of three colours—black, red, and yellow—very harmoniously interwoven. These colours are extracted from the barks of three distinct trees, and are very apparent, even in the outer bark; indeed, the colours of the barks are almost as distinct as when extracted. The colours are obtained probably in the most simple manner, that of boiling the bark. Specimens of these woods with the bark upon them, together with articles dyed with them, are in the valuable collection at Kew, and were brought home by Dr. Kirk, the indefatigable collector and medical officer to the Zambesi Expedition. It is to be regretted that he was unable to obtain specimens of the leaves and flowers of each, whereby to determine their scientific nomenclature, but the difficulties to be encountered in collecting in uncivilised Africa are not a few. Many things obtainable through the instrumentality of the natives are extremely difficult to trace to their right source.

In Soudan the roots of *Cochlospermum Planchoni*, Hook. fil., are much used as a dyeing agent, a good yellow colour being easily extracted from them. This is probably the source from whence is obtained the yellow colouring matter of the mats and baskets of the people of this coast. They employ the leaves of *Phœnix spinosa* in a similar manner to those of the East Coast. By the ingenuity of these people many other plants are made to yield dyes for their own domestic uses. A species of Sorghum (*S. vulgare*, Pers.), which would appear common to both the East and West, gives a crimson colour, from the sheathing base of the leaves; and the mode of extracting it seems equally well-known to the natives of both sides of Africa. On the Niger it is much used for dyeing mats, nets, cotton fabrics, &c.

In Sierra Leone a yellow dye is obtained from the bark of a shrub *Cœlocline polycarpa*, Hook. fil., and is called "yellow Gbeyido bark." All sorts of things are used as dyes in various parts of Africa; in fact, anything from which a colour can be extracted. The wood of a species of *Afzelia* is used on the Rovuma for dyeing black. Pods of species of *Acacia* are made in that part of Africa to give a brown colour to their black cloths. Orchella weed is one of the largest articles of commerce in dye-stuffs imported from Africa, and it would seem to grow almost universally in any favourable situation as far in the interior as has yet been explored. Barwood and camwood are also exported from the West Coast into Liverpool, and are used in this country for dyeing red. The bright red of the English bandana handkerchiefs is procured from the latter wood. Both woods are the produce of one tree, and the commercial difference would seem to be selected varieties according to the amount of colour contained in them, camwood fetching in the markets nearly four times the price of barwood. The wood is occasionally used for turning small articles, and also for the smaller kinds of furniture work. Turmeric is likewise used by the natives of South-Western Africa as a dye, while *Henna*, the powdered leaves of *Lawsonia inermis*, is known by them as well as by the natives of the more ancient and historical Egypt.

Of fruits, seeds, &c., having oleaginous properties, there are many. Cocoa-nut, sesamum, and ground-nuts are all articles of export from Zanzibar, chiefly to Marseilles. The cocoa-nut grows in immense forests. The oil is not expressed for exportation, but the dry copperah is sent in large quantities for expression by European machinery ; a large trade is also done in the seed of the sesamum (*Sesamum Indica*), and ground-nuts (*Arachis hypogeæa*). Both these oils are well-known in this country, as much in the manufacture of soap as for burning in lamps ; sesamum oil is also much employed for adulterating olive oil. The principal African oil seed, however, is that now so well-known and so extensively used in the manufacture of candles, the *Elais guineensis.* This is a native of Western Africa, and is imported into Liverpool in immense quantities. The introduction of this oil by Price's Patent Candle Company has been the means of giving employment to thousands in this country as well as of establishing a profitable speculation in Western Africa, and in some measure supplanting the slave traffic. Of seeds which are at present quite unknown in commerce, but which would appear to have great claims upon the attention of the soap and candle maker, may be mentioned, firstly, those of *Trichilia capitata*, known on the Zambesi as "Motsakiri" seeds ; these are small black seeds, about half an inch long, and contain a large quantity of solid fat, which would no doubt prove a valuable addition to our oil seeds were they exported. These seeds are the produce of a large, handsome tree, growing abundantly in the vicinity of rivers. The natives apply the wood to the manufacture of small canoes. The castor oil is also found growing wild in this part of Africa, and attains a height of from 12 to 14 feet. On the west side of Lake Nyassa, Dr. Kirk discovered a small oil palm, in habit quite unlike that of the West Coast, but more resembling the date palm. The albumen was found to contain an abundance of oil, very similar to palm oil. It is not known to be in use in any way whatever amongst the natives. The tree, which grows to about 40 feet high, was not seen in great abundance anywhere. A nut, much resembling an almond, both in shape and size, and called by the natives "Boma nut," yields an abundance of a sweet fluid oil, much used by the natives in their cooking. The fruit itself, with the fleshy covering, is about the size of a walnut. The natives cultivate the trees abundantly near the Victoria Falls. It is also found in the Shire Valley, but does not extend further south than Lake Ngami; it is probably a species of *Vitex*.

Moringa pterygosperma, Gærtn., is another good oil seed, but it is found only in the neighbourhood of villages, and has probably been introduced. In Western Africa the seeds of *Carapa guineensis*, Don., furnish an oil much in use amongst the natives for burning in lamps, and also for anointing their bodies. In Sierra Leone it is given as a purgative medicine, one teaspoonful being considered a dose. It is imported into the south of France for soap-making. The seeds of *Carapa Touloucouna*, Guib. et Pert., also contain a large quantity of oil, the residual nut, after expression, making a good oil cake for cattle. This plant is a native of Senegambia. The seeds of the *Bassia Parkii*, Don., are well-known as furnishing the shea butter of Western Africa. Mungo Park, in writing of this vegetable fat, says that the natives were then "employed everywhere in collecting the fruit of the shea-trees." The butter or fat, which is contained in large quantities in the seeds, is extracted by boiling in water, and is afterwards bleached. This butter is in great request by the natives for many domestic uses, and it forms one of the principal articles of inland commerce. The above-mentioned writer, speaking in high praise of the delicious flavour of this butter, says, "It is whiter, firmer, and, to my palate, a better flavour, than the best butter I ever tasted made of cows' milk." I cannot, however, bear out this testimony, except as to its firmness and whiteness, for the specimens which I have had the opportunity of tasting have been of the most rank and disgusting flavour, though it is said it will keep perfectly sweet for several months; but if this butter or fat is not suited to a refined palate, it seems to have many advantages as an article of commerce, and would no doubt prove a valuable import for the purposes of soap and candle making.

Of African edible fruits and seeds, one could almost go on to infinity, for there are few indigenous that are not eaten by the natives in some form or another. The blood plum of Sierra Leone, (*Hæmatostaphis Barteri*, Hook. fil.,) has a pleasant sub-acid flavour when ripe. In size and form it is similar to a grape, but somewhat larger. Another fruit of the same shape and form, but smaller and with less pulp, is considered a favourite fruit on the Niger; it is a species of *Vitex*. The fruit of *Sarcocephalus esculentus*, Afzl., called in Sierra Leone "native peach," is, when fully grown, about the size of a large apple. It is of a pulpy nature; the outside is rough and uneven and bears some resemblance to a custard apple (*Anona*). The pulp of the Baobab (*Adansonia digitata*, L.), has a very pleasant and agreeable sub-acid flavour, and is much esteemed by the natives in making a kind of sherbet or cooling drink. *Detarium senegalense*, G. et P., called *Dattock* on the Gambia, where it grows to an immense tree, produces a fruit, the pulp of which is eaten, as well as the kernel or seed. In size and shape it is like a large chestnut;

the outer skin is of a dark dull brown. The small pod of *Codarium acutifolium*, Afzl., is remarkable for its velvet appearance ; hence it is sometimes called velvet tamarind, and is also known as black tamarinds. The pulp enveloping the seed has quite the flavour of East Indian tamarinds, and is valued by the natives of Sierra Leone on that account. The ochro (*Abelmoschus esculentus*, Med.) is common on the Niger, and is used on account of its mucilaginous properties in various ways, in the preparation of native dishes. The seeds of a species of *Triculia* are also eaten in this part of Africa ; the fruit is very similar to the bread-fruit, to which it is closely allied. Its size is about that of a child's head ; the seeds are small and hard ; the native name is "Akna." The fruits of *Habzelia Æthiopica*, D.C., are used as pepper, and are sold in the markets at Nupé as well as at Bahia. The seeds of *Monodora grandiflora*, Bth., *M. tenuifolia*, Bth., and *M. brevipes*, Benth., are all more or less aromatic, and would seem to be well adapted, if shipped in any quantity, for a useful condiment in this country. Many of the *Anonaceæ* have the same decided fragrance, but none so powerful as in this genus. The fruits are very large and round ; those of *M. grandiflora* quite the size of a large cannon ball, the other species somewhat smaller. The seeds are about the size of a common scarlet runner bean, and are very thickly embedded in the pulp, which fills up the interior of the fruit. The fruits of the wild mango, probably a species of *Spondias*, are eaten on the Niger, and on the Zambesi the kernels of a species of *Sclerocarya*. The stones of this fruit, however, are very hard and difficult to crack ; these kernels appear to contain a quantity of oil, and perhaps might be turned to account in that way. The fruit of *Malpighia saccharina*, called in Sierra Leone the Sugar Plum, in shape and size much resembles the Damson. It has a sweet and agreeable flavour, and is in perfection in the months of February and March, when it is to be seen in large quantities in the market of Freetown. The tree producing it is lofty and majestic in appearance, attaining a height of 80 feet. The large seeds of *Pentaclethra macrophylla*, Bth., known in the Eboe country as "Opachalo," and in Gaboon as "Owala," are collected at the seasons of their falling, and eaten as food ; they also yield a clear, limpid oil. The young germinating shoots of *Borassus Æthiopum*, Mart., are eaten by the natives both of East and West Africa ; for this purpose they are taken up soon after the seed has vegetated, and are then boiled in a similar manner as we cook cabbages or some such vegetable. The large seeds of *Cycas circinalis*, L., from which the natives of Ceylon and Western India prepare a kind of Sago, are valued as an article of food in some parts of the Zambesi. The existence of a species of *Cycas* was discovered in Western Africa by the botanist of the Second Niger Expedition, as well as by the subsequent botanist, Gustav Mann, both of whom found the natives applied the seeds as an article of food. Of the Dika or Udika bread, a specimen of which arrived in this country some three or four years since, and was then supposed to be procured from the seeds of *Mangifera gabonensis*, it will be sufficient to say that, upon further researches, it is proved to be from no Mango, but from the seeds of *Irvingia Barteri*, Hook. fil. The fruit is similar in form and size to that of the Mango, but the seeds, which contain a large amount of oil, are separated from the fruits, and beaten in a trough till they attain a partially fluid state. This is then put into baskets of Musa leaves, and exposed to the sun, when a white tallow collects on the surface, which is poured off, and the Dika allowed to cool in the shade. The natives esteem it very highly in the various preparations of their food, but more especially in cooking fish. It has, however, a strong, rank, and highly disagreeable taste.

The fruit of a species of *Parinarium*, known on the Zambesi as "Mobola," is valued on account of the very sweet pulp which surrounds the seeds. The Gero corn (*Penicillaria spicata*, Willd.) is in common use, for household purposes, on the Niger and Gambia. The seeds of *Sorghum vulgare*, Pers., are also extensively used for preparing as malt. The fibrous plants, both of the Eastern and Western Coasts, are worth more attention than has hitherto been given to them. On the East there is the Baobab (*Adansonia digitata*, L.), a good tough, strong fibre—so strong, indeed, as to be the material from which the nets used to catch antelopes are always made. Then the *Sanseviera guineensis* furnishes a strong and durable fibre. The abundance of fibre capable of being obtained from the "Buaze," probably two species of *Lophostyles* (*L. longifolia* and *L. angustifolia*), would seem to give it a claim to be classed among the fibrous plants of commerce. Experiments were made with this fibre, some few years back, by Messrs. Pye, Brothers, who reported very favourably upon it, but since then it has been quite lost sight of in the commercial world. A notice of it, as well as Messrs. Pye's report, were published in Dr. Livingstone's book. The well-known fibrous plant, *Paritium tiliaceum*, St. Hil., also grows in this part of Africa, while, on the West Coast, are several good fibre-yielding plants. The fibre obtained from *Vigna Catjang*, Walp., is very strong and tough, and is procured by beating the stem.

These are but a few of the many apparently useful plants of the great African Continent which, if brought within the range of commercial enterprise, would undoubtedly prove valuable.

INDUSTRIAL MUSEUM, LEEDS.

The Philosophical and Literary Society of Leeds have recently rebuilt and greatly enlarged their Museum.

This opportunity was embraced by some members to urge the claims of Technology to be represented. Hence, a commodious room has been devoted to the purposes of an Industrial Museum, and fitted uniformly with glazed cases of French-polished deal. The South Kensington Museum has presented a set of duplicate specimens of a miscellaneous character, being objects from the International Exhibition of 1862. The town is, however, well able to furnish a large collection of interesting objects from its own multifarious branches of industry.

To suppose that Leeds is one great woollen warehouse is a mistake. During the meeting of the British Association in 1858, there was an Exhibition of Local Industry, which well illustrated the very numerous arts carried on in Leeds, and with which the late lamented Prince Consort expressed much gratification upon the occasion when he visited it. That the general public appreciated it was shown by its being crowded nightly for many weeks, and by a balance of 600*l.* to 700*l.* net profit which remained after paying all expenses. It was mainly to the energy of the chairman of the Chamber of Commerce, Darnton Lupton, Esq., that this success was due.

The chairman, Thos. Nunneley, Esq., F.R.C.S., and the committee of the Industrial Museum now forming indicate the following as the objects which it is proposed to include—viz.:

1. A Food Collection.
2. A Collection of Raw Products proposed for industrial uses.
3. A Collection illustrating the technical applications of products of the Animal Kingdom.

4 and 5. Two series holding similar relations to the Vegetable and Mineral Kingdom.

6. Illustrations of processes not included in the above classes.

They proceed to state their belief—"That such a collection may have a high practical value, as affording both scientific and commercial information respecting matters used or capable of being used in the multifarious manufactures of this district. To represent the operations of our local industry, with especial completeness, will be a leading object."

The following "General Information for the Guidance of Contributors" is appended to the form of application for specimens:—

1. The room devoted to the Industrial Collection has been uniformly fitted with glazed cases for the reception of specimens. These include wall-cases (ten inches from back to front) and desk-shaped cases (five to eight inches deep).

2. The object of the Collection being to instruct, systematic arrangement is needful to this end. In the instance of manufactured goods a series of specimens should commence with the raw material, following this by illustrations of the successive results of each operation to which it is submitted, until the final product is reached. Where any waste or bye-products are formed they should be shown. There is more risk of exhibiting too few stages of manufacture than too many.

3. Great economy of space is needful. Hence, specimens should be the smallest that are consistent with efficiently carrying out the foregoing.

4. Contributors will please affix to each specimen a brief descriptive

label, and the Committee propose to copy these upon uniform labels provided for the purpose. The names of contributors will be stated.

5. Upon application at the Philosophical Hall, Mr. Denny will show the room, cases, &c. The Committee will also have pleasure in giving any further information desired.

We have much pleasure in noticing this planting of a germ of our own science, Technology, in such favourable soil, where it is jointly fostered by the representatives of the Natural History Science, and by the practical business men who belong to the Chamber of Commerce.

This is as it should be, and we shall be much mistaken if the general public do not find in this new department an important addition to the treasures of the already admirable Museum, which is always open to them by the payment of one penny.

Scientific Notes.

Utilisation of Brine.—Another has just been added to the many instances in which purely scientific research has led to the development of the arts and manufactures. Mr. Alexander Whitelaw, of Glasgow, has invented and patented a process for the treatment of the hitherto waste brine of salted meat, so as to produce therefrom nutritive and wholesome extract of meat and portable soup. His process is the first practical application of Mr. Graham, the Master of the Mint's recently-made, curious, and interesting discovery of "dialysis." Mr. Graham, after pursuing those elaborate investigations on liquid diffusion that have occupied him for many years, found, that when animal membranes (as well as some other bodies of a similar nature) were interposed between solutions of various substances and water, that "chrystallized" bodies freely diffused themselves through the membrane into the water; but to "colloid" bodies, such as gum, albumen, &c., the merest film of such a membrane presented an almost impassable barrier. Mr. Whitelaw has availed himself of this principle in his process, which is of the simplest character. He can conduct the dialytic operation in vessels of various forms and materials, but the arrangement he prefers to employ as being in every respect practically the best, is a series of bladders, fitted with gutta percha necks and plugs. These bladders are filled with the previously filtered brine, and hung in rows from poles stretching across and suspended into vats of water. The water is renewed in these vats once or twice a day, and the action allowed to go on; when, at the end of the third or fourth day, it will be found that nearly all the salt and nitre of the brine have been removed, and that the liquid contained in the bladders is pure juice of flesh in a fresh and wholesome condition.

This juice, as obtained from the "dialysers," may now be employed in making rich soups without any further preparation; or it may be evaporated to a less or more concentrated state, and packed in hermetically sealed tins for sale. The extract of meat thus obtained is in the highest degree nutritive and wholesome, and well adapted for hospitals, for ships' use, and for an army in the field.

Mr. Whitelaw has also adapted his process for the use of ships at sea, for the economisation of their brine, and for the improvement of the food, and, consequently, the health of the men.

The quantity of brine annually wasted is very great. In Glasgow alone not less than 60,000 to 100,000 gallons are thrown away yearly; and if we take each gallon as equal in soup-producing power to 7 lbs. of beef, some idea may be formed of the economic value of this process.

The Madagascar Silkworm.—No country in the world appears more eminently qualified by nature for the production of silk than the island of Madagascar. Most of the caterpillars of the country cover themselves with silky envelopes, which protect them from the inclemency of winter and the sudden showers of the summer season. Some are naturally covered from their birth with a thick mantle, which grows with them, leaving only the head and legs uncovered. Others spin double and treble cocoons, and others again mix up various particles of plants with their silk, combining them artistically; and, lastly, there are some which spin a common nest, in which they live under a republican form of government, each individual spinning its own cocoon besides. The 'Bulletin de la Société d'Acclimitation' contains a curious paper on this subject, by M. Auguste Vinson, of La Réunion. He states that the Hovas weave a kind of silk which they call *landy;* and is obtained from the worm that feeds on the leaves of ambrevade, or Angola pea (*Cytisus Cajanus*). This silk is heavy, and has no gloss, but is exceedingly strong. The natives sell the tissues they weave out of this silk very dear, and it is therefore only the rich who wear them. King Radama II., who dresses in the European fashion, wears trousers and a paletôt made of this silk, which, not being dyed, is of a gray colour, like unbleached linen. The wealthy are buried in shrouds made of this silk, and it is said that such shrouds entombed for centuries have been exhumed in a perfect state of preservation. The ambrevade being an indigenous plant of La Réunion, this Madagascar silkworm might be easily introduced there. The insect is forty-five millimetres long; its body is composed of twelve segments, and covered with black sharp horny points all over. The general hue is a chestnut-brown, but the abdomen has a longitudinal rose-coloured streak between two other light brown ones. The cocoon is seventy millimetres in circumference, and forty-five in length; it is very heavy, of a dirty gray colour, but interspersed with black bristles. The chrysalis contained in the cocoon is edible, and considered a delicacy by the Hovas, who eat it fried, as the Chinese do chrysalids.

THE TECHNOLOGIST.

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THE TIMBER TREES OF CEYLON.

BY W. FERGUSON, F.L.S.

(Concluded from page 414.)

COMPOSITÆ.

Vernonia Javanica, D.C. "Kobo-Neela," S.—A large forest tree, 50 to 60 feet high. Timber light and spongy; flowers delightfully fragrant, and much frequented by the wild honey-bees.

GOODENOVEIÆ.

Scoevola Plumieri, Vahl. "Maha-takkada," S.—A sea-side plant, from the large white pith of which ornaments are made.

MYRSINACEÆ.

Moesa Indica, And. Dec. "Moeti-bembiya," S.—A small and common tree of the interior.

ÆGICERACEÆ.

Ægiceras majus, Gaert. "Heen-kadol," S.—A small tree, growing in salt marshy places with the mangroves. Wood light and soft.

SAPOTACEÆ.

Chrysophyllum Roxburghii, Don. "Lawulu," S.—A common tree near the coast. Timber for common house-buildings; fruits eaten.

Sapota elengioides, A. Dec.—One of the timber trees of India; grows in the hottest parts of the island.

Mimusops Elengi, Linn. "Moona-mal," S.; "Macharla-marum," T.—Much grown as an ornamental tree, with most fragrant flowers; wood used for house-buildings and furniture.

M. Indica, A. Dec.; *M. hexandra*, Moon. "Palu-gaha," S.; "Palimarum," T.—An abuudant forest tree, towards the north of the island. One of the best timbers, and most known under its native names, and much confounded with the real irou wood (*Mesua ferrea*). Timber extremely hard, strong, and durable; used for oil-presses, bridges, house-buildings, &c., and next in value to the Hal-milille (*Berrya ammonilla*).

Bassia longifolia, Linn. "Telmee-gaha," S.; "Illupei," T.—A most useful tree; large quantities of oil made from its fruits by the natives. Timber used for keels for dhonies, bridges, and house-buildings; very much cultivated.

Dasyaulus neriifolius, Thw. "Ganmu," S.—Timber useful for common purposes. A common tree, left for shade in the various cinnamon gardens.

Isonandra grandis, Thw. "Mieria-gas," S.

Bassia latifolia, Moon. "Kiri-hæmbiliya," S.—Central Province and Saffragam. An oil extracted from the seed of the tree, like that of the Illupei.

EBENACEÆ.

Diospyros embryopteris, Pers. "Maha-timbiri," S.; "Paniche," or "Toombika," Tam.—Wood used for buildings, but of indifferent quality. Every part of the tree used medicinally, or in the arts. Juice of the fruit very glutinous, and charged with tannic acid; used by the natives for paying the seams of fishing-boats, and for preserving their lines and nets. In Ceylon this tree is converted into masts, yards, &c., for country vessels, and the natives consider it the best sort of all the jungle-woods for that purpose.

D. cordifolia, Roxb. "Vuckuna-marum," T.—Growing in Jaffna. A hard, heavy wood; colour brown; said to be very strong, but difficult to work.

D. sylvatica, Roxb. "Sudu-kadumberia," S.—Grows in Hantanne and Ratuapoora, up to 4,000 feet. Wood whitish and very hard; used for fancy work.

D. Toposia, Ham. "Kahakala," S.—A middle-sized tree, not uncommon in damp forests, up to an elevation of 4,000 feet. Timber used for faucy cabinet-work.

D. cruminata, Thw., in the Central Province, at 2,000 and 4,000 feet; and *D. affinis*, Thw., on the lower road from Kandy to Badulla.—The timber of both these is suitable for building purposes.

D. quesita, Thw.; *D. hirsuta*, Moon. "Kalumædirya," S. Singherajah and other forests between Ratnapoora and Galle.—This species produces the most valuable of the timber known as Calamander wood, so much esteemed for ornamental cabinet-work. Nearly allied to *D. cruminata*, but its longer leaves and fruit, and its pentamerous flowers, will distinguish it. The variegated part so much in request is an accidental produce of the tree, some trees producing none of it—

some near the lower part of the trunk, whilst in others it is found only near the middle of the trees, and generally not in luxuriant trees growing in rich soil, but in those growing in dry, rocky ground. These remarks apply to several of the trees producing variegated or ornamental woods, such as the Tamarind, in which the beautiful Calamander-like wood is found only in very old trees, and generally in the heart of the lower part of the trunk, or in the roots; and the differences of soil, climate, and situation have such an effect on the timber of the same species of tree, that unless these facts are taken into account respecting the specimens used as tests, the tables of strength and weight per cubic foot, specific gravity, &c., are not to be depended upon. Again, the times of felling, mode of seasoning, &c., should also be taken into consideration.

D. Ebenum, Retz. "Kaluwara," S.; "Acha-marum," "Karungaly," and "Chararum," T., are the names given to this or some of the other trees which produce Ebony. This tree yields the best kind of ebony-wood, and, according to Thwaites, it is not uncommon up to an elevation of 5,000 feet.

Ebony, like iron-wood of different kinds, is procured from several trees, and in several parts of the world. The late Dr. Roxburgh, in writing about this tree, remarked:—"There are many species of this extensive genus (*Diospyros*) which yield a hard, black wood. I mean pure, intensely black (not variegated), to all of which we give the general appellation, Ebony. My *D. melanoxylon* is one, this one a second, *Ebenus* of Rumphius a third, from all of which I know that of the Naini trees differs essentially, whilst the mountains of Bengal, &c., produce another very distinct species—viz., *D. tomentosum*.*

The genera *Dombeya*, *Dalbergia*, *Bauhinia*, and others, produce different sorts of Ebony.

For two arm-chairs of this wood, sent home by the late Mr. Kenneth Mackenzie, Assistant Colonial Secretary, to his father, 50*l.* was offered in Scotland. The wood is so hard and difficult to work, except by those acquainted with it, that the local cabinet-maker who was employed to put castors on these two chairs gave up the job after putting castors on one, and breaking all his ordinary tools in the undertaking. The wood is so heavy, that nearly all the ships leaving Ceylon take a quantity of it in their holds, as ballast, beneath the lighter cargo of oil, coffee, &c.

D. oocarpa, Thw. "Kalu-kadumberia," S., Kornegalle district, and at Haragam, near Kandy.—Judging from its Singhalese name, the wood of this tree is likely to be fit for cabinet purposes.

D. insignis, Thw. "Gonna-gaha," S.—Damp forests, up to an elevation of 3,000 feet A valuable timber tree.

D. oppositifolia, Thw. "Kalu-mædirya," S.—Hinidoon Corle, up

* "Flora Indica," ii., p. 530.

to an elevation of 1,000 feet. Timber much resembles Calamander wood.

D. Gardneri, Thw. "Kadumberia," S.—Saffragam and Kornegalle districts, and less commonly near Kandy. Timber valuable for building and cabinet work.

D. ovalifolia, Wight.—Jaffna, Central Province, at Hewahette and below Happootella, at an elevation of 2,000 to 4,000 feet.

D. Candolleana, Wight. "Homædirya," S.—Saffragam and Hinidoon Corle.

D. hirsuta, Linn. fil.—Saffragam and Galle districts. Confounded by Moon with the real Calamander-wood tree.

D. Moonii, *D. acuta*, and *D. attenuata*, are three new species by Thwaites, found in Caltura and Pasdoon Corle, to the timber of which no quality is assigned.

Maba buxifolia, Persoon. "Kahula-baraliya," S.—Iron-wood of the Tamils. Wood dark-coloured, remarkably hard, and durable. It is employed for such uses, when its size will admit, as require the most durable heavy wood.

AQUIFOLIACEÆ.

Ilex Wightiana, Wall. "Andung Waenna," S.—A common tree near Colombo, and up to an elevation of 4,000 feet, also, on the Neilgherries. In Colombo, the tree does not exceed eight to ten inches in diameter; but Dr. Wight measured one on the Neilgherries which was eighteen feet in circumference six feet from the ground, or six feet in diameter. The wood is of a light colour, used for roofs and common purposes. The fibre is remarkable for being of a deep purple colour.

SYMPLOCEÆ.

Symplocos spicata, Roxb.—A common tree from the coast, up to 7,000 feet. Timber used for common house-buildings. There are fifteen other species of this genus in Thwaites' enumeration, most of them new; and it is probable that several of them produce serviceable timber.

OLEACEÆ.

Olea dioica, Roxb.—A native of Silhet and Chittagong, where it grows to be a pretty large tree, produces timber which is reckoned excellent, and is applied to many uses by the natives; but our two Ceylon species are rather too small to produce valuable timber.

Ligustrum robustum, Blume.—Central Province, up to an elevation of 5,000 feet; common in the Happootella district. In Silhet it grows to be a very large tree, and furnishes the natives with very hard, durable wood. Bits of its bark are put into the toddy of the *Caryota urens* in Ceylon, to make it ferment.

Chionanthus zeylanica, Willd. "Gericœta," S.—A common, small tree near the coast; wood used for ordinary house-work.

JASMINACEÆ.

Nyctanthes arbortristis, Linn. "Sepala," or "Sepalika-gaha," S.; "Pagala-mulley," T.—Common as a cultivated plant. Bark used for tanning, and flowers for dyeing. Wood hard and useful, but does not attain much size. Leaves rough, like sand-paper.

Schrebera swietenoides, Roxb. "Mogalinga-marum," T.—A large timber tree, native of India. Wood of a grey colour, very close-grained, hard, and durable; used for a great variety of purposes; and not being liable to warp or bend, is in request by weavers for the beams of their looms.

SALVADORACEÆ.

Salvadorà Wightiana, Planch. "Ooghai," T.—A common, small tree on the coast from Matura round by Trincomalie to Jaffna. The fresh bark of the root acts as a blister, the berries taste like garden-cress. This, or another species of the genus, is supposed to be the mustard-tree of the Bible.

APOCYNACEÆ.

Hunteria zeylanica, Gard.; *Cameraria oppositifolia*, Moon.—A small tree, from the coast up to an elevation of 2,000 feet. In every respect the wood of this tree resembles that of the box more than any other I have ever seen. Answers well for engraving purposes. Mr. Oondatjee, who found it at Badulla, brought it into notice as a wood fit for the engraver.

Cerbera odollam, Gaert. "Gon-kadura," S.; "Kadoo-ma," T.—Near the coast as a fence tree. Wood soft and white, used for charcoal.

Ochrosia Borbonica, Gmel. "Moodu-kadura," S.—A small sea-side tree, as its native name implies. Wood like the above.

Tabernœmonta dichotoma, Roxb. "Diwi-kadura," S.—This must be the Camara wood, described as white, but tough and strong.

Wrightia coccinea.—Produces a light and tough wood, used for making palanquins, whilst that of *W. molissima* is employed by turners; but I question if any of the four species indigenous to Ceylon will be found of value.

Alstonia scholaris, R. Br. "Ruck-attana," S.—Common, up to 3,000 feet. Wood white, compact, and valuable for the turning-lathe; employed for making packing-cases, coffins, &c.

Holarrhena mitis, R. Br. "Kiriwalla," S.—From the coast up to 1,500 feet. Wood light in weight and colour, of a fine close grain, and used for inlaying cabinet-work. It is most likely that the famous medicinal seeds of the bazaars, known as "Veppali-arise" and "Kelinda-hal," are the produce of this tree.

LOGANIACEÆ.

Strychnos nux-vomica, Linn. "Goda-kadura," S.; "Yettie-marum," T.—A large, handsome, and umbrageous tree, common on the coast. Wood described as white, hard, and strong, and not liable to the attacks of white ants; used for bandy-wheels, ploughshares, fancy and cabinet work. Iron tools said to be sharpened on this wood; but during an experience of several years in opening boundaries, I found the coolies select any bit of half-decayed wood, on which, with the help of sand, they especially perform this operation.

S. potatorum, Linn. "Ingini-gaha," S.; "Thetta-marum," T.—The well-known clearing nut-tree. Abundant from Putlam northward to Jaffna. Wood variously described as hard and serviceable, and as useless, except for firewood.

Gaertnera Kœnigii Wight. "Pera-tambala," S.—A common shrub.

Bignoniaceæ.

Calosanthes Indica, Blume. "Totilla," S.; "Vanga," or "Pana Woodachie-marum," T.—A common plant in fences, but wood soft, spongy, and nearly useless, though every part of the tree is used medicinally on the Malabar coast.

Spathodea Rheedii, Wall. "Diya-danga," S.—A small tree, generally found on marshy ground. Wood whitish, said to be strong; used in Ceylon for buoys for fishing-nets, models of dhonies, &c.

S. Adenophylla, D. C. "Ela-palol," S.—Not indigenous; rare about Ceylon. Too scarce to be valuable as a timber tree. The bark is in great repute as a medicine by the Singhalese.

Stercospermum chelonoides, D. C.; *Bignonia salina*, Moon. "Lunumadala" or "Goda-danga," S.; "Vela-padrie," T.—Affects salt-marshes and dry ground up to 2,000 feet. Wood high-coloured, hard, durable, and of much use amongst the inhabitants of the hills of India, where it is plentiful.

S. suaveoleus, D. C. "Palol," S.; "Padrie," T.—Found near Buddhist temples in the south of the island, and at Kandy. Like its congener, "Ela-palol," its bark is in great request. Wood like last-named, but of a redder hue. Strong and elastic, fitted for making bows.

Millingtonia hortensis, Lin. fil.—Wood white and firm, and close-grained. Bark very spongy, yielding an inferior kind of cork.

Boraginaceæ.

Cordia Myxa, Linn. "Lolu," S.; "Vidi-marum," T.—Found from the coast to the Central Province. Wood soft; said to have furnished the timber from which the Egyptian mummy-cases were made.

Ehretia lævis, Roxb.—Common near Colombo. Small tree, but in India pretty large, the wood being used by the hill-people for many purposes.

Acanthaleæ.

Some species of the genus *Strobilanthis*, the well-known "Nillu" plant, and which belong to this order, are used as sticks to put in mud-walls in India.

Verbenaceæ.

Premna latifolia, Roxb.—A small tree found at Kaduwella, Caltura, and Trincomalie. Wood white, firm, and used for many economical purposes in India. Agrees in character with the teak-tree and others of the same order.

P. tomentosa, Willd. "Boo-sini," S.; "Kolcutty Teak-marum," T.—Common up to an elevation of 3,000 feet. A small, hard tree. Wood hard and close-grained, of a brownish yellow colour; well fitted for ornamental purposes, and worthy of attention as a fancy wood.

The well-known bazaar drug, known by the natives for perhaps one or two hundred years, under the names of "Siritekku," "Guntabaringa," &c., was first identified by me as a species of this genus, the *Premna berbacea* of Roxburgh.

Callicarpa tomentosa, Linn. "Eella," S.; "Kaat-komul," T.—A small tree or large shrub, very common, up to 4,000 feet. Wood white, spongy, and used for making charcoal in India. Bark occasionally used instead of Betel.

Gmelina Rheedii, Hooker. "Ætdemata," S.; "Koommy-marum," T.—A small tree, common, up to 5,000 feet; said to resemble teak in colour, weight, and qualities, and to be one of the best woods in India for resisting the effects of water and the attacks of the teredo. It is applied to all kinds of purposes—for bullock-yokes, picture-frames, decks of small boats, Venetian blinds, sounding-boards, panels, grain-measures, foundations of wells, &c., &c.

Vitex altissima, Lin. fil. "Milila-gaha," S.; "Kaat-milla," T.—A common forest tree, up to an elevation of 3,000 feet. No timber tree is better known in Ceylon and applied to more useful purposes, where a hard, tough, and durable wood is required. The woods known in Ceylon as "Kaha" (yellow), "Sapu" (light), and "Mee-an" (buffalo's horn), "Milila," are simply varieties of this timber, having the colours and qualities indicated.

V. pinnata, Linn.; *V. pubescens*, Vahl.—A native of the mountainous parts of the Circars, Chittagong, &c. Wood, when old, of a chocolate colour, exceedingly hard and durable, which renders it useful for many purposes.

V. leucoxylon, Linn.—A small tree, not common. No notice of its timber.

Avicennia officinalis, Linn.—Not uncommon on the coast. A preparation made from the ashes of its wood used by dhobies for washing cotton cloths, and by painters to mix with their colours to make them adhere. The bark is used for tanning, but the wood is untried.

Nyctaginaceæ.

Pisonia oleracea, W. Ferguson; *P. alba*, Span.; *P. morindifolia*, Wall. —The Bombay lettuce-tree, with cream-coloured leaves, which are eaten by the natives; now a common ornamental plant in Ceylon. The wood of this plant, of *Cullenia excelsa,* and of the Papaya-tree, are very interesting objects for examination under a microscope.

Thymelaceæ.

Gyrinops Walla, Gaert. ; *Cameraria zeylanica,* Moon. "Walla-gaha," S.—A small, common tree on the coast. Wood white and used for inlaying ; a tough fibre procured from its bark.

Santalaceæ.

Pyrularia Wallachiana, A.Dec. "Katu-pamburu," S.; "Iddu Mulli," T.—Central Province ; 4,000 to 6,000 feet elevation. A large tree on the Malabar Coast. Wood light-coloured and the cross section curiously grained. Used for ordinary work.

Santalum album. "Rat-kihiri," S. ; "Shardanum-marum," T.—The sweet-scented wood of this tree is sold in the bazaars by weight. The remarks on the various circumstances affecting the valuable parts of the Calamander wood, Tamarind, &c., apply with equal force to this tree. The real scented sandal-wood is found in stony ground on the sides of hills, and its produce is much affected by soil, &c.

Datiscaceæ.

Tetrameles nudiflora, R. Br.—The "Weenong" of Java, and Jungle "Bendy" of the Bombay Presidency, is remarkable as being a large tree in this very small order, consisting otherwise of annual stemmed herbaceous plants. Found in the Ambegamoa districts.

Lauraceæ.

Cinnamomum zeylanicum, Breyn. "Kurundu," S. ; "Karruwa," Tam. —Thwaites has the Cinnamon-tree down as undoubtedly indigenous to Ceylon, and under several varieties ; he seems to think that a very great number of the species can be rolled up in this one. There can be no doubt of the correctness of his views in this respect. It is a common plant, from the sea-coast up to an elevation of 8,000 feet.

The wood is of a light brown colour and not unlike that of the "Raane" of Batticaloa. It is of a loose and porous texture, and handsome enough when sawn into planks. It is sometimes manufactured into caddies and the like, but its scent does not secure it from the attacks of worms.

C. citriodorum, Thwaites. "Pængiri Kurundu-gas," S.—A tree 20 to 30 feet in height. Found at Saffragam and Galagama, at 1,000 to 2,000 feet. Its Singhalese name indicates that its bark has the smell of Citronella oil.

C. litsæfolium, Thwaites. "Kuddu-Kurundu-gas."—Happootella, at an elevation of 5,000 feet. A tree 50 to 60 feet in height. The timber of these two trees, though not known as yet, are sure to be useful for various economical purposes.

Apollonias zeylanica, Thwaites.—A tree 50 to 60 feet high. Central Province, at 3,000 to 4,000 feet.

Machilus macrantha. "Ululugas," S. (the Silhet name is "Oruk").—A large tree, found in the Central and South-Western Provinces at 1,500 to 4,000 feet. Used for house-building and economic purposes.

Alsiodaphne semicarpifolia. "Waewarana-gaha," S.; "Raane," or grain-wood, T. at Batticaloa; "Yaverne" at Trincomalie.—This, though long known as a valuable timber tree in various parts of the island, has only lately become of importance as timber sent from Trincomalie to the Commissariat at Colombo. It is a common and gigantic forest tree near Batticoloa and Trincomalie, and is likely to become of considerable importance as a Ceylon timber tree, of value for building and other economical purposes. It is of a light yellow colour, much used at Trincomalie as a substitute for deal, and said not to be liable to warp. Logs of large dimension can be procured from Trincomalie; it has been exported for some years past under its native name of Yaverne. The wood resists the attacks of the teredo and wood-boring insects, and is much used in the district of Batticaloa in the construction of boats.

Cryptocarya Wightiana, Thw.; *C. floribunda*, Wight. "Golu-moragas" and "Gal-mora," S.—A large tree, used for building purposes; common, up to an elevation of 5,000 feet. Serves as timber for house-building, and supplies the best kind of firewood for brick and lime kilns.

Tetranthera Roxburghii. "Bo-inee-gaha," or "Bombii," S.—A very common tree, up to an elevation of 3,000 feet. Bark very glutinous and medicinal. Timber extensively used for planks and rafters.

T. ovalifolia, Thw.—Central Province, at 4,000 to 7,000 feet. A tree 30 to 40 feet high. Timber for ordinary purposes.

T. tomentosa, Roxb. "Kos-baedda-gas," S.—Common in the Central Province, up to 4,000 feet.

T. ligustrina.—Central Province.

T. Gardneri, Thw.—A tree 40 to 50 feet high; in Central Province, at 4,000 to 6,000 feet; and

T. iteodaphne.—Same Province, up to 6,000 feet; are likely to produce good timber.

Actinodaphne speciosa.—In the Central Province, up to 8,000 feet. A tree 30 to 40 feet high. In the forest on either side of the road between Rambodde and Newera Ellia; abundant, and remarkable for its large, broad, drooping leaves, which much resemble elephants' ears. The timber of this, and of the other five species indigenous to the island, is likely to be good.

Litsœa zeylanica, N. ab. E.; *L. trinervia*, Moon. "Dawul-kurundu," S.—A small tree, used for common house-building. Very abundant, up to 4,000 feet.

ALLIED TO THE LAURELS.

Hernandia sonora. "Palatu-gaha," S.—On the sea-shore, from Colombo to Galle. The juice of the leaves is a powerful depilatory; it destroys hair wherever it is applied, without pain. Its timber is used for common purposes.

Gyrocarpus Asiaticus, Willd. "Herna-gaha," S.—Grows to be a very large tree; not uncommon in Katregam and the hot, drier parts of the island. The wood is white, soft, and not very light; when procurable, is preferred above all others for catamarans. Much used for making cowrie boxes and toys. Takes paint and varnish well.

URTICACEÆ, OR NETTLES.

Laporta crenulata, Gaud.; *Urtica stimulans*, Moon. "Maussa," S.—A plant, the sting of which has fearfully virulent properties.

Boehmeria malabarica, Wadd.; *Urtica aquatica*, Moon. "Mahadrya-dul," S.—A small tree, the bark of which is used for fishing-lines by the natives.

Morocarpus longifolius, Blume; *Urtica verrucosa*, Moon. "Gass-dool," S.—Bark used like the above.

TRIBE ARTOCARPEÆ.

Artocarpus nobilis, Thw.; *A. pubescens*, Moon. "Del-gaha," S.—A gigantic tree, common in the Western, Southern, and Central Provinces, up to 2,000 feet. I have often seen trees of it having a diameter of 3 to 4 feet. Its timber is in great request for backs and shelves of almirahs; fishing-boats are hollowed out of single trees, &c.

A. Lakoocha, Roxb. "Etta-heraliya," "Molbaedda," and "Kanna-gona-gaha," S.—A common tree, up to an elevation of 3,000 feet. Timber used for ordinary purposes.

A. integrifolia, Linn. "Kos-gaha," S.; "Pla-marum," T.—The famous jack-tree, the fruits occasionally weighing 50 lbs. A most common tree in gardens, and often apparently in the forests; but Thwaites does not consider it indigenous. Its timber, jackwood, is perhaps the most valuable and the most extensively used for furniture and all useful purposes of any grown in the island. The wood, when old and well-polished, approaches mahogany in colour very much. It is becoming scarce and expensive.

A. incisa, Linn. The bread-fruit. "Rata-del," S.—Is now a common and plentiful tree, but its timber is not used.

Allœanthus zeylanicus, Thw. "Allan-dugas," S.—Central Province, at 1,000 to 2,000 feet. A very tough fibre obtained from its inner bark. Timber used for ordinary purposes.

Antiaris innoxia, Blume. "Ritti-gaha," S.—The famous Sack-tree, a species of the same genus as the poisonous Upas-tree. Not uncommon in the hot, dry parts of the island. A gigantic tree, timber not much used.

Streblus asper, Lour. "Gaeta-nitul," S.—Abundant, up to an elevation of 2,000 feet. A small tree, but its timber is much esteemed on account of its being hard and taking a good polish. Pieces of it often used by the natives as tooth-brushes.

Urostigma religiosum, Gasp.—The famous "Bo-gaha," S., and *U. Benghalense*, Gasp., the equally famous "Ma-rengah," S., or Banyan-tree, are too well known to need description. Thwaites has nine other species of this genus down as indigenous to Ceylon, several of which are included as timber trees in Wright's list; but they are all of a light, soft, and spongy nature, and not strong timber. Some of these are the giants of the forests, encircling other species from the root to a height often of 60 to 80 feet, sometimes left standing after the confined tree has decayed away. They facilitate much the felling of the trees on the forest land for coffee estates, as they often clasp so many trees, that, after half-cutting through the trunks of the surrounding trees, one or two acres of the forest are levelled at once by felling one large tree of these.

One species of *Pognotrophe*, six of *Ficus*, and two of *Covellia*, all of this tribe, indigenous to the island, and which, with the above, were formerly included in the genus *Ficus*, bear fruits like figs, and the timber of them has much the same character.

TRIBE CELTIDÆ.

Ulmus integrifolia, Roxb. "Dada-hirilla," S.; "Kanchy," T.—A fine large tree, in the hot, dry parts of the island. The timber, like that of its English congener, is used for various purposes requiring toughness and strength.

Celtis dysodoxylon, Thw. "Gooraenda" and "Urene," S.; "Poodaca-rapan Puttay" (its bark), T.—A middle-sized tree, in the Central Province, up to 5,000 feet. The freshly-cut wood has the most abominable and disgusting odour of all plants in the vegetable kingdom.

C. Wightii, Planch.—A small tree in the hot, drier parts of the island. One of the hardest woods I have ever met with, light-coloured; well worthy of attention.

Sponia orientalis, Planch. "Gae-dumba," S. (Indian Nettle-tree.)—A small tree, common, from the coast up to 3,000 feet, and is one of the trees which mysteriously spring up after forests have been felled and burnt, and in which they did not formerly exist. The wood is soft and light, and used for ordinary purposes. It makes one of the best charcoals for gunpowder. Every part of the tree is used in medicine or the arts.

Gironniera subæquilis, Planch.—A moderate-sized tree, not uncommon in the Central Province, up to 4,000 feet.

G. reticulata, Thw.—A tree about 40 feet high, found in Badulla, and up to 3,000 feet. Both these are likely to produce useful timber.

EUPHORBIACEÆ.

Euphorbia Tirucalli, Linn. "Gas-nawahandi," S.; "Tirucalli," T.—A common fence plant at Jaffna. Wood light-coloured, well adapted for gun-stocks when procured of sufficient size.

Excœcaria Agallocha, Linn. "Tella-keeriya," S.—A small tree affecting swamps, its wood supposed to be the Agallochum of the Greeks; but it is white and soft, and possesses no aromatic properties. Wood adapted for every purpose of house-building.

Cleidion Javanicum, Blume. "Ukuru-gaha," S.—Central Province, up to 2,000 feet. Wood used for ordinary works.

Rottlera oppositifolia, Blume. "Molabaa," S.—A small tree, up to 2,000 feet. Wood for ordinary purposes.

R. tetracocca, Roxb. "Bookaenda," S.—Common, up to 2,000 feet. A useful timber tree, of considerable size. Wood for ordinary work.

R. digyna, Thw. "Otthe," S.—Wood for common house-building, but it is small and soft.

Macaranga tomentosa, Wight. "Kaenda," or "Pat-kaenda," S.—Abundant, up to 3,000 feet. Springs up in cleared forest land. Wood for ordinary purposes, not very strong.

Gelonium lanceolatum, Willd.—Common, up to 4,000 feet. Wood white, and adapted for house-building.

Chætocarpus castanocarpus, Thw. "Haedoka," S.—A well-known Ceylon timber tree, with hard wood; very common, from Colombo to Ratnapoora and Ambegamoa.

C. coriaceus, Thw. Also "Haedoka," S.—With the preceding equally common, and timber good.

Mischodon zeylanicus, Thw. "Tamana," S.—A very handsome tree, having excellent timber, and widely spread in the island.

Dimorphocalyx glabellus, Thw. "Wellewenne-gas," S.—Common in the hot, drier parts of the island; a good-sized tree; timber unknown.

Desmostemon zeylanicus, Thw. "Wal-kakunu-gaha." S.—Central Province, up to 4,000 feet; timber used for ordinary work.

Givotia rottleriformis, Griff.—Hot, drier parts of the island; wood soft, light, and porous; much used for making cowrie boxes, toys, models of fruits, &c. in India; takes paint and varnish well. The oil obtained from the seed is considered superior to olive or almond oil for machinery.

Briedelia retusa, Spr. "Katu-kata-kala," S.; and *B. Moonii*, Thw. "Mapat-kata-kala," S.—Are both common trees, up to 2,000 feet, and produce useful timber for building purposes; said to be durable under ground.

Amamoa patula, Thw. *Cluytia patula*, Roxb.—Common in the hotter parts of the island; a small tree, but, according to Roxburgh, a valuable timber tree in India.

Prosorus Indica, Dalz. "Karron-gas," S.—Common, up to 2,000 feet; and *P. cyanospermum*, Thw. "Sudu-leyang-gas," S.—At Ratnapoora and Ambegamoa, up to 1,000 feet; timber of both white, tough, and used in house-building.

Hemicyclia sepiaria, W. et A. "Weera-gaha."—An abundant, small tree; wood said to equal that of boxwood by Dr. Wight. It looks hard and close-grained. The timber of *H. lanceolata*, Thw., is also tough and hard. Its Singhalese name is "Ella-pini-baru."

Palinga zeylanica, Thw. "Palinga-gas," S.—A large tree; timber not known.

Putranjiva Roxburghii, Wall. "Curoopally-maram," T.—In the hot, drier parts of Ceylon. Roxburgh describes it as a large timber tree, with erect, straight trunk and white close-grained hard wood. It belongs to the same section as the boxwood.

Aporosa Lindleyana, Thw. "Kaebilla," S.—A common tree, and wood used for house-building.

A. latifolia, Thw. "Ma-pat-kabella," or "Pipiliya."—Also a useful timber tree.

Antidesmeæ.

Antidesma Bunius, Spr. "Karawilla-Kabilla," S.—Timber used for ordinary purposes.

Allied to Euphorbiaceæ.

Sarcococa pruniformis, Lind.—Central Province, at an elevation of 4,000 to 5,000 feet. This, though of small diameter, has a wood so like box, that it is called the Neilgherry boxwood.

Balanophoreæ.

Balanophora Indica, Wall.—In forests of Central Province, at 3,000 to 4,000 feet. This species produces the great knots on the maple-roots, from which the Thibetans form the cups mentioned by Messrs. Huc and Gabet.

Casuarinaceæ, or Beefwood.

Casuarina equisetifolia, Forst. "Kasagha," S.; "Chowk-maram," T.—The Tinian pine is now a common, naturalized tree in Ceylon. The timber is of a reddish colour, bears a great strain, is well adapted for posts, and is said to bear submersion in water very well.

Palmaceæ.

Caryota urens, Linn. "Kitul-gaha," S., the tree, "Niepera," S., often for its wood "Ootaly-panna," T.—Common, up to 3,000 feet. The hard dark-coloured wood of old trees is so like that of the Palmyra palm, that it is difficult to distinguish them without the use of a lens. Its wood is used for rafters, window-bars, handles of agricultural implements, pestles for paddy pounders, and is exceedingly hard and durable when old. Its trunk, hollowed out, is uuiversally used for conduits and water-buckets in irrigation in Canara.

Areca Catechu, Linn. "Pawak-gaha," S., "Kannegu," or "Pawk maram," T.—One of the most graceful of all the Palm trees; very common, up to 3,000 feet, but not truly wild in Ceylon. A most useful tree for the erection of temporary buildings, &c. The wood being at once straight, firm, and elastic, is employed for making the pingoes (yokes for the shoulders) by means of which the Singhalese coolie, like the corresponding class among the ancient Egyptians, carries his burdens, &c.

A. globulifera, Lam.; *Seaforthia oryzoeformis*, Mart.—The "Rata (foreign) Puwak," S., is a native of the Eastern islands, but is common in Ceylon.

A. Dicksonii, Roxb.; *Seaforthia Dicksonii*, Mart. "Lenætari-puwak," S.—This is a small and graceful tree, met with in the Western and Southern Provinces.

A. horrida, Griffith; *Caryota horrida*. "Kattu-kitul," S.—A common palm in forests, from 2,000 to 3,000 feet; gregarious, armed with long spines, taller than the Areca, and more liable to branch than any of the Ceylon palms. I have often eaten the centre bud of this tree, when compelled to fell it in opening boundaries; it is equal to that from the cocoa-nut or kitul.

Macrocladus sylvicola, Griffith; *Caryota mitis*, (?) Moon.—A handsome gregarious palm; found in the Western, Central, and Southern Provinces, up to 3,000 feet. It is most likely a species of Areca.

Cocos nucifera, Linn. "Polgaha," S.; "Tennam-marum," T.—A very common tree on the sea-coast of Ceylon; supposed to be a native of South America. I question if a truly wild cocoa-nut has ever been seen in Asia, although the Sanscrit writers refer to it. Its cultivation in Ceylon is most extensive. Its wood is almost too well known to require description. It is used for sleepers and various purposes, but is inferior to that of the Palmyra. Very handsome desks, &c., are made of this wood at Galle and elsewhere in Ceylon.

Borassus flabelliformis, Linn. "Tal-gaha," S.; "Panei-marum," T.—A most common and useful tree, found in the north of the island and in Southern India. Its timber is used very generally for rafters and reepers, and is also largely exported to different parts of India for these. A paper on this wood, for the construction of bridges, by Mr. Byrne, of the Civil Engineers, was lately read at the Institution of Civil Engineers, London.

Corypha umbraculifera, Linn. "Tala-gaha," S.; "Conda-pana," T.—The well-known Talipot palm, common in Ceylon; flowers once and then dies.

Calamus Rotang, Linn. "Heen-we-wael," S.—A common plant in Ceylon; its uses are well known. There are three or four other species indigenous to Ceylon—one is said to grow sometimes to a length of 500 to 600 feet.

Graminaceæ.

Bambusa arundinacea, Willd.; *B. spinosa*, Roxb. "Unalée," S.; "Mungil," T.—These are the common yellow, green, and spiny bamboo, found on the banks of rivers and elsewhere; common in Ceylon. The stems of this gigantic grass, for it is nothing else, are applied to more uses, perhaps, than any other plant of the vegetable kingdom.

B. stridula, Moon. "Bata-lee," S.—Thousands of acres are covered in Ceylon with this small bamboo. Its stems are in great request for fences, &c.

B. nana, Roxb.—The Chinese dwarf-bamboo, of which their umbrella handles are said to be made, grows about Colombo and Galle.

ON GRANITE AND ITS USES.

BY THE LATE PROFESSOR GEORGE WILSON.

No. II.

Special reference has been made to the enduringness of granite, and the relation of that enduringness to industrial science. We are now to consider this rock as very perishable, and as yielding by its decay materials for important arts, and, in particular, for three—namely, the arts of the glass-maker, of the potter, and of the metal-worker, of which, however, I can discuss scarcely more than the first.

With a view to understand this, let us look again at the three minerals in ordinary granite. They are, as we have seen, the dark, glimmering, scaly mica; the glass-like quartz, which, when violet, we call amethyst, when yellow, cairngorm or false topaz; and the marble-like felspar, which appears of so rich a red in Peterhead and Egyptian granite.

The same Hebrew poets who loved to call the mountains everlasting also tell us that the "perpetual hills bow down." They do so in the sense of bending their heads, in the course of ages, to the blast, and wearing away under the storms of millenniums, slowly corroded by the air, dissolved by the rain, ploughed by the glacier, split by the frost, shivered by the lightning, and by all consumed into dust. They also bow their heads in the sense of abasing themselves; and as they originally rose from the lower depths of the earth, often sink again into them. Those great physical agencies which suddenly, and as it were spasmodically, exerted, produce under our eyes earthquakes and volcanoes, more slowly and silently exercised, lift entire continents to immense elevations, and build them up as mountain chains; and again those agencies reverse their work, and the mountain-chains are buried "deeper than plummet ever sounded." But in so sinking, they are at length, in the majority of cases, plunged beneath the sea, and there are, of necessity, exposed to all the wear and tear of its waves, to the ebb and flow of its tides, to the fierce collision of rocks broken from themselves dashed wildly against them, to the grinding action of fragments of those rocks furrowing their surfaces, to the abrading contact of sand reducing them to its own likeness, and to the disintegrating influence of water soaking into every pore, and dissolving ingredients essential to their stability, till they are broken into pieces, worn into pebbles, ground into sand, and degraded into mud.

In this way the most ancient of the granite rocks of the world have, in the remotest geological ages, utterly perished, and their relics, strangely altered, are all that remain to us. Those relics, sifted and sorted by the action of the waves, have afterwards been built up again beneath the sea into coherent masses, have been consolidated by pressure, have been hardened and, as it were, baked and semi-fused by subterraneous fire, and, torn and twisted by volcanic forces, have been lifted again to the surface, so as to form anew what we creatures of a day call everlasting hills.

Among those re-made rocks I notice, and that simply in passing, that the mica of the granite is found predominating in certain of the stones which can be split into roof-slabs and floor-slabs ; that the quartz forms sandstones, such as we prefer in this city and neighbourhood for building with ; and that the felspar changes into those clay-stones which, when easily split, form our finest roofing-slates, and, when more compact, our flagstones or pavements.

Now, leaving unconsidered mica altogether, and passing without further reference from the consideration of the slates and sandstones as building materials, let us look at sand, *i.e.*, ground-down quartz, as the basis of glass ; and at clay, *i.e.*, disintegrated felspar, as the chief constituent of pottery, and the source of the metal aluminium. Before doing so, however, let me notice that certain even of the more recent granites are so prematurely perishable, that they waste away even under serene atmospheres, and crumble down so swiftly where other granites show no signs of decay, that the continental geologists gravely refer to them as "diseased granites." It is from them that our finest porcelain clay is derived, so important an ingredient in pottery. First, however, of glass.

Pliny has a pleasant story of certain Phœnician sailors accidentally discovering the mode of making glass, by kindling on a sandy river-bank a fire to heat their cooking-vessels. These, for want of better supports, were rested upon lumps of natron, that is, crystallised carbonate of soda, such as is found at the present day in many parts of the world. The effect of the fire, as the story goes, was to melt the sand and soda into glass. But the story is incredible ; for natron, under a slight heat, dissolves in the water which its crystals contain, and the fire must have been extinguished long before the sand and soda melted ; nor is it easy to understand how an open fire could yield heat sufficient in any circumstances to effect their fusion. But the legend, doubtless, is founded in truth. Mankind probably first learned how to produce glass from striking incidental phenomena unexpectedly brought under their notice. Among such phenomena, special prominence may be assigned to the effect of discharges of lightning in reducing the most refractory minerals to the condition of clear glass; to the effect of great casual conflagrations in reducing portions of buildings to vitreous masses; and perhaps, most of all, to the effect of the prolonged heat of furnaces, in causing the ashes of the fuel burned in them to glaze the stones or bricks of their walls and floors, and in fusing the calcined dross or scoriæ of metallic ores into slag, *i.e.*, opaque glass.

Such phenomena must more or less have awakened the interest and attention of even rude workers, since fires were first lighted; and in all probability the ancient arts of the baker, potter, and blacksmith were not long practised before the dwellers in widely distant regions of the globe had learned the first principles of glass-making. It is thus, in all likelihood, one of the oldest of the arts. It is, at all events, a very old one, for we know, from drawings in the Egyptian tombs, and from objects found in them, that 2,000 years B.C. expert glass-blowers abounded in Egypt.

The word "glass" is perhaps derived from the Latin word for ice, "glacies," from which we derive our words "glacial" and "glacier," but this is uncertain. The thing itself is very familiar to all of us, though probably most would be puzzled to define or describe it. Its only synonym is crystal, and this term may connect it with rock crystal or silica, which is the largest constituent of all the ordinary kinds of glass. The most remarkable thing, however, about glass is not its materials, but, as in the precious stones, its workmanship; and in the full sense of the word, as understood by natural philosophers, glass signifies a solid body possessing a peculiar structure, not a peculiar composition. In other words, it is the mode in which its particles are arranged together, not the nature of its particles, which makes glass, glass.

To render this clear, let it be observed that (setting aside plants and animals, the forms and structures of which are foreign to our present inquiry) three quite unlike external shapes and internal arrangements of particles are found in solids. These three are not the only kinds of form and structure found characterising dead matter, but they are the three most striking which prevail in those solids which have not formed parts of living beings. They are as follows:—1. Some solids are crystalline in shape and structure; 2. Some are glassy or vitreous; 3. Some are neither crystalline nor glassy, and are called amorphous, *i.e.*, formless or shapeless, but the adjective also includes the idea of their being structureless. Glass is intermediate in character, between a crystalline substance and an amorphous one, and it is rather unfortunate that one kind of glass should be called "crystal," which it is, however, only as resembling colourless quartz in hardness and transparency, not in shape or in structure, seeing that it is essential to good glass not to possess the properties of any crystal, but certain quite different properties. Let us very briefly consider wherein the difference lies. A crystal, such as the six-sided pyramid of quartz, or the eight-faced double pyramid (octohedron) of diamond, or the cube of rock-salt, has not merely a peculiar external configuration, but an equally peculiar internal structure. That such is the case may be easily proved.

One of the most familiar and interesting crystals is a rhomb of Iceland or calcareous spar, one of the forms of crystallised carbonate of lime or chalk. It has a highly characteristic shape, distinguished by crystallographers as rhomboidal or rhomboohedral, *i.e.*, rhomb-faced or lozenge-faced, because all its flat sides or faces, which are six in number, have the outline of the heraldic lozenge, or the diamond on a playing card. These six lozenge faces are bounded by sharply-defined, unvarying angles.

But the spar crystal is something more than a mere shape. A plaster bust has externally the configuration of a human head, but the resemblance ceases within a line of the surface. You could not, by examining a portion of the powder scraped from the back of the bust or the bottom of the pedestal, tell that it had been a bust, or what it had been ; and if the bust be broken by, for example, a fall, the fragments have nothing in structure in common with the mere surface. So, also, an apple or a rose, modelled in wax, or a grape blown in glass, may completely deceive the eye, and, so far as form and colour are concerned, be mistaken for a real fruit or flower, but the resemblance ends with the outside.

On the other hand, if a crystal of calcareous spar be broken by a fall or a tap with a hammer, it breaks into rhombs, each with its six lozenge faces a perfect miniature copy of the original crystal, and those small rhombs may be broken by a gentle force into smaller rhombs, and these again into smaller, till the fragments, without varying their shape, become microscopically small. The Iceland spar thus resembles a house built of very small bricks all alike, or a piece of colourless mosaic where all the portions are identical, or a piece of marquetry or Tunbridge wood-ware, consisting of exactly similar squares.

Further, Iceland spar crystal has long been famous for its exhibition of the double refraction of light, *i.e.*, for its power to split into two a ray of light which falls upon it in any but a single direction, so as to double the image of every object seen through it; and if one of these doubly refracted and, in consequence, polarised rays be sent through such a crystal in any direction but one, it produces a curious array of black and white crosses and of beautifully coloured rings.

Now, the crystal thus endowed may have its salient angles knocked away, and any external configuration given to it without depriving it of those endowments. It may be carved into a square block or turned in a lathe into a sphere, and still it will break into lozenge-faced rhombs ; still it will refract light doubly ; still it will show crosses and prismatic rings when illuminated by a doubly refracted or polarised ray of light ; still it will conduct heat, according to the law that regulates conduction of heat by the unmutilated crystal ; still it will obey a magnet (diamagnetically) as if it were a perfect rhomboid.

All crystals more or less exhibit the same unity of structure. All are crystals in the atom as well as crystals in the mass. Through their height and depth and length and breadth, from their centre to their circumference, they are crystals; and you no more change their inner and essential characters by changing their outer configuration, than you change a yew-tree into a church steeple by cutting it into the shape of a pyramid, or a box-tree into a bird by clipping it into the form of a peacock.

The crystalline structure is one which the glass-maker dreads, because the most important properties of glass are lost if it crystallise, and it greatly tends to crystallise. Yet, strangely enough, it is not that a crystal would not rival glass, for rock-crystal is better than glass for lenses and prisms: it is that we cannot produce *one* mighty glass crystal, out of which, like a great iceberg or ice-field, to saw windows, and chisel goblets, and carve lamps and looking-glasses, lenses, and prisms. We are in this respect like men to whom some hundred acorns have been given, and who, if they had their will, would grow the hundreds into a single mighty oak, out of which might be sawn logs fit to form in one piece the keel or deck of a man-of-war, but who are compelled to accept a mere copsewood of many trees, and, in despair of oak, build their ships of fir and iron.

When glass crystallises it does not do so in one clear mass, but shoots up like an underwood into a forest of crystals; and how incompatible this arrangement is with the employment of glass as a transmitter of light, any one may judge from the dimness of a window covered by a tree-like crystallisation of frost.

Glass, then, must not be crystalline. As little must it be amorphous. This word "amorphous" is not a technical one, for which technology need apologise; but it is a scientific one, and I use it because I know no everyday word which conveys its meaning. To speak of a solid body which presents to our eyes a visible, conspicuous shape, and a well-marked form, as shapeless and formless, seems on first consideration a foolish and contradictory thing. It is like speaking of a shapeless shape. Yet the language of poetry and the language of everyday life equally acknowledge the necessity of thus characterising certain indefinable forms. Thus Milton, in a famous passage of 'Paradise Lost,' describes Death as—

> 'The other shape,
> If shape it might be called, that shape had none
> Distinguishable in member, joint, or limb;
> Or substance might be called that shadow seemed,
> For each seemed either.'

Here we have the two essentials of amorphism, externally, vague outline, internally, vague structure. And if we at once descend from poetical altitudes, we shall find in the homely word *jelly* the occurrence of these amorphic essentials as fully recognised as in Milton's picture of Death. All are familiar with what a cook or confectioner calls a "shape of jelly," as a very visible, tangible, and withal beautiful solid. Yet think of that other most sad use of the word as applied to the utter annihilation of the perfection and beauty of a sensitive, living, graceful human body, when it is spoken of as the victim of some railway collision, or other terrible catastrophe, and is described as having been crushed or beaten into a jelly. We know that it retains a shape, but one so ill-defined that we speak of it as shapeless. In the same sense, the endlessly altering, undulating sea-Medusæ are popularly called jelly-fishes.

The other familiar amorphous bodies which I might name are, on the one hand, such soft substances as the curd of milk, the boiled white of egg, or clay in its plastic state as used by the potter and the sculptor; and on the other, such shapeless hard masses as flints or other silicious pebbles. In their internal structure, the softer of those bodies have an arrangement of particles approaching in mobility and unfixity to that of liquids; and the harder of the amorphous bodies exhibit none of the distinctive properties of crystals, and may be compared to congealed or rather coagulated jellies.

The only everyday English word which I have been able to think of as expressive of this formless form of matter is one which, from its associations, is perhaps not a very welcome one—namely, the word "clot." Clotted (or clouted) cream has no unpleasant associations with it, but one cannot say the same of clotted blood. Both, however, convey the same idea of vaguely consolidated substance; and I do not know a more significant phrase for solid sense apparently jumbled, till it has seemingly lost, though in reality it retains solidity, than the words of an old writer, applied by a reviewer of Thomas Carlyle to his 'Sartor Resartus,' as a book consisting of "clotted nonsense." The amorphous, curdled, or clotted condition, is as alien to the useful properties of glass as the crystallised one.

What, then, is the glassy shape or structure? It is a compromise between the crystalline and the amorphous one. Glass reflects and transmits light as a crystal does, but without necessarily doubly refracting or polarising it. It does not break into flat-faced, sharp-cornered solids like a crystal, but into curved or hollowed pieces, scooped out like shells; and when struck, as with a hammer, or allowed to fall, it is fractured into all kinds of curvilinear solids without shattering into acute-angled fragments or keen-edged grains.

You may be disposed to say that broken glass is sharp and cutting enough; and so, no doubt, it is, especially when the glass was originally thin; but look at the relics of a broken tumbler not deliberately ground to powder, and you will see that the sharpest pieces are rounded in their fracture. I have in my possession part of a glass air-pump receiver, crushed in by the pressure of the atmosphere; part of a soda-water glass machine, blown to pieces in my class-room; as well as the fragments of a glass basin, which spontaneously split in two. All display the same curved and waving outline, and, though sharp enough to hurt, are blunted on their edges. This waving, sinuous line is closely related to a property of glass, which connects it with the most glass-like of the amorphous bodies—viz., the jellies. If we take animal jelly or gelatine—for example, thick liquid isinglass or glue—we can draw it out into threads, and mould it into pliant shapes. But it is too semi-liquid in character, too unsolid, to admit of being condensed into permanent forms. Glass, however, at a certain stage in its passage from the perfectly liquid to the perfectly solid form, has this jelly-like or viscous plasticity, so that it may be run into moulds, spun into gossamer threads, blown into bubbles, drawn into tubes, rolled out and stamped as if it were dough, clipped with scissors, pared with knives, squeezed, twisted, compressed, dilated, pulled out, pushed in, patched, puckered, smoothed, and welded, as if it were a ball of softened India-rubber or steam-hot gutta percha; whilst, in addition, glass finally settles or consolidates into a mass of stone-like hardness, which may be broken but will not bend.

Glass, then, has the following characters:—1. A brilliant lustre, which in other bodies we call the glassy lustre; 2. A shell-like or conchoidal, curved fracture; 3. A jelly-like plasticity, when passing from its liquid to its solid condition. Its particles are not marshalled together in the same rigidly harmonious way that the particles of crystals are, neither are they grouped or piled on one another, in the irregular fashion which characterises coagulated or amorphous masses; but it is impossible to give a precise definition of the internal structure of glass. In our ordinary language we restrict the word "glass" to a very few silicious compounds, but this is a merely conventional restriction. Thus, the simple combustibles, phosphorus, sulphur, and carbon (as the diamond), can put on all the characters of glass. Many acids and their salts, such as phosphoric, boracic, and silicic acid, do the same. So do metallic oxides, such as oxide of lead, and many vegetable products, such as the gums, resins, and sugars.

All bodies possessing the characters named above constitute glass, whatever their nature or composition may be; and as the glassy or vitreous state and structure are intermediate between the amorphous and the crystalline one, so all kinds of glass are liable, on the one hand, to degenerate, as it were, into shapeless amorphism, or, on the other, to develop into symmetrical crystallinity. For example, the brilliantly combustible phosphorus, which we believe to be a simple or elementary substance, exhibits in its ordinary form, as melted and preserved under water, the glassy structure. But if we keep it long melted at a comparatively low heat, it becomes a crystalline mass, showing sometimes perfect twelve-sided lozenge-faced crystals (rhombic dodecahedrons), like those of garnet. Again, if we keep it long heated, at a comparatively high temperature, it ceases to be either vitreous or crystalline, and becomes totally amorphous.

In like manner, sulphur may be procured in large, brilliant, beautifully transparent crystals; and also by heating to a certain point and suddenly cooling, as a glass which long retains plasticity and pliancy; and, further, by protracted heating and subsequent irregular cooling, as an uncrystalline, unvitreous mass.

The gums, resins, inspissated balsams, and other exudations from trees, along with amber, oscillate as it were between the glassy and amorphous conditions, being generally glassy, sometimes amorphous, and, most rarely of all, crystalline. No substance, however, exhibits the contrast between at least the vitreous and the crystalline condition, and the ready transition from the one to the other, better than sugar. Sugar, as it occurs in brown sugar, or in a sugar-loaf, or, still better, in sugar-candy, is one of the most perfectly crystallized bodies. Keep that sugar for some time melted, and it changes into a glass, and hardens as such. If you give a piece of it to a child as a plaything, and tell it that it is glass, sugar-glass, or vitreous sugar, it will smile at you, and tell you it is not glass, but barley-sugar; and so it is, but none the less glass! It has all the essential properties of glass.

Lastly, the great ingredient of household glass, silica, can easily assume the crystalline, the vitreous, or the amorphous condition; and as it transfers this property to all the kinds of glass containing it, the glass-maker is often hard put to it, to keep the happy medium between amorphous shapelessness and crystalline symmetry. Thus, the most beautiful pyramid of colourless quartz, of purple amethyst, or yellow cairngorm, may be uncrystallised and changed into glass simply by being melted. It is true that no ordinary fire, or even seven times heated furnace, will melt such crystals, nor any artificial heat easily procurable, except that produced by the burning together of the elements of water, hydrogen, and oxygen; but under this heat the hardest crystals of quartz melt into glass.

Electricity also can furnish a heat sufficient to effect this result, and it is seen on the grandest scale when thunder-storms send their discharges into beds of pure sand, and the white hot lightning melts its grains into glass. Tubes thus made in a moment out of lightning-melted sand, may be seen in the British Museum and Jermyn street Museum, and are justly reckoned objects of great interest and value.

And if it be possible to uncrystallise rock crystal into glass, it is still more easy to change both the rock crystal and its glass into amorphous, structureless silica. To do this it is only necessary to expose either to the vapour of the corroding hydrofluoric acid which fluorspar gives out when wetted with strong sulphuric acid. The crystal or the glass equally changes into a pulpy, gelatinous, starchy mass, which dries up like gum and hardens like glue. Chalcedony, common and precious opal, perhaps flint, jasper, and agate, are examples of this.

The glass-maker has thus a difficult task. Phosphorus, or sulphur, or barley-sugar, will scarcely do as the materials of window-panes and drinking glasses; and lightning is an unmanageable servant. Our actual glass is in larger part silica, that it may be a clear, bright, transparent, insoluble, incorrodible, solid, enduring thing. But to secure its melting under our ordinary furnace heats, alkali, namely, soda or potash, is added, which renders it fusible and diminishes its tendency to crystallise; and to give back to it the solid enduringness and insolubility in liquids which the alkali diminishes, infusible earths and heavy metallic oxides are added.

Thus window glass is made of the whitest sand melted with the cheapest alkali, soda, and hardened by lime; but as soda colours glass green, flint-glass has potash instead of soda; and as neither of these alkalies nor lime confers the greatest brilliancy upon glass, oxide of lead is added to the sand and potash, when the sparkle which we love to see in decanters and lamp shades and lustres is desired; and by largely employing this lead oxide, the lenses and prisms suitable for the optician, and passable imitations of the gems are produced, whilst small additions of other metallic oxides give those beautiful colours which add such glory to cathedral windows. According to some, we have lost the secret of the ancient glass dyes; but this is a mistake. Gold is as willing as of old to stain glass ruby red, and so is the humbler copper, which can also tincture it green. Silver secures a yellow or an orange, and iron gives the same. Cobalt provides for blue, copper and chromium for green, manganese for purple, and uranium for a topaz-like canary yellow. Tin makes a white glass milky and opaque, such as we see in the dials of watches; and a black enamel is secured by the darker oxides of manganese, iron, and cobalt. Bottle glass is the humblest product of the glassy materials. Brown sand, spent lime, soapers' waste, clay, and common salt, are resolved by the furnace into a dark glass, which, if only cast into more graceful forms, would be as useful as it is without offending the eye.

The glass-maker's work, however, does not end when his vessels are fashioned into shape by dexterous manipulation of its substance when pliant and plastic. They are in the highest degree fragile as they first leave his hands, so that they scarcely endure touching, and often fall to pieces. This fragility is owing chiefly to the different amount of extension and contraction which different parts of the glass have undergone whilst being fashioned into vessels, and to the unequal cooling of the deeper, as compared with the more superficial layers of the substance which have been more exposed to the cold external air in certain manipulations, and to the hot air of the furnace in others. A plastic mass like glass contracts most where it is most cooled, and least where it is least cooled. It thus resembles to some extent a web of woven tissue, such as a sail-cloth where some of the threads are pulled so tight as to be on the verge of breaking, whilst others are hanging in curves with no strain upon them at all. Such a piece of cloth is easily torn, for when pulled or stretched it does not resist with the united tenacity of all its threads, but only with that of the overstrained fibres, which quickly give way. If all the threads were equally tight, and the strain borne by them all, the web which before could be rent by the hands might, as the storm-sail of a man-of-war, withstand the fiercest hurricane.

Now, in the case of glass the unequally strained threads or fibres which make it up are afforded the opportunity of lengthening or shortening themselves till they are of the same length, by heating the completed vessels or other articles of glass up to the temperature at which it begins to soften, but no higher (otherwise they would lose their shape and symmetry), and then allowing it very slowly to cool down to the temperature of the air. Glass for choice optical purposes is thus allowed to fall gradually from a high to a low temperature through the space of many days, and in all cases hours are allowed to elapse during the cooling. This process is called annealing. Shakspere introduces a most expressive figurative use of it, strikingly bringing out its meaning, when he makes Hamlet's father denounce his murderer for hurrying him into the world of spirits—

> "Un-annealed;
> No reckoning made, but sent to my account
> With all my imperfections on my head."

In other words, unprepared to endure unscathed the powers of so dread a place.

It is exceedingly probable that in the glass-maker's annealing process there is not merely an equable mechanical arrangement of the glass particles in the way mentioned, but also a combination of heat with them, which is another element of stability. We know, for example, that when cold iron and other metals are long hammered, they give out so much heat as even to become red-hot; but at the same time, they grow brittle and lose malleability, and the only way in which this brittleness can be removed, and malleability restored to them, is by heating them red-hot and allowing them slowly to cool. During this process these metals apparently recover and render latent within their substance the heat which is essential to their solidity; and in the same way glass appears to require and to obtain, during the process of annealing, an amount of heat essential to its stability. At all events, annealing renders glass, which otherwise would be uselessly brittle, wonderfully strong and enduring, as the immense window panes and mirrors which can now be cast in plate-glass strikingly exhibit; and not less the comparatively thin tubes employed by the chemist, which he is not afraid to expose to a pressure of several hundred pounds upon each square inch.

An industrial museum is intended to be a repository for all the objects of useful art, including the raw materials with which each art deals, the finished products into which it converts them, drawings and diagrams explanatory of the processes through which it puts those materials, models or examples of the machinery with which it prepares and fashions them, and the tools which specially belong to it as a particular craft. Such a museum should also include illustrations of the progress of each industrial art from age to age ; of its dependence on the sister arts, and the extent to which it ministers to them ; of its relation to the products of our own country, and to those of foreign lands ; of the amount of wealth which it consumes, circulates, and produces ; of its healthfulness as a vocation for the different sexes and ages ; of its relation to good morals, and the service which it can render the State by employing the needy, increasing the comforts of the poor, advancing the civilisation of all classes, adding to the material, intellectual, and moral prosperity of the whole nation, and, through it, more or less of the entire world.

Now, instead of attempting a formal catalogue of all the arts which would thus be represented in an Industrial Museum, let us be content on this occasion to see how it would deal with glass in the several relations referred to. In the first place, then, the museum itself might be built of glass, like the Industrial Palace at Hyde Park in 1851, or the present Palace at Sydenham. The raw materials of glass, arranged in due order, would directly connect the museum with distant regions of the globe, and with men of various nations and of still more various professions. Thus, the sand used in glass-making is brought to Scotland from the Isle of Wight, from North and South America, and from Australia. The soda comes in part from our northern and western shores, in part from Spain and the Levant, in part from the natron lakes of Egypt : but most of the soda is made in our own country, by a complex chemical process from common salt, which involves the consumption of shiploads of sea salt from different parts of the world, of shiploads of sulphur dug up in Sicily, of shiploads of chalk or limestone quarried in England, and of shiploads and truckloads of coal mined in our coal districts.

The potash of flint glass is extracted from wood-ashes for us by the Americans, Canadians, and Russians. The lead of our flint glass is mined and smelted in Lanarkshire, Dumfriesshire, and Cumberland. The manganese, used both to bleach and to give a purple colour to glass, is brought from England, Spain, America, and the Continent. The copper used in staining it green, and the tin for white enamel, come from Cornwall. The cobalt, so extensively employed in colouring glass blue, is imported from the Saxon mines, or from those in the mountains of Norway. The silver, which stains glass yellow and orange, may be from Transylvania, Chili, or Peru, and the gold, which makes it ruby red, from California. There is thus a whole fleet of ships, and an entire battalion of sailors, engine-drivers, railway porters, colliers, quarrymen, miners, metal workers, and others, waiting on the glass-maker.

Again, the glass-work must be very carefully built by the mason and bricklayer, and the potter must exercise his greatest skill in furnishing suitable pots in which to melt the glass, and the brick-maker his skill in providing suitable fire-bricks for the furnaces.

Machinery is also needed to grind and mix the materials, and to move the glass-cutting wheels, as well as for other purposes, so that the mill-wright and mechanician, the engineer and carpenter, must lend their aid.

Again, the tools employed in fashioning glass are chiefly of iron, and the smith is needed for them ; nor will I detain you further by enumerating one by one the chemist to analyse, the artist to design, the managers, financiers, and multitude of unskilled labourers who must be connected with a glass-work. I might, I think, without expending any overplus of ingenuity, bring in all the other craftsmen under the wing of the glass-maker, and if restricted by my superiors to the illustration in the Industrial Museum only of glass-making, could include under that art all other arts, because they are needful to it, as it is to them. But my present motive in speaking thus is to make all perceive how full of profit, interest, and instruction an Industrial Museum could not but be to every honest, open-eyed visitor, no matter what his or her rank, vocation, tastes, or sympathies were, provided only there was some love of mankind in the heart, and some power of perception acting through the brain.

Take this matter of glass in proof thereof. Under what immeasurable obligations are all sections of mankind to the glass-maker, and with what interest should we study the properties of glass. But for the glass-maker, astronomy would now be but little advanced beyond its condition in the days of the Chaldean shepherds ; and in cloudy climates like our own, the great Newtons, and Hookes, Flamsteeds, and Herschels, who have triumphed by their optical instruments over all the gloom of our sullen heavens, would have abandoned to the lonely herdsman under cloudless eastern skies a science forbidden to them, or would have wasted their days in vain wishes that they had been called like David to follow upon Syrian hills "the ewes great with young."

But for the glass-maker, optics would be but the shadow of what it is. The telescope, the microscope, and the prism might never have been, and we might still be profoundly ignorant of the wonderful properties of light, and literally walking in darkness.

But for the glass-maker, the chemist would have remained an anomalous compound of the cook and the blacksmith, boiling and distilling in opaque vessels, through whose walls nothing could be seen, and blinding himself by staring into a furnace, where the changes which its heat was producing on substances exposed to its flames could not be traced otherwise than most imperfectly. Chemistry may, in truth, so far as the greater part of it is concerned, be defined as the "science of the glass vessel."

Natural philosophy, however, is scarcely less indebted than chemistry to the wonderful properties of glass. But for the glass-maker, there would be no transparent air pump, and, as a result, no satisfying knowledge of the air, and only a maimed and imperfect science of pneumatics and the gases.

But for the glass-maker, there would be no transparent barometer or thermometer, and meteorology would now be a science crippled from birth, and halting on both feet.

But for the glass-maker, we should have had no glass electrical machine, and had that not been in our hands for more than a hundred years, we should still be far distant from electric telegraphs, electric lights, electro-metallurgy, or lightning-conductors.

But for the glass-maker, we should have had no photography, and that most faithful of all artists, the sun, would still in vain be offering us the command of the pencil, which he had in vain been offering to the generations which preceded us for thousands of years.

But for the glass-maker, the botanist could never have tempted the palm-trees and bananas, the passion-flowers and camelias, the grapes and melons, and pine-apples of more sunny lands, to migrate to our cold island, and defy its rigours under a sky of glass; and he would have had no microscope to reveal to him the hidden marvels of their beautiful structure.

But for the glass-maker, the zoologist could not, as he now can, even though far inland, study better than even at the sea-side all the habits of the rarest and most fragile sea-creatures, and watch through the walls of their glass prison the ever-changing phenomena of their strange life.

But for the glass-maker, the anatomist would still, like the botanist, be without his microscope, and the knowledge which it has given him of the structures of the body; nor could he, as he does, preserve in transparent vessels, for detailed study by himself and others, those curious organs which it is his delight to unfold.

Such are some of the obligations of science to glass; but it is not theoretical science alone that is indebted to the glass-maker. The sailor on the outlook, the mariner doubtful of his latitude, the sentinel at his post, the engineer planning a siege, the general guiding a battle, the surveyor mapping out the globe, the engraver, the watchmaker, and many other practicist on the great and small scale, are beholden to the glass of their telescopes, sextants, theodolites, and magnifying lenses, for the success, not to say the perfection of their arts. The health and beauty of the whole community are ministered to by the large modern transparent window, the glass lamp-shade, and glass drinking-vessel, and its beauty is especially cared for by the modern looking-glass.

It is curious, indeed, to see how many useful objects appropriate to themselves as sufficiently distinctive the one word "glass." The thirsty man calls his drinking-vessel a glass. The sailor looks out for his land-marks with a glass. The beauty gazes into a glass. Best of all, the otherwise blind man, grateful to the special artist we are praising for his gift (with reverence I use the words) of "eyes to the blind," calls his spectacles "glasses."

Lastly, if we do not yet see winter gardens domed with glass, where invalids may realise a Madeira at home, or, at least, throw away their respirators, and be forgetful of the east wind; at all events we have our Crystal Palaces, which more than most human productions resemble divine ones, inasmuch as they are at once as perfect as mechanical works and pieces of engineering, as they are as works of beauty.

Whilst in the Crystal Palace the lover of mathematical precision in squaring sheets of glass, and in piecing them together in multiples of the dimensions of each single sheet, and the delighted calculator of the proper length, breadth, and thickness of iron pillars, cross-ties, and girders, might enjoy himself to the full; the artist, blind to these things which he could not see, though his eyes were open, might admire the beautiful result, for him as causeless as the glory of a flower, which, nevertheless, is realised in conformity with mathematical and numerical laws, as much more rigid than those observed in the construction of a Crystal Palace as the glory of a flower exceeds the glory of the grandest edifice that man can plan.

Had I been privileged, as some of my friends were, to walk alone by midsummer twilight through the long aisles and arcades of the first and most famous Crystal Palace of 1851, I should not have paced its solitary courts without thinking of it as an emblem of this earth, with its over-arching, half-revealing, half-concealing sky, or without remembering that St. Paul, spanning by a divine standard the horizon of man's knowledge in all directions, declared that "here we see through (or in) a glass darkly." This earth is for the industrial man a transparent bee-hive; for the æsthetical man, a covered garden and green-house, full of flowers, and statues, and birds of song; for the scientific man, a dark diving-bell, with mere eyelets to admit the light, lying at the bottom of the ocean, which he longs to explore; and for all men, however thin and invisible the walls at times may appear, it is a prison; and, as Shelley sang—

> "Life, like a dome of many-coloured glass,
> Stains the white radiance of Eternity,
> Until Death tramples it to fragments."

Such are some of the modes in which the glass objects collected in an Industrial Museum might instruct and interest its visitors, whatever their tastes or inclinations.

Pottery would have equally served to illustrate the idea and aims of such a museum. It takes its name from the word "pot," by which is generally understood a cooking-vessel; but in its earlier and quite innocent meaning it signified a drinking vessel, and is connected with our terms "potion" and "potation." The French have borrowed from the Greeks, and transferred to us the term "Ceramic," to denote the art of the potter. If those philologists are right who derive this word from the ancient Hellenic name of a horn, *i.e.* a drinking horn, then potter's art and Ceramic art have exactly the same signification. But both these derivations, favoured by the French writers on the art under notice, are disallowed by our ablest English classical scholars. We have, certainly, from the Latin the term "fictile" art, in allusion to the great plasticity of unbaked clay.

Fictile is the best title, if we are to employ a foreign word, not very familiar to all. This I am slow to do, but we have scarcely a choice, for no adjective is readily derivable from the word "pottery," whilst such an adjective is often needed.

The plasticity of wet clay is its characteristic property, and permits it to be moulded into all shapes. The potter from the oldest times has turned this to ample account by that very ancient machine, the potter's wheel, of which, did time permit, I could say much. I will only observe on the whole subject that, keeping to our own old English word "pottery," we include under it two things, namely, earthenware, *i.e.*, earth or clay (silicate of alumina), baked in the sun, or burned in the kiln, and china or porcelain. The last word is said to be derived through the Portuguese, from the same Latin root which yields our English term pork. The Portuguese, after their discovery of the passage to the East round the Cape of Good Hope, brought the fictile productions of China, for the first time, largely to Europe. They called the material of those wares porcelain, from its surface and polish resembling those of certain shells belonging to the genus Cypræa, often seen on our mantelpieces, and familiar, probably to all, as represented by the common cowry. These shells they had long been in the habit of likening to young swine, and to them they also likened the porcelain cups, which they thought resembled them.

By a curious coincidence we have long been in the custom in Scotland of applying the term "pig" to a stoneware vessel; a use of the word which surprises an Englishman, and still more an Irishman, but would probably please a Portuguese. Our Scotch term, which is not generally associated with the notion of an animal, is said to be of Celtic origin, but this seems scarcely reconcileable with its wide employment in our Lowlands, where I believe it is more familiar than in the Gaelic districts of the country. Be this as it may, we can find an expressive English term for china or porcelain. Earthenware is otherwise clayware, *i.e.*, clay or crumbled felspar (silicate of alumina), thoroughly dried, and intesely heated, but not fused or vitrified. Porcelain is clay and glassware, *i.e.*, clay and vitreous matter (which may be of many kinds) incorporated, and heated till they are semifused into a mass, which combines the opaque rigidity and earthiness of the clay, with the transparency and elasticity of the glass. Between indurated earth, such as we have in a flower-pot, and perfect glass, we may produce by suitable mixtures a very large number of intermediate "wares," admitting of almost endless modifications, and of application to as many arts.

Under clay, and the alumina (oxide of aluminium) which occurs in it, large reference might be made to the applications of compounds of alumina in dyeing and pigment making, but I will only make a reference to the metal of clay, aluminium. Take from the non-silicious earth (alumina), which is one of the two constituents of clay, its oxygen, and a metal remains, aluminium. It is most easily prepared from a beautiful mineral called cryolite, from its resemblance to ice, and containing the metal united with sodium and fluorine. Aluminium is spoken of as rivalling silver in brilliancy; but those who wish it to pass for such would do well to recall what Caleb Balderstone said, when he tried to make the polished pewter flagons of the Master of Ravenswood pass for plate—"I think it may do; I think it might pass, if they winna bring it ower muckle in the licht of the window." Aluminium certainly more resembles tin or pewter than silver in lustre. Its better qualities are its little liability to tarnish, and consequent cleanliness, its great lightness, which places it for the present, so far as many useful purposes are concerned, above all the other metals, and its remarkable sonorousness, which gives it a peculiar value as a material for bells, gongs, and musical instruments. Should it hereafter be used instead of silver for table services, it will be curious to consider how little at any time has been the difference between the poor-man's stoneware platter and the rich man's plate. In the platter there are two metals united with oxygen in the plate, one which is free. It is not improbable that the two metals in question, aluminium and silicium, will hereafter rival silver in economic, if not in monetary value. But to such speculations of industrial science there is no end.

HISTORY OF THE GOLD DISCOVERIES IN NEW ZEALAND.

The early history of the discovery of gold in New Zealand is enveloped in a good deal of uncertainty. It is somewhat singular that the Maoris, sprung as they are supposed to be from the Asiatics of the Indian Archipelago, have no traditionary knowledge of the precious metals, nor do ornaments of gold or silver appear at any time to have been in their possession. There is, therefore, fair ground for supposing that Europeans were the first to discover gold in New Zealand—or at least the first to make any practical use of the discovery. As far as the records of the colony go, gold may be said to have been first discovered in New Zealand in 1842, by a small exploring party under Captain Wakefield, while engaged in examining the country in Massacre Bay for coal and limestone. Several specks of gold, in quantities sufficient at the present day to cause a large "rush," were found, but the discovery seems to have been regarded as simply an interesting and curious accident. When the party returned to Nelson and mentioned having found gold, the story was not considered entitled to much credit or importance, and no attempt was made to verify the statement. It is a singular fact that although the coal and limestone deposits, in the vicinity of which the particles of gold had been found, were afterwards worked by the settlers, no further auriferous indications were noticed by the workers, who probably had not cared to remember the story told by Captain Wakefield's party ; and it was not until fourteen years afterwards that the attention of the colonists was again drawn to this locality as a gold-bearing district.

From 1842 until nearly ten years afterwards, the history of the gold discoveries is very vague. A Mr. Palmer, an old settler in the Province of Otago, informed Mr. Pyke, the Secretary of the Otago Gold Fields Department, that many years prior to the settlement of that Province in 1848, a native chief, Tuawaiki by name, had assured him that far in the interior "plenty *ferro*," or yellow stone, similar in appearance to the seals worn by the white men, could be obtained. The country of the Upper Molyneux or Clutha River was also indicated by the Maori, as a locality in which the *ferro* could be found. It is difficult to reconcile this story with the singular ignorance of the uses and value of gold enjoyed by the Maoris. In every country where gold has been found to exist—at any rate, in such quantities as to occasion remark—we invariably find that the native inhabitants have made some use of the metal, generally, if not always, as an article of ornament. The Maoris are not indifferent to the adornment of their persons, and we know that in the case of the "pœnamu," or green-stone, they took considerable pains to procure substances adapted to ornamental purposes. We are inclined to consider Tuawaiki's story as somewhat legendary.

Few persons, in speaking of the gold fields of New Zealand, possess a full knowledge of their extent and importance, and still less of the history of gold discoveries in this colony. It is not too much to say that New Zealand, in comparison to its area, is more extensively auriferous than any known gold-bearing country. From Coromandel down to the mouth of the Molyneux River, or for a distance of a thousand miles, gold is found in greater or less quantity, at various points. The progress of discovery has been far greater in the Middle Island, but there is every reason to believe that when the alluvial plains and flats of the Thames and Waikato rivers are thrown open to the researches of the gold-seeker, gold fields, rivalling those of Otago, will be discovered.

Gold is now being successfully worked in several parts of the colony. At Coromandel, in the Province of Auckland ; at Massacre Bay, and in the Buller Wanganui, Lyell, and Wangapeka rivers, in the Province of Nelson ; at Teramakau, on the West Coast of Canterbury ; and over a very considerable area of the Province of Otago.

The year 1852 was marked by the discovery of gold almost simultaneously at opposite ends of the colony, viz., at Auckland and Otago. By this time the important discoveries in California and Australia had imparted an increased value to the vague statements of the Maori and earlier European inhabitants of New Zealand, and many attempts were made to discover the auriferous indications reported to exist. In March, 1852, a party of five Europeans, one of whom had worked for gold in California, started in a whale boat up the Molyneux River, in search for gold. They had been induced to this expedition by the reports of some Maoris. The account of this expedition is thus given by one of the individuals engaged in it, Mr. T. B. Archibald, of Pomahaka :—

"Nearly all the Maori residents at the Molyneux, at the time of our excursion, were strangers, having been only a few years in the place. There were only a man and woman who knew the country between the mouth of the river and the Lakes. The man, Raki Raki, had resided on the Wakatipu Lake, but had left many years ago. He left a brother, who had two wives, behind ; and who, he said, were the only Maoris in the interior. He told me he once picked up a piece of 'simon' (gold) about the size of a small potato on the banks of the Molyneux, but did not know its value, and he threw it into the river. They told us they had seen the small 'simon' on the sides of the river, where three canoes had been lying. On seeing a small sample of gold (which, I think, Mr. Meredith brought down from Tasmania, about the beginning of 1852), the natives were the more convinced we should find it in the sands of the Molyneux. As some of us were on the eve of starting for Australia, we thought we would give the river a trial first, more especially as we had the services of a Californian miner, who had left a whaling vessel in the bay. We made a party of five, and started up the river in March, 1852, in a whale boat which I brought from Dunedin. We prospected the bars and banks of the river, as far as a creek, now named the Beaumont. As none of us knew anything about gold-seeking, except the American, and getting nothing more than the color, we resolved to return, after having nearly a three weeks' cruise ; the more so, as the river seemed a succession of rapids, which it was difficult to get the boat through. If our Californian miner had been the practical man he represented himself to be, I have no doubt we should have been successful at least in getting a good prospect."

In the same year, several specimens of quartz, supposed to be auriferous, were sent from Otago to the New Zealand Society at Wellington ; but after a careful analysis only a few specks could be found, and the opinion was expressed that the discovery was of no value. The discovery of gold at Coromandel in this year (1852) was of much greater importance, and attracted considerable attention throughout the colony. Small pieces of gold were found in a stream running into Coromandel Bay, and further search revealed the existence of other strong indications of the auriferous nature of the ground. There were many persons living in Auckland who had worked in the gold fields of Victoria, and they immediately conceived that the glories of Bendigo and Ballaarat were to be reproduced at Coromandel. Auckland went wild with excitement, and a great rush of people took place to the locality of the new discovery. But the work of prospecting was checked by the opposition of the natives to whom the land in the Coromandel district belonged. The Maoris looked with great disfavour on this sudden invasion by a host of unprincipled and unscrupulous diggers, and at once prohibited the Europeans coming on the land to search for gold. Serious complications would have arisen had not Sir George Grey, then Governor of the colony, succeeded in concluding an arrangement with the natives, by which, for a certain payment, the permission to dig for gold was given. But beyond a very partial examination of the district, nothing was done to develop the supposed auriferous resources of Coromandel; and the excitement died out almost as speedily as it had arisen. Gold was found, it is true, but its possession was only secured at a cost of labour and appliances exceeding the value of the metal obtained. Some 1,100 ounces of gold were thus procured after much trouble and great outlay. Of course this process was too unprofitable to last, and the diggings became quickly deserted. It is believed that the natives continued to find gold in the district after its desertion by the Europeans, but nothing like a systematic search was made. Occasional visits were paid by some of the more ardent believers in the gold-bearing character of the district, and specimens of auriferous quartz were frequently brought surreptitiously to Auckland, where, however, they served only as interesting additions to geological cabinets, all public excitement on the subject having subsided.

In 1856, Nelson was again the scene of further gold discoveries, gold having been found in the Motueka district. This time the rumoured discovery of the precious metal was eagerly caught up, and a large number of anxious gold-seekers at once rushed to the spot. But the gold was found to be exceedingly minute in quantity, and quite unremunerative to work, consequently the diggers were not long before they left the place, and Nelson again subsided into its wonted quiescent state.

In the same year, Mr. C. W. Ligar, then the Surveyor-General of New Zealand, and who at present fills a similar position in the colony of Victoria, wrote officially to the then Superintendent of Otago (Captain W. Cargill) stating that during a visit to the south part of Otago he had found gold very generally distributed in the gravel sand of the Mataura River, and expressing the opinion that a remunerative gold field existed in that locality. Strange as it may seem, the Pilgrim Fathers of Otago paid no particular attention to Mr. Ligar's statement, and it appears to have attracted but little notice at the time anywhere. Later, Mr. Thomson, the Provincial Surveyor of Otago, whilst engaged on a reconnaissance survey of the Province, found gold distributed over several localities, but he expressed the opinion that it did not exist in sufficient quantity to pay for working.

In the early part of 1857, the Massacre Bay district, in the Nelson Province, again excited public attention, gold having, it was alleged, been found in payable quantities not far from the deserted diggings of Motueka. The new discovery was made by a storekeeper in Nelson, who, in company with a man who had had some experience in gold mining in Australia, visited Aorere to prospect for gold, induced thereto by a reward of 500*l*., which the Nelson merchants had offered for the discovery of a payable gold field. The two adventurers found gold readily in most of the gullies and places that they tested, and some three or four ounces were brought back to Nelson. The discovery having been made known, a considerable number of persons flocked to the place, and a systematic search took place, which was attended with considerable success. The population rapidly increased, and within three or four months of the discovery, about 1,000 persons were working on the spot. A township sprung up, and in an incredibly short space of time, shops, stores, and hotels were erected, and a Custom House established. But during the summer months no provision had been made for the ensuing winter. There were no roads, and the communication with Nelson was unfrequent and tedious. When winter arrived, it found the miners utterly unprovided against its severities, and great distress ensued. Numbers left, and a temporary falling off in the yield of gold caused a partial rush from the place, and although fair average returns continued to be made, the population never again reached its former number. Some estimate may be formed of the extent and value of these diggings from the fact that up to the 1st October, 1858, 16,473 ounces of gold, the produce of this gold field, passed through the Custom House.

The richest diggings on the Aorere gold field were on the Slate River, a stream which takes its rise in the Anatoki range, and afterwards falls into the Aorere. On each side of the river are high precipitous banks, composed of slate, quartz, and granite rocks, 400 or 500 feet high, and mostly clothed with dense forest to the water's edge. The river bed was filled with huge boulders, lying on the top of ridges of slate, which run across the river, and it was in these ridges or crevices, in yellow gravel, that the heaviest gold was found. The cases of individual success were numerous and brilliant, some lucky miners getting as much as a pound weight per day. The gold was traced up into the Anatoki or Snowy range, and heavy nuggets found.

In the latter part of 1857, the Provincial Government of Otago, influenced by the rumour of the existence of gold, offered a reward of 500*l*. for the discovery of a payable gold field. It is curious to note what the idea of a "payable" gold field was. The conditions of the reward were to the following effect :—One moiety of the reward to be paid when a quantity of gold exceeding 100 oz. should have been brought to Dunedin or exported from the Province within any one year, and the balance of the reward to be paid when 500 oz. should have been exported. Singularly enough, this reward had hardly been announced, when Mr. R. Gillies, Sub-Assistant Surveyor, wrote stating that he and party had found gold in a creek running between the Waikioi and Makerewa bush, and emptying itself into the Makerewa. Their attention was drawn by the very large amount of mica mixed with the quartz gravel, iron-sand, and blue clay forming the bed of the creek. Mr. Assistant-Surveyor Garvie also confirmed about this time the existence of gold in Otago. During a reconnaisance survey of the south-eastern district of the province, he found traces of gold in the gravel and sand of several streams and rivers. One of the survey party happened to have previously worked on the Australian gold fields, and his experience was of considerable value in the searches that were made. The gold found was small and scaly, and the opinion was expressed that it existed in several localities in payable quantity. It was ascertained that a man named Peters had for some time been engaged in obtaining small quantities of gold from the sands of the Tokomairiro River, now known as the Woolshed Diggings, and from which large quantities of gold have been taken.

In March, 1858, Mr. Garvie brought down to Dunedin some specimens of gold which he had obtained in the neighbourhood of the Dunstan ranges. The gold was mixed with iron-sand and oxide of tin, and found in every dishful of earth they washed. And yet this district was the site of Hartley and Reilly's great discovery four years afterwards. On the 23rd of the same month, Mr. Garvie wrote as follows to the Chief Surveyor of Otago :—"I have the honour to inform you, that while engaged in the survey of the Tuapeka country, one of the men belonging to my party discovered gold to be pretty freely distributed even among the surface gravel near the mouth of this stream." Still no public interest appeared to be felt in the discovery. Well might the local newspaper comment on the strange apathy of the people. During this year (1858) gold was also found in the Lindis River, in the north-eastern part of Otago.

The Nelson gold fields were tolerably prosperous during the year, but a prevalence of very heavy floods, which swept away the tools and appliances of the miners, interfered considerably with mining operations, and the yield of gold fell off. Still fresh discoveries continued to be made, and great confidence was expressed in the permanency of the diggings. In the early part of 1859, several large nuggets were found in the Rocky River, weighing from two to nine ounces. In March, gold was found on the Waikaro, for a distance of nearly twenty miles along the bed of the river. During 1860, the population on the Aorere gold fields suffered considerable diminution, and although the yield of gold bore a very satisfactory proportion to those engaged in the pursuit, there was no excitement, and but very little attention was paid to the diggings out of the Nelson Province.

In March, 1861, gold was found in sufficient quantity to create excitement, by a number of road makers, in the River Lindis, a tributary of the Molyneux River, in the Otago Province. The gold found consisted of large, water-worn nuggets about the size of a bean. Immediately on the discovery being made public a considerable number of persons abandoned their ordinary employments for the more tempting and exciting pursuit of gold-seeking. Some three or four hundred people proceeded to the scene of the new discovery, but only a small proportion obtained any gold worth the labour and expense of procuring, and in a short time the diggings were deserted by all but a few experienced hands, who managed to earn good wages. Just about this time gold was discovered on the Kakanui, and also near Moeraki. The credit of discovering gold in the Lihdis was claimed by a man named M'Intyre, who was induced to search for it in consequence of the resemblance the district bore to the gold-bearing regions of California, where he had previously worked. He found gold in small quantities from the Lindis River to the Hamea Lake. In the early part of this year (1861) the Nelson gold fields again attracted the notice of the colonists. The older diggings were yielding satisfactorily, and several important new discoveries were made. The Wangapeka River was found to be gold-bearing, and the reports spread concerning its auriferous character caused great excitement throughout the colony. The season was, however, unfavourable for mining operations, and the real value of the discovery was not ascertained for some time afterwards. News was also received of the discovery of gold on the west coast, some Maoris having brought to Nelson 27 ounces of gold procured in the most primitive manner. These natives had picked up a slight knowledge af gold mining on the Aorere gold field, and on returning to visit their settlement on the west coast they had fossicked about the banks of the River Buller, and found gold without much difficulty. The gold was found about 25 miles from the mouth of the river. This statement produced great excitement amongst the Nelson people, and despite the very difficult nature of the country between Nelson and the Buller, and the approach of winter, a number of adventurous miners set out for the scene of the new discovery.

In the month of June, 1861, a discovery was made in the Province of Otago which was destined to exercise an enormous influence on the future, not only on the whole of that Province, but of the whole colony of New Zealand. Mr. Gabriel Reid had been led by curiosity to attempt to verify the reported presence of gold, and in the course of his prospecting expedition had examined the ravines and tributaries of the Waitahuna and Tuapeka rivers. His only tools were a tin dish and butcher's knife, but in one place he succeeded in collecting seven ounces of gold for ten hours' work, and obtained gold in payable quantities in various creeks and gullies. At first Mr. Read's statements were received with a good deal of incredulity, but further investigation proved their correctness. The most promising indications were found in the valley of the Tuapeka River, as much as seven pounds weight being procured by one party in a few days with the most simple appliances. The existence of a rich gold field on this spot was so conclusively established that the Provincial Government felt justified in giving official publicity to the fact, and immediate measures were taken for developing the district and for the preservation of order. Of the results of this publicity much need not be said, as all who then lived in New Zealand will remember the excitement created, and the commotion into which the colony was thrown. The purpose of this article is more particularly to trace the more important discoveries of gold which have from time to time been made in various parts of New Zealand. Following rapidly on the discoveries of Gabriel Read came several others of minor note, and in the early part of 1862 discoveries of gold were made on the Waipori River and its tributaries, and those of Mount Highlay and Shag River. But in August of that year a discovery was made public surpassing in importance even that by Gabriel Read. Two men, named James Hartley and David Reilly, both of whom had worked for gold in California, and one of whom, Hartley, was a most intelligent American, and of great experience in gold mining, set out in the month of February on a prospecting tour up the Molyneux River. It appears that they were led to this expedition by the striking resemblance the country of the Upper Clutha (or Molyneux) bore to the gold-bearing districts of California and British Columbia. Their expedition was a hazardous one. The country was difficult to traverse, desolate, and inhabited only by a few shepherds, living miles apart from each other. The prospectors had to use the double precaution of providing a sufficient stock of supplies for the expedition, and of not taking with them such a quantity as would rouse the suspicions of men who like themselves were on the look-out for fresh diggings. However, they started, and amidst hardships and difficulties of no common kind they penetrated the country of the Upper Molyneux. And richly were they rewarded. They found gold literally paving the bed of the river, and without trouble and with the simplest apparatus they obtained a golden harvest. "We had nothing to do," said Hartley, "but to set the cradle at the edge of the river and keep it going from morning to night, as one could get dirt to feed the cradle as fast as the other could wash it. Several times did their provisions run out, and they had to resort to many ingenious shifts to conceal their rendezvous and occupation. One of the party would set off perhaps to a distance of fifty, sixty, or one hundred miles for provisions, leaving his partner to go on collecting the precious wash-dirt. These men paid several vessels to Dunedin and other places in order to sell gold and purchase horses and provisions, but at last various signs of their being "watched" induced them to return to Dunedin and endeavour to sell their secret to the Government. In the early part of August these men deposited in the Treasury at Dunedin, a bag of gold containing 87 pounds weight. They declined to inform the gold receiver whence such a splendid haul had been obtained, and led him to imagine it came from a quite a different locality to its true origin. Of course the gold receiver mentioned the matter to some one else, and some one else to the newspapers, and the public of Dunedin were on the following morning startled from their propriety by the announcement in the largest type that eighty-seven pounds weight of gold had been brought in from somewhere near Waikouaiti. The Government obtained the necessary information from the lucky discoverers on certain conditions of reward. As soon as the locality of the discovery was made public a tremendous "rush" took place thither, and in a few weeks the banks of the Molyneux were lined for miles on either side with thousands of busy miners. The gold field was named the Dunstan, by which it is still known. Soon afterwards gold was found on the Nokomai River, and in numerous streams and gullies branching from the Molyneux.

In the early part of 1862, the Coromandel diggings again attracted attention. Some fresh discoveries were made, which established the auriferous character of the district, and considerable excitement in Auckland was the result. As soon as publicity was given to the new discovery, a number of miners at once flocked to the spot. But the natives, with whom at this time the relations of the Government were not of the most satisfactory kind, warned the prospectors off the land, and refused to allow gold-digging to be carried on in their territory. Public meetings were held at Auckland, and the Government was urged to make arrangements with the native owners for the working of the ground. An attempt was made by one of the then Ministry to come to terms with the Maoris, but they demauded so exorbitant a sum for the privilege of working on the ground, that it was feared the negotiations would have fallen through. His Excellency Sir George Grey, however, was more successful, and for an equitable consideration the natives consented to allow the miners to work. A large number of persons soon assembled at Coromandel, and numerous shafts were sunk into the quartz reefs with which the district abounds. The peculiar nature of the deposit of gold, however, interposed great difficulties in the way of individual effort, and it was necessary to the proper development of the undoubted auriferous resources of the district that the work should be done by means of co-operation. Several companies were formed, and the results of their exertions, if uot positively remunerative, were satisfactory, in so far as proving the existence of deposits of gold in sufficient quantity to pay, if worked economically and on intelligent systems. It is a fact, however, that the machinery brought to bear was of a coarse aud imperfect character, and the various companies were not strong enough, nor had the shareholders that firm conviction in the auriferous wealth of the district, to ensure success. The disturbed state of the country, and the counter attractions of the alluvial diggings of Otago, caused most of the miners to leave Coromandel. There can, however, be no doubt that the whole of the Coromandel district and other localities in the Auckland Province are richly auriferous. No opportunity has yet been afforded of testing the alluvial plains of the Thames and Waikato rivers; but there is every reason to hope that they will yet form the sites of valuable gold fields.

The Nelson diggings also shared the attention of gold-seekers in 1862. The discoveries of gold reported by the Maoris at the Buller and

Wanganui Rivers drew a considerable number of miners to those places, and the West Coast diggings eclipsed in attraction those of Aorere and Wangapeka. Individual success of a very brilliant nature was common; but the great difficulties and danger of the country and the unaccountable apathy of the local Government have, up to the present time, hindered the development of auriferous resources, which there is a fair reason to believe are equal to anything that has yet been discovered in New Zealand. What an impetus might have been given to the progress of the Nelson Province may be fairly imagined by the extraordinary advancement of Otago. Had the Nelson Government used even ordinary exertion to develop the golden resources of the province, it might by this time have enjoyed a revenue second only to that of Otago.

In the latter part of 1862 and beginning of 1863, large additions were made to the gold fields of the colony. In the early part of the year, the rich discoveries on the Wakatipu Lake and its tributaries were revealed. Some of these discoveries were made in the most accidental manner. For instance, a party of miners found gold near the Cardrona in the following manner, as related by one of the party, a man named Grogan :—

"On the 9th November, whilst a band of diggers were camped on the banks of the Cardrona, Mullins and myself took a walk to see how that part of the country looked, and in walking along the side of the river, where what I call a slide had occurred, there had been a track formed by the cattle. I being a little further up the creek, sat down until he came up, and he immediately told me that some persons must have lost some gold, and produced about four pennyweights that he got on the cattle track. We still continued up the creek, until we thought it time to return to our camping ground ; and on our way back he showed me the place, and on searching for more we could get more ; and from the appearance of the black soil, we certainly thought it must have been lost by Fox, or some person. . . . On Tuesday, the 11th, after receiving some information as to whereabouts Fox was working, myself and mates were ahead of others ; and on coming to this place, I took my swag and laid it on the bank. 'There,' said I, 'is where the gold was got.' Then I walked to the spot, and on breaking up the surface, the first thing I discovered was a bit about three pennyweights, and that afterwards we nuggeted out nine ounces six pennyweights twelve grains, which all hands that were there could see."

Probably the richest gold-bearing stream in the colony is the Shotover River, which takes it rise in the lofty and almost inaccessible range of mountains which extend to the north of the Wakatipu Lake. Some of the earlier workers on this and adjacent streams obtained gold literally by the hundredweight, and many of the more fortunate claimholders realised large fortunes. The great drawbacks of this region are the sudden and frequent floods, which almost without warning come rushing down, and sweep away the dams, sluices, and other mining contrivances. In winter, the greater part of the country, from the Wakatipu

Lake right across to the Molyneux, is closed to mining operations, except in the most sheltered spots. The heavy rains and sudden alternations of temperature cause immense hardships, which in some cases have resulted in great loss of life. But in spite of all these drawbacks, this region is yet the most favourite resort of the skilled miners, and under ordinary circumstances gold mining in this district is as profitable as it is on any known gold field in the world. During the last year further evidence of the richness of the Nelson West coast diggings was afforded, but the lack of encouragement which the miners have sustained at the hands of the local authorities has hindered, and will continue to hinder, the development of the country. Judging from occasional cases of success, the Lyell and Buller River diggings are much of the same character as those on the Shotover and Arrow rivers in Otago, but the utter want of roads, the scarcity of provisions, and other causes, have interposed almost insurmountable obstacles in the way of miners. Gold in small quantity has been found at Teremakau, on the west coast of Canterbury, but it is questionable whether a payable gold field exists there. Still it is possible a belt of auriferous country may be found north of the Awarora River, and above the Hawea and Wanaka Lakes.

There has been much speculation as to the auriferous character or otherwise of the west coast of Otago, and numerous parties of adventurous miners have explored the country for gold. But the results of many expeditions discourage the idea of finding any gold field on the west coast of Otago. In addition to the testimony of the several parties of prospectors who have examined the country almost the entire length of the coast, we have the expressed opinion of Dr. Hector, the Provincial Geologist of Otago, that the physical structure of the western seaboard of Otago forbids the expectation of important auriferous deposits. At present, the known gold-bearing area of the middle island commences to the eastward of a line drawn from the mouth of the Matura River, through the Wakatipu Lake to Martin's Bay, thence across the foot of the Hamea and Wanaka Lakes to the Waitaki River; there is a small strip of country on the Teramakau River that is gold-bearing, and there is then a break until we get to the Buller, and it is supposed that nearly the whole of the streams on the coastline from Cape Foulwind to the Motueka are auriferous. But the ruggedness of the country is much against its development. Auriferous signs are reported to exist in Queen Charlotte's Sound, but no authenticated account has been given. The known auriferous area of the North Island is confined to the Coromandel district, but there is every reason to believe that the whole of the peninsula is auriferous, and that rich alluvial diggings will be found in the valley of the Thames and on the Waikato. Gold is said to have been seen near Raglan, and also in the Hawke's Bay Province. Probably, when the North Island becomes more open to the researches of Europeans, gold fields will be found in places where their presence is not now suspected.

LABORATORY NOTES.

MUSEUM OF IRISH INDUSTRY, DUBLIN.

The four following analyses are by WILLIAM PLUNKETT, F.C.S., Assistant Chemist to the Museum.

MAIN SEAM COAL, 4 feet 6 inches thick, Ballycastle Colliery West; Antrim Coal Field.

Absolute Heating Power of the Coal.

13·29 lbs. of water at 212 deg. F. converted into steam by 1 lb. of the coal.

1058·0 lbs. of water at 212 deg. F. converted into steam by 1 cubic foot of the coal.

Proximate Composition of the Coal.

Water	7·45
Volatile combustible matter	37·25
Fixed carbon (coke)	51·10
Ash	4·20
	100·00
Amount of sulphur in volatile portion	0·49
Amount of sulphur in non-volatile portion	0·22
Total amount of sulphur in 100 parts	0·71
Percentage of nitrogen	0·95
Specific gravity of the coal	1·273

COAL from the Coalbrooke Colliery, Tipperary Coal Field.

Absolute Heating Power of the Coal.

7·29 lbs of water, at 212 deg. F. converted into steam by 1 lb. of the coal.

768·2 lbs of water at 212 deg. F. converted into steam by 1 cubic foot of the coal.

Proximate Composition of the Coal.

Water	6·47
Volatile combustible matter	5·74
Fixed carbon (coke)	74·80
Ash	12·99
	100·00
Amount of sulphur in volatile portion	0·27
Amount of sulphur in non-volatile portion	2·34
Total amount of sulphur in 100 parts	2·61
Percentage of nitrogen	0·07
Specific gravity of the coal	1·686

BITUMINOUS COAL from Lough Alten (Arigua) District; Leitrim Coal Field.

Absolute Heating Power of the Coal.

12·65 lbs. of water at 212 deg. F. converted into steam by 1 lb. of the coal.

1082·37 lbs. of water at 212 deg. F. converted into steam by 1 cubic foot of the coal.

Proximate Composition of the Coal.

Water	1·72
Volatile combustible matter	19·05
Fixed carbon (coke)	71·60
Ash	7·63
	100·00
Amount of sulphur in volatile portion	1·156
Amount of sulphur in non-volatile portion	0·717
	1·873
Percentage of nitrogen	0·341
Specific gravity of the coal	1·369

COAL from the third seam from Gubbarudda Colliery, Valley of Arigua; Connaught Coal Field.

Absolute Heating Power of the Coal.

14·29 lbs. of water at 212 deg. F. converted into steam by 1 lb. of the coal.

1193·0 lbs. of water at 212 deg. F. converted into steam by 1 cubic foot of the coal.

Proximate Composition of the Coal.

Water	1·12
Volatile combustible matter	16·55
Fixed carbon (coke)	74·46
Ash	7·52
	99·65
Amount of sulphur in volatile portion	0·34
Amount of sulphur in non-volatile portion	0·64
Total amount of sulphur in 100 parts	0.98
Percentage of nitrogen	0·76
Specific gravity of the coal	1·336

COKE MANUFACTURED FROM THE UNWASHED CULM OF THE SELTANNASKEAGH COLLIERY, CONNAUGHT COAL FIELDS.—By SYDNEY R. PONTIFEX, Student in the Laboratory.

Absolute Heating Power of the Coke.

6·51 lbs. of water at 212 deg. F. converted into steam by 1 lb. of the coke.

769·35 lbs. of water at 212 deg. F. converted into steam by 1 cubic foot of the coke.

Proximate Composition of the Coke.

Water	0.25
Volatile combustible matter	5·33
Fixed carbon (coke)	90·64
Ash	3·78
	100·00
Amount of sulphur in 100 parts of the coke	0·792
Percentage of nitrogen	0.285
Specific gravity of the coke	1·891

Determination of the Specific Gravity of Specimens of Different Kinds of Wood from British Guiana. By William Plunkett, F.C.S., Assistant Chemist.

1. *Turiballi, Eureballg, or Guiana Mahogany.*—Specific gravity, 0·74; weight of 1 cubic foot, 46·3 lbs.

2. *Greenheart, or Spiri.*—Specific gravity, 1·08; weight of 1 cubic foot, 67·5 lbs.

3. *Sirebadany.*—Specific gravity, 0·98; weight of 1 cubic foot, 61·3 lbs.

4. *Suradani, or Dalina.*—Specific gravity, 0·77; weight of 1 cubic foot, 48·1 lbs.

5. *Banya, Bannia, or Guiana Ebony.*—Specific gravity, 1·23; weight of 1 cubic foot, 76·8 lbs.

6. *Purple Heart, or Courabarilla.*—Specific gravity, 0·69; weight of 1 cubic foot, 43·1 lbs.

7. *Carisiri, Carra-Seri, or Black Lancewood.*—Specific gravity, 0·70; weight of 1 cubic foot, 43·8 lbs.

8. *Brown Silverballi.*—Specific gravity, 0·57; weight of 1 cubic foot, 35·6 lbs.

9. *Duculiballi.*—Specific gravity, 1·02; weight of 1 cubic foot, 63·8 lbs.

10. *Kretti, or Bastard Silverballi.*—Specific gravity, 0.44; weight of 1 cubic foot, 27·5 lbs.

11. *Horbaballie, or Surinam Snakewood.*—Specific gravity, 0·71; weight of 1 cubic foot, 44·4 lbs.

12. *Breadnut.*—Specific gravity, 0·53; weight of 1 cubic foot, 33·1 lbs.

13. *Mora.*—Specific gravity, 1·1; weight of 1 cubic foot, 68·8 lbs.

14. *Hyaroabally.*—Specific gravity, 1·07; weight of 1 cubic foot, 66·9 lbs.

15. *Bully Tree.*—Specific gravity, 1·12; weight of 1 cubic foot, 70·0 lbs.

16. *Letter Wood, or Brazil Wood.*—Specific gravity, 1·36; weight of 1 cubic foot, 85 lbs.

18. *Yellow Silverballi.*—Specific gravity, 0·68 ; weight of 1 cubic foot, 42·5 lbs.

18. *Tiger Wood.*—Specific gravity, 0·88 ; weight of 1 cubic foot, 55 lbs.

19. *Red Cedar-tree Wood.*—Specific gravity, 0·58 ; weight of 1 cubic foot, 36·3 lbs.

20. *Tabiecushi, or Tibicusi.*—Specific gravity, 1·30 ; weight of 1 cubic foot, 81·3 lbs.

Composition of Finzel's Crystallized Sugar.—By Wm. I. Wonfor, Student in the Laboratory of the Museum.

A fine sample of crystallized sugar, manufactured by Messrs. Finzel, of Bristol, having been presented to this Museum, I made an analysis of it at the suggestion of Mr. Galloway. There is some interest attached to the analysis, as some refiners believe that the crystals contain a quantity of water. This opinion is disproved, as I anticipated by my analysis ; the sugar is, in fact, perfectly pure. The beauty, size, and regularity of the crystalline form of the sugar, and its purity, prove that science must have been reduced to practice in its manufacture.

The analysis was made in the ordinary method. The sugar, in a state of powder, was first dried at a temperature of 212 deg. F. ; this gave the amount of water. A combustion of the dried sugar with chromate of lead was then made, in order to obtain the quantity of carbon, hydrogen, and oxygen.

	First Analysis.	Second Analysis.	Mean.
Percentage of Water .	0·0345	0·0507	0·0426

The amount of carbon, hydrogen, and oxygen in the sugar when dried at 212 deg. F. :—

	First Analysis.	Second Analysis.	Mean.	Theory.
Carbon .	42·136	41·754	41·945	42·105
Hydrogen .	6·420	6·480	6·450	6·433
Oxygen .	51·444	51·766	51.605	51·462
	100·000	100·000	100·000	100·000

COMPRESSED ASPHALTE.

At a recent meeting of the Society of Civil Engineers, at Paris, M. Malo read a very interesting paper, "On Compressed Asphalte as a Material for Roads." After referring to the defects inherent in the old systems of paving adopted in the French capital, M. Malo treated of the attempts which had from time to time been made to substitute something better. Of all the systems tried, however, he stated that but one had borne the requisite tests, and that after a trying noviciate, extending over a period of ten years, compressed asphalte now took a place as a powerful rival to ordinary stone paving and macadam.

The asphalte employed for the works already executed in Paris is a pure carbonate of lime, naturally impregnated with from six to ten per cent. of bitumen. The rock is quarried in regular beds, four to seven yards thick, at Seyssel (Ain), Val de Travers (canton de Neufchatel), and in several other places in the Jura. At a temperature equivalent to that of boiling water, the bitumen softens so much that the stone crumbles to powder ; if now this powder, while still hot, be powerfully compressed, it will form masses possessing, when cold, an amount of hardness equal to that of the unquarried rock, and it is this peculiar property which has been somewhat recently applied on an extended scale to the formation of roadways in Paris.

M. Malo stated that the crude asphalte is first broken by mechanical means into small pieces, then reduced to powder, and subsequently placed in large iron cauldrons, wherein it is heated to about 140 degrees cent. While thus hot it is carried quickly, in suitable ladles, to the locality where it is to be employed. The proper curved form which the finished road is intended to assume has been previously imparted to a bed of concrete (*Beton*) on which the hot asphalte, in powder be it observed—for pressure is needed to make it agglomerate—is spread, and carefully rammed, with heated cast iron rammers, into a solid sheet, so to speak. Three heavy rollers are then passed successively over the gradually hardening roadway. The first weighs about five hundred-weight, the second one ton, and the third roller about two tons five hundred-weight. By this means the stratum of asphalte is reduced to a uniform thickness, fixed in Paris at four centimetres. Two or three hours after the passage of the last roller the material has become so far cooled and consolidated that traffic can be freely resumed on its surface.

In 1850, one year after the discovery of this process, M. Darcy, Inspector-General of Roads, proposed its application to a portion of the Boulevards ; but it was not until 1854 that the first piece of compressed asphalte pavement was put down in the Rue Bergère, under the superintendence of MM. Homberg, chief engineer, and Vaudry, engineer in ordinary in the municipal service. In 1854, we find that about 700 or 800 metres only of the new roadway were in existence. In 1858 the area had increased to 8,000 metres, and now it is more than 100,000 metres, without including many large courtyards, for which the new pavement has been selected, less for the sake of solidity than for the absence of noise, which follows on its use. As in all other new things, M. Malo stated that many mistakes were made at first, many mishaps met with, and difficulties overcome. We will mention a few of the more important.

The first essential was obviously to discover a good method of preparing the material. After months of labour and care this object seemed as far from being obtained as ever. Then followed the difficulties of application, and in this department the experiments conducted in the Rue Neuve Petits Champs were fertile in instruction. The asphalte used was hard and unmanageable; the season far advanced, and it was a matter of some difficulty to procure a dry surface of concrete for the asphalte to rest on. The moisture was evaporated by the heat, and pervading the mass, prevented the efficient agglomeration of its particles. Worst of all, the concrete itself reposed on soil recently disturbed in the formation of a sewer, and the settlement which followed, as a matter of course, led to the rupture of the bed of asphalte. Ultimately all these obstacles were overcome, and M. Malo states the advantages of the new roadway as follows:—It produces neither mud nor dust; the annual wear equalling only one millimetre, once it has become thoroughly consolidated by the passage of vehicles. It is almost perfectly noiseless—no trifling advantage, be it remarked. What would not we dwellers in London give for a noiseless pavement? The labour of horses is materially lessened on the compressed asphalte, as compared with stone paving or macadam; a fact disputed, however, by M. Tresca, a gentleman who has conducted a valuable series of experiments on the tractive resistance of various roads. The expense of maintaining wheel carriages in repair is considerably reduced by the suppression of ruts and jolting. M. Malo stated the saving at 8,500,000 francs, supposing all Paris asphalted, yearly; and, lastly, the absence of vibration tends to the durability of the houses on either side. In opposition, it has been urged that the new pavement is too slippery for smoothly shod carriage and saddle horses (*chevaux de luxe*). According to M. Malo, this inconvenience is never experienced unless the curvature of the road is exaggerated, or on steep hills. This has been verified by experience. It was stated that one horse in 1,308 fell in passing through the Rue de Sèze, which is paved, and but one in 1,409 in passing through the Rue Neuve des Capucin, which is asphalted. Sometimes, however, the surface is rendered slippery by the presence of foreign substances dropped in traffic. A simple washing removes the evil. The same end may be attained by means of a slight sprinkling of sand.

M. Malo estimated the cost of the different roadways used in Paris at the following rates per square metre:

Material.	Formation.	Annual Maintenance.
Compressed Asphalte and Concrete	15f.	1f. 25c.
Pavement of Belgian Porphyry	10f. to 22f.	0f. 50c. to 1f. 50c.
Macadam	7f.	2f. 40c. to 3f.

M. Malo concluded by stating that all the Jura district, from the department of the Bas Rhine to Savoy, abounds in asphalte, so that no fears need be entertained of exhausting the supply by extending the application of the material.

PRODUCTS OF DISTILLATION OF COAL.

At the meeting of the Institution of Civil Engineers, May 10, a paper was read "On the Means of Utilizing the Products of the Distillation of Coal, so as to reduce the Price of Coke; with Descriptions of the Ovens and of the best Processes in Use in Great Britain and on the Continent in the Manufacture of Coke," by M. Pernolet (of Paris).

The author believed that this question had been practically solved, by the employment of existing ovens, to which certain inexpensive additions were made, and which, while still giving to the coke all the solidity, density, and lustre that distinguished good coke made in the ordinary way, enabled every product of the distillation of coal to be turned to account. This was effected, mainly, by keeping the coal from all contact with the air during its distillation, by performing that process very slowly, and by collecting and making use of the volatile products. The whole arrangement had been sanctioned by many years' experience, both in Belgium and France, where it was actively and profitably pursued at ten different establishments, with more than 400 ovens, of the largest dimensions, capable of receiving from five to seven tons of coals at each charge.

In converting an old oven into one of the improved form, the floor was taken up and raised about a foot, so as to allow of its being heated from below, by means of a fire-grate and flues. A new opening was made in the roof, in which was fixed a pipe intended to receive the volatile products, and to conduct them to their destination. The ordinary door and the other opening at the top were so arranged that they could be kept hermetically closed. A chimney was also added to the masonry of the old ovens, and this was an essential part of the system, as it secured the circulation of the products of distillation. It had been ascertained that this chimney should be 50 feet high, and not less than $3\frac{1}{2}$ feet square, inside dimensions, for a group of sixteen contiguous ovens; and that the sectional area of the main flue, connecting the different ovens with the chimney, should be three-fourths that of the chimney. In order to try whether the distillation was finished in any one oven, a valve was closed in the outlet pipe; when, if the charring was incomplete, the gas still given off would cause cracks in the loam, with which the joints of the door were closely luted, and thus the necessity for continuing the process was demonstrated. The valve was then simply reopened, so as to allow the gas again to pass off by the pipe. If, on the other hand, when the valve was closed, no gas escaped at the joints, the charring was known to be finished, and the coke was fit to be drawn. During this operation the valve was closed, to prevent the mixture of the external air with the gases circulating in the outlet pipe, and the cast-iron cover of the opening at the top was kept shut, to avoid the risk of igniting the coke by the draught of air which would be created if it was open. The oven was arranged for charging from the top, by means of waggons running upon rails, and in this way five tons of coal would be introduced in fifteen or twenty minutes, a rapidity which was most desirable for preserving the heat of the oven. When the charge was being withdrawn and replaced, the gas from the other ovens was allowed to pass continually into the fire-place, so that the floor was kept hot, and the gas accordingly began to show itself, above the opening at the top, only a few minutes after the closing of the door. This opening was then hermetically sealed, and the valve in the outlet pipe being raised, the communication was re-established between the interior of the oven and the great common flue. The products of the great distillation were drawn off by the draught of the chimney, together with the condensation of the liquid, and the cooling of the gaseous products. After circulating in the great general flue, the products penetrated into the condensating apparatus, where they deposited most of the tar and ammoniacal liquor, and returned to the ovens by the small general flue, whence the gas, purified and dried, passed to each fire.

The time occupied in charring varied with the nature of the coal, and the density desired for the coke, and with the arrangement of the oven. At St. Etienne it took upwards of seventy-two hours, with rich coals, while at Torteron the time occupied was only twenty-four hours, with the rather poor but flaring coals of Commentry.

As to the cost, it was stated that the expense of altering each oven at St. Etienne was about 20*l.*, and that as the value of the additional yield from each oven ought to be about 60*l.* per annum, this outlay should be repaid by four months' work.

It was asserted that the supplementary products due to these arrangements were, a larger yield of coke, and all the tar, the ammoniacal liquors and the gas, which would be obtained from the same coals, if distilled in the retorts of a gas manufactory. Thus, in the great coke works at St. Etienne, the yield had been advanced from 58·8 to 69·3 per cent., and in the "Fonderies et Forges d'Alais" from 54·6 to 69·5 per cent. Generally speaking, with rich, or partially rich coals, the increase in the yield of coke was from 10 to 15 per cent. As to the tar, the proportion collected depended on the nature of the coal, and on the care taken, both in the distillation of the coal and in the condensation of its volatile products. It had averaged 2·53 per cent. at the Forges d'Alais, 3 per cent. at Elonge, 3·25 per cent. at St. Etienne, and had reached as high as 5 per cent. from the ovens of the Paris Gas Light Company, where only very bituminous coals were employed; but it was thought that there might be reckoned 3 per cent. of tar from the bulk of the coal distilled. The proportion of ammoniacal liquors depended also on the quantity of moisture contained in the coal; but it might be stated at a weight of not less than 10 lbs. of sulphate of ammonia, and sometimes it was as much as 13 lbs. per ton of coal distilled. At the ovens of the Paris Gas Light Company, from 10,000 to 11,500 cubic feet of purified gas were generally obtained from a ton of coal, which yielded from 69 to 70 per cent. of coke, fit for delivery to the railway companies.

THE TECHNOLOGIST.

MANUFACTURE OF PAPER-HANGINGS.

Paper-hanging, or, as the French call it, "tapestry on paper," is an art which is now matured into system, and its products have become of universal use. Its purpose is to gratify the taste by decorating the interior walls of a dwelling, and this, in the better class of houses, in consistency with the uses of each apartment and with the general style of architecture represented within a building. The colour-tone, the brilliancy, and particular pattern of the paper-hanging adopted in any case has, besides, an intimate relation to the household furniture with which an apartment should be equipped. House furnishing in this view is a work of art, and demands judgment and a cultivated taste for the work.

Paper-hangings used, in the earlier period of their manufacture, to be grouped into two classes :—1. Those which were really painted, and which were designed in France, under the title of *papier peints*, with brilliant flowers and figures ; and, 2. Those in which designs were formed by foreign matters applied to the paper, under the name of *papier tontisse.* This classification has now fallen to be inaccurate under the first head, nor is either distinction sufficiently descriptive of the method or materials of manufacture, or comprehensive of the great variety of the products which we now possess. The more expensive papers are block-printed ; the cheaper sorts are cylinder or machine-printed. Under block printing come the more ornate and elaborate designs, in the form of stamped golds, bronzed golds or brocade papers, dining-room damasks in flock and gold, and the higher class of bedroom papers. Under machine printing fall grained or damask papers, grey or white, chintz papers, pulps, &c. The final operations of satining and embossing papers, carried on here also, create characters and distinctions of their own in the classes of papers. It, besides, frequently happens that the operations of block-printing follow those of the cylinder in filling in the colour and completing the design.

It is commonly alleged that we owe to the Chinese the art of paper-hanging. That the English first imported into Europe, and subsequently began to imitate the Chinese paper-hangings, seems pretty certain. The beautiful hand-painted papers of China are still to be met in some old family mansions in this country. But if we regard paper-hanging as an indigenous art, and not borrowed from the far East or anywhere else, we may not greatly err. Tapestry had been known to Europe for many ages before the cheaper substitute, paper, for decorating the walls of apartments was thought of. Tapestry was an ornamental figured textile fabric of worsted or silk, employed for the very same purpose as that for which we now use paper, and we can easily suppose the former might suggest the latter. This conjecture is further supported by the fact that, just as in the case of tapestry, which could only be afforded by the rich and great, paper-staining came to be employed in France for the illustration of popular historical subjects. The French, in fact, called the art "tapestry in paper," and the victories of the First Napoleon were represented in picture by this means. In France, paper-staining was a recognised art as early as 1586. The earliest printing blocks for work of this kind were those of Francois, who carried on a manufactory at Rouen in 1620. Jerome Lanier patented in England, in May, 1634, the process of flocking papers. In Lanier's patent it is stated "that by his affixing wool, silk, and other materials of diverse colours upon cloth, silk, cotton, leather, and other substances with oil, size, and other cements, to make them useful for hangings and other occasions, which he calleth Londriana, and that the said art is of his own invention." We find paper-staining in England recognised as a trade in 1712 by the imposition of a tax of 1¾d. per square yard for printing, in addition to the duty on the paper itself. The great Chelsea manufactory was established by George and Frederick Echardts in 1786. Flocking, though so early known, appears to have fallen into disuse or been forgotten up to near 1800, when it was re-introduced. Arabesque papers, as they are usually termed, were first introduced in any excellence by Mr. Herringham, of London. The first method of making these flocks (*papiers tontisse* of the French) was by stencilling—that is, by laying upon the paper when on the wall a plate of metal or piece of pasteboard having spaces cut out for the pattern, gumming those spaces with the brush, and then dusting on the coloured wool powder to form the flock. At an earlier period water colours were brushed on the paper ground by the same means.

At a period some few years before the beginning of the century, Government restrictions hung heavily upon the manufacturers of paper-hangings. The double duty of an excise of 3d. per pound on paper and 1¾d. per yard on its decoration, together with an annual licence of 20*l.*, compelled the makers to use first-class paper, and thereby limited their market to the affluent. All these burdens operated, besides, like a bounty in favour of our commercial rivals, the French. One effect of these restrictions was to drive the trade over to France; and about 1780 the manufacture of paper-hangings passed from England into France. Several large factories were opened at Paris and Lyons; but the chief part of this important manufacture was soon monopolised by Paris, which still retains a leading position in this respect, followed by the example of London. What was needed to develop this industry, and what it now possesses, was web paper. Before the inventions of M. Didot, of Paris, the improvements made by Mr. Donkin, of London, and the complete patent confirmed to Messrs. Fourdrinier in 1807 (for fifteen years), enabled the manufacturers to obtain a machine-made paper of any length and width. The enormous advantage of this improvement will be at once understood when it is considered that before the introduction of web paper the dimensions of the paper employed were limited to hand specimens executed in moulds of certain sizes or sheets, and in order to print a piece of paper-hanging twelve yards long, the manufacturer was compelled to stick together sixteen or eighteen sheets. The joinings of so many pieces were a manifest blemish in the work, not to speak of the great increase of the labour that came of this method.

Germany began the manufacture of paper-hangings on a limited scale, and, later than France, Belgium, Holland, and Switzerland followed on a still smaller scale. Austria and Russia have severally taken up the same occupation under the auspices of their Governments.

In 1827, there were in Paris seventy-two large manufactories of paper-hangings. The vast workshops employed—in preparers, chemists, firemen, engravers, draughtsmen, travellers, and workpeople, young and old, and of both sexes—4,200 individuals. The value of the white paper used amounted to about 193,600*l.*, and that of the colours used to 92,600*l.* The exportation from Paris alone at this time was about 34,000*l.* in value. In an exposition of the products of French Industry which took place in 1839, in Paris, M. Delicourt's panel papers and his low prices took the world by storm, and in 1844, the enterprising manufacturer obtained the highest reward—the gold medal.

It is a criticism of Mr. Digby Wyatt on the artistic claims of French paper-hangings shown in 1855 in Paris, "that they are by no means all that could be wished. Faultless as far as the fitting of the block impressions over one another, as far as the perfect cleanness and precision of every tone, and as far as the apparently unlimited range and brilliancy of palette were concerned, the most important specimens appeared to me to tend rather to the abuse of the art. The simple reason why the Parisian paper-hangings were this year so generally *outré* and bad in design, I believe to have been because they were left to painters to arrange, and not properly subordinated to any architectural design." Mural decoration extended to every style and historical epoch is one characteristic feature of French paper-hangings. Stone balustrades with peacocks upon them, grown over with tropical plants of no particular regard to geographical propriety, mixed up with shells and all kinds of conceits, were among the riotous extravagances of fancy, which, while it revolted the artistic taste, captivated the fancy of the uncultivated. Our imports of foreign paper-hangings in 1862 amounted to 4,210 cwts.; the computed value of this was 17,680*l.* Of this total 3,926 cwts. came from France, and 284 cwts. from other parts. Besides this, we imported of French papers for transhipment for the same year 2,000 cwts.

Up till within these few years the paper-hangings produced in Britain were altogether manufactured in the southern portion of the United Kingdom. It was reserved for the firm of Messrs. Wylie and Lochead to take the lead in domesticating this beautiful industry in Scotland and in Glasgow. This they have done upon a liberal and expanding scale of business, and with an artistic excellence and courage of treatment in their finer patterns, which bid fair to rival either London or Parisian makers in a field that for more than a century has been held almost exclusively in possession by one or other of these. We are aware that paper-hangings are also manufactured in Edinburgh, and we are far from desiring to disparage the very creditable efforts that are made in our Scottish capital in this path of industry, but, on the contrary, would gladly hail any proofs of persevering enterprise and of successful skill wherever shown. In England for many years up to 1825 the manufacture of paper-hangings was protected by the absolute prohibition of foreign papers of the same general kind; but at the same time the home-made papers were subjected to a tax so vexatiously and onerously applied, that before the introduction of web-paper each piece composed of twenty-four sheets received on its back twenty-four stamps, with two more stamps to mark the ends. This duty amounted to 1s. 4d. per piece. In 1825, Mr. Huskisson removed the prohibition, and replaced it by a duty on foreign products of 1s. per yard square, which, taking a piece of French measurement, amounted to the enormous sum of 5s. 6d. per piece. Yet, notwithstanding this restriction, French papers entered the British market readily and at a profit. The English makers confessed that neither absolute prohibition nor a heavy duty had been of service to them in improving their products up to the level of the French. The consequences that came of this change were that the English makers were driven, in self-defence, to improve their work, and the Government reduced their customs duty, and took off at the same time the stamp duty on English-made paper-hangings. In 1846, Sir Robert Peel reduced still further the import duty, and that by two-thirds of its former amount, or to about 2d. per yard, or a franc a piece. The French manufacture now entered in full inundation, and a depression of English production was the immediate consequence. The imports were soon doubled under the new regulations; but the tide was soon arrested, by-and-by in some degree reversed. To the French we owe much for the improvement of this manufacture. To some points under this head we have already referred. To them mainly we owe embossed flocks and the shading of flocks, the perfect imitation of chintz, improvements in the satin grounds, and the introduction of work printed from engraved cylinders. It is now about twenty-two years since machine printing was first introduced. With this enormous change came greater productive power, greater economy in the work, cheaper paper-hangings, and a vastly extended basis for the general trade.

As early as 1851 there were shown in the London Exhibition of that year, by Messrs. Heywood, Higginbottom, and Co., of Manchester, patterns whereon were printed twenty colours made by fourteen rollers. J. Woolams and Co., London, a firm which may be regarded as representing the trade in England, in the Paris Exhibition of 1855 were represented as producing goods soundly made and well printed, at moderate prices. In their higher efforts, they exhibited in the style of the Italian renaissance, pilasters, corners and borders, cornice and frieze, together with some panels of various flock gold damasks in the mediæval style, and a cornice and mouldings from the Alhambra, all of which were from drawings made in England. At this period—eight years ago—English paper-hangings of the more pretentious kinds were sadly wanting in that refinement of colour which we believe to arise in the French papers mainly from the use of better whiting, more colourless size, finer pigments, cleaner vessels, better light, careful overlooking, and, above all, scrupulous delicacy of manipulation, and a measured and moderate pace in the speed of working. As compared with 1851, the English makers in 1855 were seen to have made great advancement; and in London in 1862 the improvement, where formerly defective, was still more decided. The manufacture of paper-hangings is spread pretty widely over England. We find it in Manchester, in Leeds, and Southampton, as well as in London. From Scotland the representation was limited to the successful imitation of woods and mouldings, showing good evidence of taste and executive skill, by Mr. R. Dow, of Perth. Among the best attempts in this walk shown in the Exhibition of 1862, and which had any connexion with Scotland, was the complete decoration of the walls of a drawing-room and of a dining-room, by Messrs. Purdie, Bonnar, and Carfrae, of London and Edinburgh. These were of full dimensions and done up in the highest example of the French style, and illustrated admirably the legitimate scope and resources of the art of paper-hanging, associated as it was in the instances with the cognate industries of the artistic painter, carver, and gilder; and for the full effect of each these must go together for the effective decoration of the leading apartments of the houses of the affluent.

We purposely adduce these picked examples as pointing out thereby the true tendency of this new industry for Scotland, in order to impress our readers with the conviction that we owe a debt of gratitude to those gentlemen who have been so conspicuously instrumental in introducing it. Paper-hanging in its choicest applications means a great deal more than the clothing of the walls of an apartment with a figured paper. Its use and particular style have their root in the history and habits of civilised society. It is employed to symbolise to the eyes periods in art, conventions, or manners. It is made the means of illustrating historical epochs or great events, as we perceive in the hands of the French. It should consent to architectural decoration, and require consistency with itself, in the window hangings and general furniture suitable for an apartment. It ranges over all conditions of the people in its application. This noble art is a civiliser : it makes the homes of the poor beautiful, and thus favours cleanliness, taste, order, and respect for woman as the centre of domestic life.

When we speak of the working people as having an interest in the progress of this industry as well as the more affluent classes, our meaning will be sufficiently evident when it is stated that an elegant paper-hanging can be produced for a few pence, a piece of twelve yards long, sufficient at a small cost to cover and embellish the walls of a humble home. On the other hand, wall papers quite as ornate as those produced by the French can be produced here at not over half the price at which the French manufacturer charges for his goods, and with ample room for selection to suit the most fastidious fancy. The richer sorts of paper-hangings made by the firm vary from 5s. to 12s., and in one conspicuous instance in process at present of fulfilling, an order to a distinguished foreigner for a piece of only nine yards long, 45s.

The works of Messrs. Wylie and Lochhead are finely situated at Whiteinch, on the banks of the Clyde, a few miles below Glasgow, and are conspicuous from the deck of the steamer in passing down the river. The workshops consist of two ranges of buildings parallel to each other and to the course of the Clyde. Each block is upwards of 300 feet long and about 50 feet wide, and one of them is two and the other three storeys in height. A lofty chimney stalk in connexion with the steam power is a conspicuous feature of the general buildings. The numerous and various working apartments are exceedingly well adapted to the work carried on in them. They are very spacious, well lighted in all parts, scrupulously clean, adapted to their different uses, and heated by the waste steam of the engine. The several floors are accessible by steam-worked hoists. About 300 workpeople, young and old, are employed on the ground, and these are mostly piece workers.

The raw material of this manufacture is the white paper as supplied by the paper-maker. This arrives in large rolls of webb paper about eighteen inches in diameter, hundreds of which are constantly kept in stock, and many of which are always under the process of transformation into the final manufacture.

The padding of the raw paper consists of laying the grounds for the reception of colours from the printing machine in the cheaper sorts of goods upon the surface of the paper. This is done with French chalk, or earthy colours, or coloured lakes thickened with size and applied with brushes. When the paper is to be machine-printed it is retained in the continuous web, and padded by machine action operating by a system of rotatory brushes, and afterwards dried. There are here three such padding machines, and three persons are in attendance on each machine. The paper so prepared is afterwards polished by machine action, using French chalk in the process. The more expensive papers are worked in piece lengths, and more laboriously prepared by hand operations. An expert workman, assisted by a couple of boys, can lay the grounds of 300 pieces in a day. The operation is conducted with brushes upon a smooth table, and the pieces are suspended upon cross rods near the ceiling, where, in a genial temperature, they are permitted to dry. They are then rolled up and carried to the apartment where they are polished by friction rollers and brushes, and in some establishments by being laid upon a table for the purpose with the coloured side under, and rubbed with the polisher. Pieces intended to be satined are grounded with fine plaster of Paris, and operated upon with a brush attached to the lower end of a swing polishing rod. Talc or china clay is sometimes used with the brush to give the surface a fine satiny lustre.

The colours employed:—The whites used are French chalk, good whitening, and, in some works, white lead is mixed with the latter. The yellows are chrome yellow, *terra de sienna*, yellow ochre, and when vegetable extracts are used, Persian berries. The reds are afforded by decoctions of woods, such as Brazil wood, &c. The blues are artificial ultramarine, Prussian blue, or blue verdila. Some colours are produced by mixtures, such as greens from blues and yellows, and Scheele's green is also used. Violets, browns, blacks, and greys are procured from various vegetable and mineral sources, and from mixtures. All colours are rendered adhesive and consistent by being worked up with gelatinous size or a weak solution of glue, and in the engine-house of the work there are placed three steam-heated rectangular vats charged with materials of this kind ready for use at all times.

There are three printing machines in the work, severally a four, a six, and a twelve colour machine. The operation of printing is effected by means of a succession of rollers arranged round a drum, with a colour box, sieve, &c., to each roller, similar to the well-known process of calico printing, the difference being that the rollers for paper-hangings produce surface work and with body colours, whereas calico printing is done from engraved rollers. Immediately on leaving the printing machine the paper passes into a chamber heated to about 200 degrees or more, and is thus dried and finished, the power of production being at the rate of forty-two yards a minute. Counting thus, one machine should be capable of turning out 1,500 pieces of twelve yards each in a day. An incomplete pattern is sometimes filled by the hand after the paper has left the machine and been dried.

The finished paper, as it passes from the printing machine, is barrowed forward to where it is hoisted to an upper floor, when it is reeled in the form in which it appears on sale in the warehouse. There are here three reeling machines, superintended by young women. The apparatus feeds itself, leading the paper through the long wooden troughs, and accurately registers the twelve-yard lengths, and rolls them up into a firm and compact shape. The finished goods are temporarily stored up before removal in an ingeniously contrived system of shelving of huge dimensions in the ends of one of the floors of the works.

We witnessed the operation of a twelve-colour machine, which demanded for this one pattern as many rollers, and the reader may therefore conjecture the number of such that must be required when there are more than a hundred patterns on the spot to be worked by the machinery. Great care is taken to keep the rollers in good order, and disposed in sets, and subject to a dry and equable temperature, in their place of deposit. The roller is a cylinder of lime-tree or plane-tree, having through its axis a strong iron spindle, which adapts to the construction of the printing machine. The pattern is first drawn upon paper, and then transferred to the roller, and its construction lines are inserted into the wood either in brass or composition metal. The superfluous wood is worked away into relief after the roller has been worked in the lathe into a true cylinder. For the more elaborate patterns, casts in an alloy of bismuth, tin, and lead are taken, and these casts from being flat are bent by machine action into the curvature of the roller, and then applied to it. The beautiful operations of preparing the matrix and of effecting the cast were well explained to us by an intelligent workman, who has our warmest thanks for his courtesy, but we cannot afford space for the statement of either.

The blocks for printing are made of three boards glued together to a thickness of about 2½ inches. The middle board is made to cross the grain of the two outsides of it so as to prevent the block from warping. As many blocks are required as there are colours and shades of colour in the pattern, and so also as regards the number of rollers. To make the figure of a rose, for example, three several reds must be applied in succession, the one deeper than the other, a white for the clear spaces, two and sometimes three greens for the leaves, and two wood colours for the stems, altogether from nine to twelve for a rose. We have heard of a French design brought out by M. Zuber, where 3,000 blocks were required for one pattern. Each block carries small pin points fixed at its corners to guide the workman in the insertion of the figure exactly in its place. Here again it may be easily conjectured what a vast number of printing blocks are needed for so extensive a work as this, where so many and such elaborate patterns are turned out. The block stores contain several thousand specimens.

In the block printing shop there are altogether thirty-seven block printing presses, and in nearly full work. In this branch of work the operation resembles what takes place in calico printing. The workman takes off the colour upon his blocks and impresses them upon the paper extended upon a table. In urging the block home to secure a good impression, a system of compound leaves of the second order is employed, and the workman's own weight in the power exerted in the case. When the piece has received one set of coloured impressions, it is hung aside to dry before it is ready for another. The workman, assisted by a boy called his "drawer," hooks up the paper upon the drying poles in the ceiling, and has taken care to have a sufficient number of pieces to keep his hand in for the day in the alternate work of stamping and dyeing.

VEGETABLE MATERIA MEDICA SOLD IN THE BAZAARS OF BAGHDAD, WITH SUPPLEMENTARY NOTES.

BY M. C. COOKE.

In the following list of Materia Medica, found on sale in the bazaars of Baghdad, I have only included those of vegetable origin; this is based upon a catalogue furnished by Commander F. Jones, and obtained by him, whilst Surveyor of Mesopotamia for the Hon. East India Company in 1857. It is incomplete as far as regards the botanical names of the sources of many of the articles, because, in the absence of specimens to examine, I could not presume to add any, except in a few undoubted cases, strengthened by collateral evidence. The prices have been calculated after the rate of 450 Riege piastres to an English sovereign, and the weights on the basis of one hoogeh being equal to three pounds troy. The miscal is a jeweller's weight, and equals 72·28125 grains troy. It is used for the most expensive drugs. The weights given are all troy unless otherwise expressed. The prices given are those which are usually paid for the articles in the bazaars, and were, in fact, the prices demanded for them at the period of Commander Jones's visit. In the majority of cases the Arabic names have been compared with Dr. Seligmann's 'Liber Fundamentorum Pharmacologiæ,' which is, in fact, a translation of the Arabic work of Abu Mansur Mowafik ben Ali al Herui :—

ABHUL, Ar. Juniper (*Juniperus Phœnicia?*).—Native produce. Sold at 7d. per lb. *Arar* is the Arabic name given for *Juniperus communis*, L., by Dr. Seligmann; whilst *Ebhul* is also alluded to as a *Juniperus*. Undoubtedly the *Abhul* (Hindustani), and *Ahuber* (Sindh), is a species of *Juniperus*, and most probably *J. communis*, to which species Dr. Birdwood refers *Hub-ul-urur* (Arabic) as a synonym. The fruit of *Juniperus Phœnicia* is employed in the Punjab as a substitute for that of *J. communis*, which it greatly resembles, except that it is larger.

AFYUN, Ar. Opium.—Imported from Smyrna and Persia. Price, 5 piastres per miscal (about 1s. 6d. per ounce).

ALU BUKHARA, Ar. Prunes.—Imported from Persia. Sold in the bazaars at 5d. per lb. *Adschass*, Ar., and *Alu*, Pers., are Dr. Seligmann's synonyms for Prunus Damascena.

ANISUN, Ar. Anise seed (*Pimpinella anisum*).—Derived from Aleppo, and sold at the rate of 5d. per lb. troy. *Anisun*, Ar., is a species of *Anethum* in one place and *Pimpinella anisum* in another, in 'Liber Fund. Pharm.'

ASARUN, Ar. Asarabacca (*Asarum Europœum*).—Obtained from Syria and sold at 7d. per lb. troy. It is also not an uncommon product in the bazaars of N.W. India. At Kangra the price is only 3d. per lb. avoir.

ASFUR, Ar. Safflower (*Carthamus tinctorius*).—Imported from Persia. Sold at 5d. per lb. The seeds are sold also under the name of *Kurtum*, Ar. *Miosfur* is given by Seligmann as a synonym for the flowers, but *Asfur* or *Usfur* is undoubtedly an Arabic name.

ASHBEH, Ar. Sarsaparilla (*Hemidesmus Indicus?*).—Imported from India. Sold at 6s. per lb. I am doubtful whether I have referred this correctly. *Ashba* is quoted by Dr. Birdwood as the Arabic name of *Hemidesmus Indicus*. I find no notice of it in the 'Liber Fund. Pharm.'

ASL-ES-SUS, Ar. Liquorice root (*Glycyrrhiza glabra*).—Native produce. Sold at 1d. per lb. The extract is sold also under the name of *Rabb-es-sus*. *Sus*, Ar. = *Glycyrrhiza glabra*, L. (*vide* Seligmann).

BABUNEJ, Ar. Camomile flowers (*Anthemis nobilis*).—The produce of Persia, whence they are imported. Sold at 2d. per lb. The *Baboonee-phool* (Hindustani), and *Babooneh-gaw* (Persian), which are referred to *Anthemis nobilis*, seem to indicate that the *Babunej*, Ar., are true camomile flowers, so far as names can go to establish identity.

BADIYAN RUMI, Ar. Star anise (*Illicium anisatum*).—Imported from India. Price in the bazaars, 10½d. per lb. This article is the *Badian khutai* of the bazaars of India.

BADIYAN KATAI, see *Bodyan Khatai*.

BARBIN, Ar. Purslane (*Portulaca oleracea?*).—Obtained from

Persia. Sold at 3½d. per lb. N.B.—This reference is doubtful. *Buklut-ul-hukema* is Dr. Birdwood's Arabic name, and *Baklet-elmu-barek* that of Dr. Seligmann, for *Portulaca*.

Bezr al Benj, Ar. Hemlock seed.—Obtained from Persia and sold at 7d. per lb. I have not ventured, because Commander Jones has called this product "hemlock seed," to conclude that therefore it is *Conium maculatum*, although it may be very probably the case.

Bezr Hendeba, Ar. Endive seed (*Cichorium endivia ?*).—Obtained from Persia and sold at 3½d. per lb. This is *Hinduba*, Ar., *Kesni*, Pers., in Dr. Seligmann's translation, and there referred to *C. endivia*, whilst other authors refer the same vulgar names to the chicory (*Cichorium intybus*), the seeds of which are found in the bazaars of India.

Bezr el Jazar, Ar. Carrot seed (*Daucus carota*).—Native produce. Sold at 1¾d. per lb. Evidently the same name is written *Dschezer*, Ar., by Dr. Seligmann, and *Juzir-ul-bostanee* by Dr. Birdwood. The plant thrives luxuriantly in some parts of India.

Bezr el Khass, Ar. Lettuce seed (*Lactuca sativa*).—Native produce. Price 3½d. per lb. *Chas*, Ar., *Kahu*, Pers., according to Dr. Seligmann, and the *Kahoo* of the Hindoos are equally the common garden lettuce.

Bezr Khetmi, Ar. Melon seed.—Native produce. Price 7d. per lb. It is uncertain what species of melon the *Khetmi* may be. So many cucurbitaceous plants are indigenous to this part of Asia, that it would be rash to venture a supposition.

Bezr el Khujar, Ar. Cucumber seed. — Native produce. Price 3½d. per lb. The above remark will also apply to this product. Dr. Seligmann refers *Kisa*, Ar., *Chiar*, Pers., and *Gunde* (Khorassanee) to *Cucumis sativus*, L.

Bezr Kittan, Ar. Linseed (*Linum usitatissimum*). — Native produce. Sold at 1¾d. per lb. *Besr-el-Kettan.*—Semen lini usitatissimi, L. *Vide* Seligmann.

Bezr el Rihan, Ar. Dill seed (*Anethum sowa ?*).—Native produce. Sold at 3d. per lb. This reference is also uncertain. In the 'Liber Fundam. Pharm.' *Schibit* is given as the Arabic equivalent of the Indian *Sowa* and the Persian *Sud*, all of which are referred to *Anethum graveolens*, L.

Bezr Safarjal, Ar. Quince seed (*Cydonia vulgaris*).—Imported from Persia. Price 5d. per lb. Dr. Seligmann writes the same name *Seferdschil.* (The prefix *Bezr* only meaning "seed" in these combinations.) I know not what may be Dr. Birdwood's authority for giving the Arabic name of Quince seed as *Hubusufirjul*, but it is probably a corruption of the same.

Bodyan Khatai, Ar. Fennel.—Obtained from India and sold at 10½d. per lb. See also *Badiyan Rumi.* This is certainly not the *Badian*

Khatai of Indian bazaars, which is Star-anise. *Rasianedsch*, Ar., and *Rasiane*, Pers., are Dr. Seligmann's synonyms of *Anethum fœniculum*, L., and Dr. Birdwood gives *Razeeanuj* as the Arabic name of *Fœniculum panmorium*.

CHALPA, Ar. Jalap.—Obtained from India and sold at 6s. per lb. This is uncertain. It may be the Turbith (*Ipomea turpethum*). The *Exogonium purga* is only cultivated in botanic gardens in India.

DAMM AL AKHUWAYN, Ar. Dragon's blood.—Derived from India, and sold at about 5s. 6d. per lb. In Dr. Seligmann's work, *Demelachwein*, Ar., and *Chuni-siawuschan*, Pers., are given as names for Dragon's blood, the source of which is stated as *Dracœna draco*, L.

DARSINI, Ar. Cinnamon.—It is uncertain whether this is a true cinnamon; probably only a cassia bark. Imported from India. Sold at 1s. 2d. per lb. *Darsini*, Pers., is referred by Dr. Seligmann to *Laurus cinnamomum*, L, and *Seliche*, Ar., to *Laurus cassia*, L. *Dar-chini* is applied in India to various aromatic barks.

DEHN OL KHARUA, Ar. Castor-oil (*Ricinus communis*).—Native produce. Sold at 7d. per lb. There is not much doubt about the correct reference of this, although in the 'Liber Fund. Pharm.' *Chirwa* is given as the Arabic, and *Bid-indschir* as the Persian, synonym of *Ricinus communis; Duhn elchirwa*, Ar., and *Rugani chirita*, Pers., of Oleum Ricini. Dr. Birdwood writes the Persian *Beedinjeer*, and the Arabic *Khiroa*, *Cherna*, *Tehscha*, and *Djar*.

DEHN KITTAN, Ar. Linseed oil.—Native produce. 7¼d. per lb. For seeds, see BEZR KITTAN.

DEHN LAUZ, Ar. Oil of almonds (*Amygdalus communis*).—Native produce. One piastre per miscal (equal to 3½d. per oz.). *Lews* is the Arabic name for the almond given by Dr. Seligmann. *Dehn*, as will be observed from this and following examples, is "Oil." *Duhn ellewz*, Ar., and *Rugani badami*, Pers., are Seligmann's synonyms for oil of almonds.

DEHN NANA, Ar. Oil of peppermint.—Native produce. 2s. 6d. per ounce. In Commissioner Jones's list this is called oil of peppermint, whilst Dr. Seligmann gives *Nânâ* as the Arabic name of *Mentha sativa*.

DEHN SIRAJ, Ar. Sesame oil (*Sesamum orientale*).—Native produce. 7d. per lb. This reference is subject to the remark that *Simsim* is the Arabic, and *Kundschud* the Persian name, given by Dr. Seligmann for *Sesamum orientale*. Dr. Birdwood has *Djyl-djylan*, Ar., *Kunjed*, Pers., and *Semsem*, Egyptian. In the list forming the basis of these notes, *Dehn Siraj*, Ar., is called "Sesame oil."

DEHN-ZEYTUN, Ar. Olive oil. Native produce. 7d. per lb. Written *Sejtun*. Ar., by Seligmann; whilst *Duhn-elzeit*, Ar., and *Rugani zeit*, Pers., are employed for olive oil.

EKLIL-EL-MALEK, Ar. Rosemary (*Rosmarinus officinalis*).—Native produce. Price 1¾d. per lb. Dr. Birdwood gives *Ukleel-ul-jilbal* and *Hasalban-achsir* as Arabic names of *Rosmarinus officinalis*.

Elk-el-Laban, Ar. Olibanum.—Imported from Kurdistan. Sold at from 10d. to 1s. per lb. *Vide* Seligmann. *Lebban*, Ar., *Kundur*, Pers. Thus (*Boswellia thurifera*), Roxb.

Enab Ahmar, Ar. Red jujube (*Zizyphus jujuba*).

Enab Aswed, Ar. Black jujube (*Zizyphus jujuba*).—Imported from Persia and sold at 1¾d. per lb. According to Dr. Seligmann, *Unnab* is the Arabic of "Jujube," and *Ineb* of "Grapes." Dr. Birdwood give *Sidr* and *Nabik* as Arabic names of *Zizyphus jujuba.*

Farfayun, Ar. Euphorbium.—Derived from Persia and sold at 7d. per lb. It is written *Eferfiun* in the 'Liber Fundam. Pharm.' Dr. Birdwood gives *Firfyoon*, *Firbeyoon*, and *Ukeil-nefseh* as Arabic, and *Sheerderukht-zekoom* as Persian vernacular names for this gum-resin.

Faufal Aswed, Ar. Black betel-nuts (*Areca catechu*).

Faufal Abyad, Ar. White betel-nuts (*Areca catechu*).—Obtained from India, and sold at 2d. per lb. Written *Fuful* by Seligmann. There can be very little doubt in naming this, *Aswed* and *Abyad* only referring to the colour of the nuts, which are pale when mature, but dark coloured when collected and dried in an immature state.

Franjemushk, Ar. Sweet basil.—Obtained from Persia. Sold at 7d. per lb. In Part I., p. 39, Seligmann refers *Badarudsch*, Ar., to *Ocymum basilicum*, and in Part II., p. 41, *Schahsiferem*, Ar., is referred to the same plant; whilst *Ferendschemuschk*, Ar., is referred to *Melissa calamintha*, L.

Fulful Ahmar, Ar. Red pepper (*Capsicum frutescens*).—Partly native produce, and partly imported from India. Price 5d. per lb. Dr. Seligmann, under *Fulful*, says: "Præfertur rubrum omnibus (*Capsicum frutescens*) quod *Fulfuli ahmer* audit." Birdwood gives *Darfelfel* as the Arabic name of *Capsicum frutescens.*

Fulful Aswed, Ar. Black pepper (*Piper nigrum*).—Imported from India. Sold at 5d. per lb. Dr. Birdwood writes *Filfiluswud*, Arab., *Filfil-seeah* and *Pilpil*, Pers., for *Piper nigrum.*

Gheznaij, Ar. Carraway seeds (*Carum carui*, and probably *Carum nigrum*).—Native produce. Sold at 7d. per lb. *Kerawja*, Ar., is *Carum carui*, according to Dr. Seligmann, which Dr. Birdwood writes *Curweeya*, and gives *Kushneez* as the Persian for *Coriandrum sativum.*

Hanzal, Ar. Colocynth (*Cucumis colocynthis?*).—Native produce. Sold at 1d. per fruit. *Hanzal*, Ar., of Seligmann is colocynth, but whether the true colocynth or pseudo-colocynth is not stated; probably the latter.

Harmal, Ar. Wild rue (*Peganum harmala*).—Native produce. Price 7d. per lb. *Harmel*, Ar., *Sepend*, Pers., is the *Ruta sylvestris*, or wild rue, of Seligmann, and, without doubt, *Peganum harmala. Ruta graveolens* is referred to *Sedab*, Ar. The *Lahooree Hoormul* of India is *Peganum harmala.*

Hayl, Ar. Cardamom seeds (*Elettaria cardamomum*).—Imported from India, and sold at 2d. per lb. troy. *Hal*, Ar. = *Fructus cardamoni* of 'Index Fund. Pharm.'

Hobbeh, Ar. Fenugrec seed (*Trigonella fœnum græcum*).—Native produce. Sold at a trifle less than 1d. per lb. The name given by Seligmann is *Hulbet*, Ar.; and by Birdwood, *Helbeh*, Ar. *Shimlet* is used as a synonym in the Ulfaz Udwiyeh.

Hubbeh es Sauda, Ar. Black cumin seed (*Nigella sativa*).—Native produce. Realises about 2d. per lb. troy. It would appear uncertain whether I have referred this to its true source, since *Schunis* is given in some Arabic works as *Nigella sativa*. It is certain that the *Hub-sindee* of Egypt is identical with the *Siah-daneh* of Persia, and *Mugrela* of Bengal, and these are *Nigella sativa*.

Jauzbua, Ar. Nutmeg (*Myristica moschata*).—Obtained from India and sold at ½d. per nut. Written differently, but pronounced similarly. The *Dschewzi-buwa*, Ar., of Seligmann is undoubtedly the same. *Besbas*, Ar., is "mace," but this is not enumerated in Commissioner Jones's list.

Jauz el Kayy, Ar. Nux vomica (*Strychnos nux vomica*).—Imported from India and Persia and sold at 4 piastres per miscal, or about 1s. per oz. This is also subject to the same remark as the last. It is the *Dschewzi-elkei* of Seligmann. Dr. Birdwood gives *Falooz-mahee* and *Khanek-ul-Kelb* as Arabic synonyms.

Jawashir, Ar. Opoponax.—Imported from Persia. Sold at 10½d. per lb. Written *Dschawschir*, Pers., by Seligmann, and *Juwashur*, Ar., *Gawsheer*, Pers., by Birdwood.

Jentiana, Ar. Gentian (probably *Ophelia chirayta*).—Imported from India. Sold at 2d. per miscal (= 72 grains troy). Seligmann says *Dschunthiana*, Ar., is the root of the Roman Colocynth, and Dr. Birdwood, that the Arabic synonyms of *Ophelia chirayta* is *Kubs-al-Zarireh*. This is the only gentian-wort exported from India.

Juwifeh, Ar. Asafœtida (*Ferula asafœtida*).—Imported from Persia and sold in the bazaars at 7d. per lb. troy, or 40 Riege piastres per hoogeh (= 3lb. troy). *Endschudan*, Ar., and *Enkujan*, Pers., are the names given by Dr. Seligmann for Asafœtida; whilst Dr. Birdwood gives *Hilteet*, Ar., and *Ungooseh*, Pers. According to the Ulfez Udwiyeh, the Arabs also call the gum-resin, *Sumugh-ul-mehroos*, the root, *Mehroos*, and the plant, *Kashem* and *Unjudan*.

Kadumeh, Ar. Common melons.—Obtained from Persia. Price 7d. per lb.

Kafur, Ar. Camphor (*Laurus camphora*).—Imported from India and sold at 2s. 4d. per lb. troy.

Kammun, Ar. Cumin seed (*Cuminum cyminum*).—Native produce. Sold at 7d. per lb. *Kemmun*, Ar., and *Sire*, Pers., according to the 'Liber Fund. Pharm.;' written *Kimoon* by Dr. Birdwood. Ainslie mentions a variety called *Coomunie-siah* by the Arabs.

Kasab el Felus, Ar. Cassia fistula (*Cathartocarpus fistula*).—Imported from India and sold at 7d. per lb. This does not at all correspond with Dr. Seligmann's *Chiar schenber*, Ar., which is referred by him to "Cassia fistula." Dr. Birdwood gives *Buckbur*, *Kayar-shembir*, and *Khirnoob-hindee* as Arabic, and *Khyar-chember* as Persian, names.

Kasab ez Zuwayrah, Ar. Sweet flag (*Acorus calamus*).—Imported from India and Persia. Price 7d. per lb. In this instance also, Dr. Seligmann's names and ours do not accord. He gives *Serire*, Ar., for *Acorus calamus*, L., whilst Dr. Birdwood gives *Igghir* and *Akaroon* for Arabic, and *Vunge* and *Ugir-toorkee* for Persian, synonyms.

Kasni, Ar. Gum Galbanum (*Opoidea galbanifera*).—Imported from Persia and sold at 10d. per lb. In the 'Liber Fund. Pharm.' *Kinne*, Ar., is stated to be "Gummi Galbanum." In the Ulfaz Udwiyeh, *Kinneh* and *Nafeel* are given as Arabic names of the plant.

Katar Mekki, Ar. Kino (*Pterocarpus marsupium*).—Imported from India. Price about 6s. per lb. I do not remember that Kino is represented under any name in Mowaïfik's 'Materia Medica.'

Kathira, Ar. Tragacanth.—Obtained from Persia. Sold at 3½d. per lb. *Kesira*, Ar., of Dr. Seligmann's 'Liber Fund. Pharm.' is referred to *Astragalus verus*, L.

Khardel, Ar. Mustard.— Native produce. Price 1¾d. per lb. *Churdel*, Ar., and *Sependan*, Pers., according to Seligmann. The different oriental species of *Sinapis*, with their varieties, are difficult to determine with certainty even from specimens of the seeds.

Khashkhash Aswed, Ar. Black poppies }
Khashkhash Abyad, Ar. White poppies } (*Papaver somniferum*).

—Imported from Persia and sold at 5d. per lb. The only variation necessary to notice is in the writing of the name, which Seligmann renders *Chaschchasch*, and gives as Persian and not Arabic.

Kotuniya, Ar. Fleawort (*Plantago psyllium*).—Imported from Persia and sold at 1¾d. per lb. *Bezrikatuna*, Pers. = "Psyllii semen." *Vide* Seligmann. Dr. Birdwood refers *Buzr-katoona*, Ar., to *Plantago Ispaghula*, which is known as *Ispaghool* in Persia and India; whilst in the latter country *P. psyllium* is called *Bartung*, under which name I have seen it from Kangra.

Kranful, Ar. Cloves (*Caryophyllus aromaticus*).— Imported from India and sold at 10½d. per lb. *Karenful*, Ar., of Seligmann.

Kubabeh Sini, Ar. Cubebs (*Piper cubeba*). Imported from India. Sold at 10d. per lb. *Kebabe*, Ar.—*Piper cubeba* of Seligmann, *Kibabeh* of the Persians, and *Cubab-chinee* of the Hindoos.

Kurkum, Ar. Turmeric (*Curcuma longa*).—Imported from India. Price 4d. per lb. *Uruki-safr*, Ar., *Serdi-tschube*, Pers., is the *Curcuma longa* root of the 'Liber Fund. Pharm.' Dr. Birdwood gives *Zirsood* and *Urook-us-sefer* as Arabic, and *Zirdchoobeh* as Persian, names. *Kirkum* is a Persian word for Saffron, and it may be sometimes applied as above on account of the colour of the powdered rhizome.

Kurtum, Ar. Bastard saffron (*Carthamus tinctorius*). — Obtained from Persiā and sold at 1¾d. per lb. troy. This product is certainly not the flowers which are called *Asfur*, and realise treble the price, but the seeds (*vide* Dr. R. Seligmann in 'Liber Fund. Pharm.,' sub "*Kurtum*," = Semen carthami tinctorii).

Kuzberah, Ar. Coriander seed (*Coriandrum sativum*).—Native produce. Price in the bazaars, 1¾d. per lb. (10 Riege piastres for 3lbs. troy). *Kusbere*, Ar., *Kuschnis*, Pers., of Seligmann, and *Kuzeeruh*, Ar., of Birdwood.

Lauz el Murr, Ar. Bitter almonds }
Lauz Halw., Ar. Sweet almonds } (*Amygdalus communis*).—
These are of native produce, and are sold at the rate of 7d. per lb. troy. Vide *Dehn-lauz* supra.

Leban, Ar. Benzoin (*Styrax Benzoin*).—Imported from India, and sold at about 1s. 9d. per lb. troy. I do not notice "Benzoin" in Dr. Seligmann's work. "Olibanum" is generally regarded as the Arabic *Leban* or *Loban*. Vide *Elk-el-Laban*. Benzoin is called *Loobanee-Ood* in the Deccan, and *Hussee-Looban* in Persia.

Ma Lumi, Ar. Lime juice.—Native produce. Price 3½d. per lb.

Mann, Ar. Manna.—Imported from Persia and sold at 1s. 9d. per lb. The brief reference to this substance in the 'Liber Fundam. Pharm.' is as follows:—"*Menn*, Ar. (Manna Syriaca), Ex Syria advehitur e regione urbis Bagdad. Mannam hedysari virtute sua æmuleatur."

Mastaki, Ar. Mastic (*Pistacia lentiscus*).—Imported from Constantinople. Sold at two piastres per miscal (about 6d. per oz.). This is the *Kinneh* or *Kinnoli* of the Persians, according to Dr. Birdwood, and the *Musteka* of the Arabs. A kind of mastic is collected, it is said, from *Pistacia Khinjuk* and *P. cabulica* in Sindh; but as the above product is imported direct from Constantinople, it would be the true mastic.

Mürr Makki, Ar. Myrrh (*Balsamodendron myrrha*).—Obtained from Mecca and sold at 10½d. per lb.

Nana, Ar. Peppermint.—Native produce. Sold at 3½d. per lb. See also *Dehn Nana*.

Ofes, Ar. Galls (*Quercus infectorius*).—Obtained from Kurdistan and sold at 4d. per lb. *Afs*, Ar., and *Masu*, Pers., are given by Dr. Seligmann as galls of *Quercus infectorius*.

Ofsentin, Ar. Absinth (*Artemisia sp.*).—Procured from Persia and sold at the rate of $\frac{1}{16}$ of a 1d. per miscal (= 72 grains troy). It is doubtful, amongst the large number of species of *Artemisia*, to which of these the bazaar product is to be referred, in the absence of specimens for examination. In India the *Afsunteed* of the bazaars appears to be in part the produce of *Artemisia Indica*, Wild., and in part *A. absinthium*, L.

Rabb Ruind, Ar. Gamboge.—Imported from India. Price 3s. per lb. *Assara-rewund* is given by Dr. Birdwood as the Arabic and Persian name of Gamboge.

Rabb-es-Sus, Ar. Extract of liquorice.—Imported from Aleppo. Sold at one piastre per miscal. See also *Asl-es-Sus*.

RAWEND, Ar. Rhubarb.—Imported from Smyrna. Sold at 6s. per lb. *Riwend*, Ar., is referred by Seligmann to *Rheum palmatum;* it is the *Rivend-tchini* of the Persians, *Rewund-cheenee* of the Hindoos, and *Rawund* or *Reebass* of the Arabs, according to Dr. Birdwood.

SABR, Ar. Aloes (*Aloe Indica, &c.*).—Procured from India and sold at 1s. 2d. per lb. troy. It is doubtful whether any portion of this consists of Socotrine Aloes. Dr. Birdwood states that *Sibr* and *Bol-seoh* are the Persian, and *Moosumbir* the Arabic names of Aloes, from whatever source derived.

SACMUNIYA, Ar.—Scammony, obtained from Egypt, realises upwards of a ½d. per grain (80 piastres per miscal). It is *Sekmunia*, Ar., and *Mahmudeh*, Pers., of Seligmann. A spurious *Sakmuniya*, consisting of coloured rosin, is sold in the Indian bazaars, and is really a bad imitation.

SAMGH ARABI, Ar. Gum Arabic.—Native produce. Price 7d. per lb.

SAMGH KURDI, Ar. Koordish Gum.—The produce of Kurdistan. Sold at 1¾d. per lb. I have at present no materials from which to determine the sources of these gums.

SINBEL ET TIB, Ar. Spikenard (*Nardostachys Jatamansi ?*). — Imported from India. Sold at 2 piastres per miscal (6d. per oz.). Dr. Seligmann gives *Sumbul* as the Arabic name of *Valeriana* (Nardostachys) *Jatamansi*. There is another product from Western Asia, known in this country as *Sumbul*, which is very different, and cannot be the above, since it is more rarely seen in India than in England.

SOKAPENJ, Ar. Sagapenum.—Imported from India. Sold at 7d. per lb. *Sikbinedsch*, Ar., of Seligmann ; *Sugbeenuj*, Ar., and *Sagafioon*, Pers., of Birdwood.

SULINJAN, Ar. Colchicum.—Derived from Egypt and sold at 7d. per lb. *Surindschan*, Ar., Hermodactyls. *Colchicum autumnale* and *Iris tuberosa* of Seligmann. Hermodactyls in India often contain a large proportion of the kernels of the curious fruits of *Trapa bispinosa.*

TAMR HINDI, Ar. Tamarinds (*Tamarindus Indicus*).—Imported from India. Average price, 2½d. per lb.

TARAMENTIN, Ar. Turpentine.—Obtained from Kurdistan, 2½d per lb.

THUM, Ar. Garlic (*Allium sativum*).—Native produce. Sold at 1½d. per lb. *Sum*, Ar., of Seligmann. Dr. Birdwood has given *Teriacrowstyan* as an Arabic, and *Seer* as a Persian, synonym, with *Tom* as the Egyptian name of Garlic.

TIN, Ar. Figs (*Ficus carica*).—Native produce. Sold at 3½d. per lb. *Tin*, Ar., *Indschir*, Pers., *Ficus carica*, Seligmann. The Persian name is more commonly written *Unjeer*, under which the Fig is known in many parts of India.

WERD BENEFSHEH, Ar. Violets.—Imported from Persia. Sold at 1s. 2d. per lb. *Benefsedsch*, Ar.—*Viola odorata.* "Optima est Cufica, tum Ispahanica," Seligmann. Birdwood gives *Behussej* as the Arabic, and *Banafsha* as the Persian, synonym.

Werd Khetmi, Ar. Mash melon.—Native produce. Price 3½d. per lb.

Werd Rumman, Ar. Pomegranate flowers (*Punica granatum*).—Native produce. Sold at 3½d. per lb. *Rumman*, Ar., and *Nar*, Pers., of Seligmann. *Kilkul* and *Rana* are also Arabic names.

Wushak, Ar. Gum ammoniacum (*Dorema ammoniacum*).—Imported from Persia and sold at 3½d. per lb. *Eschak*, Ar., Seligmann. Sometimes also written *Ooshak*.

Zafaran, Ar. Saffron (*Crocus sativus*).—Obtained from Persia. Sold at 4 piastres per miscal. Written *Safran*, Ar., by Seligmann. *Koorkum* and *Zafran* are given by Dr. Birdwood as Arabic names, and *Kerkum* as the Persian.

Zahr es Samak, Ar. Cocculus Indicus (*Anamirta cocculus*).—Imported from India, and realise 3½d. per lb. troy. Not included in the 'Liber Fund. Pharm.'

Zenjefil, Ar. Ginger (*Zinziber officinale*).—Obtained from India. Price 3½d. per lb. *Zinebeel-rutb*, Ar., and *Zinjebeel-tur*, Pers., of Dr. Birdwood.

PEARL FISHERY OF CEYLON.

The fishery usually takes place in the month of March, when the sea is calm and the currents least perceptible.

The process is as follows: The whole of the boats assembled are numbered and divided into two squadrons, the red and the blue, each consisting generally of sixty or seventy boats. The squadrons fish alternately. Each boat has its company, five diving stones, and two divers to each stone. All the men are numbered as well as the boat, and in the Kottoo there are divisions with corresponding numbers, so that each boat knows the precise spot where its oysters are to be deposited.

The squadron starts usually between eleven and twelve p.m., so as to reach the fishing ground by sunrise. The banks are about twelve miles from the shore. As soon as the boats have arrived, the signal is given, and the diving-stones go over the sides of the boats with a low rumbling noise. One diver goes down with each. The other holds the signal rope, watches the motions of his comrade, draws up first the stone, then the net in which the oysters are lodged as torn from the bank, and then the diver himself. Each pair of divers keep their oysters separate from the rest in large nets or baskets, so that luck and labour determine the remuneration of the pair.

When one man is tired the other takes his place; but they do not dive alternately, as too much time would be lost by changing. The man who has been down, after remaining a minute or so upon the surface, during which he either floats without apparent exertion or holds on by a rope, descends again, and repeats the process, until he requires rest, when he takes his turn on board. This continues without interruption for six hours. Indeed, the stimulus of self-interest brought to bear upon all is so great, that as the time approaches for striking work, the efforts of the men increase, and there is never so much activity as when the heat is most intense, the sky without a cloud, the sun glaring frightfully, and the sea like molten lead. At last the second gun is fired; every stone goes down simultaneously for one more haul, and then every hand is employed in making sail, and every boat has her head to the shore.

The Adigar (a native head-man stationed at Manaar, who is allowed a boat with five stones as his share of the fishery) acts as commodore.

As the boats reach the beach they let go their anchors opposite the Government "Kottoo," the first arrivals getting the best places.

Each boat swings upon her anchor, with her stern to the shore, and in an instant the divers are in the water, and each pair carries the results of its day's work to the Kottoo. Then they divide the oysters into four heaps. In two hours the whole of the seventy-five boats are unloaded, unless delayed by contrary winds. The divers' share removed, and the three-fourths belonging to Government left in the Kottoo, divided into heaps of 1,000 each, the doors are locked, guards stationed, and everything is in readiness for the Cutcherry sale.

This system appears peculiarly well suited to the country and to the objects in view, by bringing to bear upon the daily results of the fishery the largest amount of private interests and the smallest amount of Government control. No man could be forced into doing what the divers do voluntarily. No fixed payment would induce them to dive as often in the day, or to unload their boats with equal dispatch.

The revenue derived from the pearl fishery is of a very uncertain and precarious nature. The Dutch had no fishery for twenty-seven years—from 1768 to 1796, and they were equally unsuccessful from 1732 till 1746. From 1833 to 1854 there was no fishery at all. But the scientific inquiries recently made led to the conclusion that the pearl oyster may possibly be brought within the domain of pisciculture.

The pearl fishery of 1859 was, as regards results, the most successful that has taken place since the fisheries were resumed in 1855. It realised 48,215*l.* This great increase in the selling power of the oysters was owing to the profit, which could not have been less than 300 per cent., made by the speculators in 1858. The fame of this brought all India into the field as competitors. Money was as plentiful as buyers; and the same oysters which averaged 1*l.* 19s. a thousand in 1858, in 1859 produced an average of 4*l.* 10s., the highest rate paid being no less than 8*l.* 8s. There is no reason to doubt that even at these high prices large profits were made.

Captain Pritchard describes the fishery of 1860 in the following terms:

"The most prominent feature connected with this fishery has been the unprecedentedly high prices given for the oysters; those of the North Modregan having sold at rates varying from 155 to 115½ rupees per 1,000 (for 8,726*l.* 18s.), and the oysters of the south-east Modregan at 180 to 92 rupees (for 27,954*l.* 14s.). Circumstances generally favoured this result. But the principal causes were, that the oysters themselves had yielded a most valuable out-turn, and that there exists now a very great demand for pearls in the various markets of India and China. The following statement shows the result of this pearl fishery from 1855 to 1863:

Years.	No. of Oysters fished for Government.	Average Price per 1,000.	Total Produce.
		£ s. d.	£ s.
1855	5,012,108	2 4 0	10,922 0
1856	Nil.	—	—
1857	24,380,308	0 16 8½	20,550 15
1858	12,353,049	1 19 0	24,120 0
1859	6,391,549	4 10 0	48,215 19
1860	2,733,954	13 4 0	36,681 12

There was no fishery in 1861 and 1862. The annual expenditure incurred by the Government for the fishery is about 4,000*l.*

SILK TRADE OF BEYROUT.

That there is not much to see at Beyrout is a fact which will be corroborated by everyone who has had the ill-fortune to spend a summer there—as was the lot of the writer of this article. One visit will suffice to perfectly explore the dark, straggling bazaars. One excursion to the Dog River serves to make the scene of the conflict between the Druses and Maronites familiar to the tourist. Nor will the Damascus Road present any greater attraction. The extensive manufacture of silk, however, in and near Beyrout, renders it easy to acquire a knowledge of the processes by which the raw material is successfully transformed from the *cocoon* to the costly fabric for exportation, and finally into the *robe de bal.* In June (the laying season) the silkworm-moths deposit their eggs. These the Syrian peasants carefully collect and store in bags, which are sewed through at regular distances to prevent the lower eggs being crushed by the superincumbent weight. When all the eggs, so insignificant in appearance, so valuable in reality, have been safely stored in the manner described, the bags are sent from Beyrout to the mountains in order to prevent their being hatched too soon, the climate of the mountainous parts of the country being colder. The stored bags thus remain at a comparatively low temperature until the month of April in the following year, when the owners cause them to be sent back to Beyrout. Care is now taken to subject the eggs to a temperature considerably higher than that in which they have passed the winter; and, as it is desired that the hatching should not take place until the young leaves of the mulberry-trees have appeared, artificial heat is so regulated in its application as to produce the silkworms immediately after the food so necessary for their support has presented itself. The period of time regarded as the hatching season varies from five days to fifteen. As soon as the newly-hatched silkworms are able to adhere to the mulberry-leaves, they are plentifully supplied with them, and placed on broad stone trays for the space of twenty days. After a period of ten days has elapsed the silkworms cease to feed, and a marked pause ensues, and is followed by another ten days' feeding and a second pause. The worms having now "twice fasted," as it is called, the trays are removed to the open air, and placed on shelves one above another; here they remain twenty-five days, and at the expiration of this term the worms begin to make the cocoon or oval ball of silk, the completion of which occupies some fifteen days more. When the cocoons are completed, it is usual to select such insects as are intended for stock, and destroy the remainder by smoke without delay, lest the worm, or rather chrysalis, should, as would be the case in a further space of five or six days, become a moth and proceed to lay eggs, in which case the cocoons would be comparatively valueless.

Leaving aside those preserved as stock—a comparatively small proportion—let us now return to the silkworms that are sacrificed by being smoked to death for the sake of the cocoon. The cocoon, once the house now the coffin of the silkworm, becomes, after its tenant has been smothered, a marketable article, and is sold by the poorer rearers to their richer neighbours. The price varies from 4s. to 6s. per *oke* (= $2\frac{3}{4}$lbs.), according to the quality of the silk. To produce an oke of fine silk, some 10 or 11 okes of cocoons will be required, and its value will be from 350 to 400 piastres (a piastre = 2d.). Coarse silk is not worth more than from 170 to 210 piastres.

Having now conducted the reader through the mazes of hatching, feeding, and cocoon-making, as well as the sale of the raw material, we must now repair to one of the reeling-sheds, of which there are so many in the vicinity of Beyrout. The creaking sound of rudely-constructed wooden machinery, of great size, at once attracts the notice of visitors, and on entering the hut from whence the sound proceeds a huge, lumbering wooden wheel may be seen in motion. This wheel is fed by a man or woman from a mass of silk of a light straw-colour, the thread passing from the feeder's hand to the wheel being scarcely thicker than one fibre of the silk. The vicinity of the reeling-sheds is easily discovered, independently of the noise, by the presence of a very peculiar odour arising from the boiling of the cocoons over a fire, in order to detach the fibre of silk. This process must first be performed ere the fibre-silk can be used as feeding for the revolving wheel, the diameter of which is usually ten or twelve feet in size.

The colour of the silk when wound round the wheel becomes somewhat deeper, and exhibits a glossiness not so observable before. The more extensive manufactories, of which there is one some two miles' ride from Beyrout, have many cauldrons, and also many wheels. In one there are as many as 600 hands employed. After the silk, in almost fibre-fineness, has been all wound around the wheel, it is removed and doubled up into hanks, and taken to the houses of the dyers, where it may next be seen steeping in large cauldrons until the dye has thoroughly pervaded it ; the silk is then wrung out and dried, and finally removed to the bazaars for sale, or else—as is the case with a great portion—exported. Handlooms are the only weaving machines in use in Syria.

TRADE OF CENTRAL ASIA.

The common manufactures comprise inferior sabres, glass, delf, coarse cloths of goats' hair called *kurk*, and of camels' hair called *barakshutri*, which are made into cloaks and exported to Túrkistàn and Persia. A coarser fabric is used for nomad tents. Cotton cloths are woven for shirts and trousers. Sheepskins with the wool on are skilfully prepared and embroidered at Kàbul, and sent all over Central Asia. Metals, Bukhára silk goods, cloth, muslins, woollens, and cottons, principally of European manufacture, are amongst the chief imports. General Ferrier states that fowling-pieces, watches, delf, cutlery, spectacles, rich and heavy silk goods, woollens or cottons for turbans, and sashes for the waist, paper, and sugar might be offered for sale with advantage.

The mulberry is largely grown for rearing silkworms.

About ten days or a fortnight after the mulberry-trees put forth their leaves, the eggs of the silkworms are removed from the place where they had been preserved during the winter, and being wrapped in a cloth are carried against the naked breast, or still oftener under the armpit. Three or five days are quite sufficient for the little insect to be hatched. They are then placed in a vessel, and fed with the leaves gathered from the mulberry ; after ten days, the worms, according to the expression of the Bukhárians, fall into their first sleep or trance, *i. e.*, they take no nourishment three days running ; repeating the same process every ten days until the time it begins to spin the cocoon. When these are finished, the worm inside is destroyed by exposing the cocoon to the heat of the sun. That done, the Bukhárians proceed to reel off the silk threads.

The quality of the silk of Bukhára is much inferior to that of China, and even to the French and Lombard silks, as well in colour as in the softness of the thread.

The trade carried on by the Tatar merchants at Semipalatinsk with the Kirghiz tribes is thus described by Atkinson:—

"They supply them with silk dresses, tea, raisins, and wooden bowls from China; khilats of printed calicoes from Khokand; Russian hardware, iron, copper, leather; for which they receive in exchange black and grey foxskins, horses, oxen, and sheep. The horses and oxen are driven into Eastern Siberia to the different gold mines. One of these Tatar traders told me that he imported 50,000 horned cattle into Siberia annually; and these are chiefly consumed at the gold mines. I have met the Kirghiz, with herds of from 3,000 to 4,000 oxen, 1,500 miles from their homes, and 500 from their destination. When the cattle are delivered at the mines, the men remain a few days and then start on their return—a very long ride. Their journey home is by the post as far as Semipalatinsk, and then to their hovels in the steppe on horseback. The sheep are driven acrose the steppe to Petropavalosk, on the frontier of Siberia, and thence to Ekaterineburg, where they are killed, and their fat melted down into tallow. More than 1,000,000 sheep are brought from the Kirghiz steppe yearly, which are disposed of in this manner. The whole of the tallow was (till within the last five years) forwarded to Europe; now the bulk is converted into stearine at the large works near Ekaterineburg. This establishment supplies all Siberia with candles, besides sending a great quantity into Russia."

Entertained in the steppe by a chief, Mr. Atkinson observed "the ground inside the dwelling covered with Bukhára carpets. Tea, dried apricots, and raisins formed the refreshments, together with boiled mutton, served up on a wooden tray with boiled rice. The chief wore a Chinese silk khilat of varied colours, a fine shawl round his waist, a brown conical cap turned up at the sides, and a pair of green leather boots, with overshoes or slippers."

The summer costume of both men and women consists of two, sometimes of three, silk or cotton khilats (long dressing gowns).

Opium-smoking is prevalent. The drug is sold by the Tatar merchants for its weight in silver. Before the caravans reach the town of Kulja (Ila) and Khoubachak they are met by Chinese, who purchase their whole stock, paying for it in silver, and these men smuggle the opium into the towns.

In the province of Khutan, grain, vegetables, and fruit abound. The mulberry flourishes, and furnishes sustenance to the silkworm, which is very generally reared. Horses, yaks, and sheep are numerous, and the fleeces of the shawl goats are equal to those of Chan-than. The manufactures comprise woollen camlets, cottons, and silks; and the silk fabrics are celebrated.

Raw silk, both white and yellow, is first taken to Bukhára, where it is dyed. It is then purchased by Nogai traders, and carried to various parts of Russia.

The chief article of trade in Khutan and Ladakh consists of the fleece beneath the undercoat of the hair of the shawl goats; it is cut once a year; the wool picked out is sent to Kashmir, but the hair is made into ropes, coarse sacks, and blankets; after the hair of the goat has been cut short with a knife in the direction of its growth, or from the head towards the tail, a sort of comb is passed in the reverse direction, and brings away the finer wool almost unmixed with the coarse hair; if not shorn as the summer commences, the animals themselves rub off the wool.

Moorcroft (volume ii., page 347) mentions that "by ancient custom and engagements, the export of the wool is exclusively confined to Kashmir, and all attempts to convey it to other countries are punished by confiscation. In like manner it is considered illegal in Rodokh and Chan-than to allow a trade in shawl wool except through Ladakh; and in the latter country considerable impediments are opposed to the traffic in wool from Yarkand, although it is of superior quality and cheapness." But in these days a good deal of shawl wool is brought by different paths on sheep to Rampur, and sent from thence to the Kashmir colonies in the Punjab.

The goats are found domesticated all over the mountainous country of Western Thibet, particularly in the provinces of Ladakh, Rodokh, and Garoo. Chan-than is the name given to the elevated plateaux, where innumerable flocks are pastured, and which the following description will exemplify:—

"The valley of Rupshu (in Ladakh) varies in breadth, and occasionally expands into a broad plain, but in general it is not more than 500 to 700 paces in breadth. The hills on either side were covered on the 12th of June with the winter's snow, and we had occasional falls of hail and snow in the plain. The soil of the latter was at first loose clay, and afterwards consisted chiefly of micaceous sand, scattered over with stones, and thinly patched with stunted furze; several rivulets crossed it, and in their beds and on their banks a small quantity of grass was growing, which affords pasturage to the flocks of the shepherds of the more exposed districts. Near our encampment, a champa, or shepherd and his family, had encamped, and several other tents were near; the tents are of ragged black blanket, about four feet high, and open all along the top. Their interior is furnished usually with abundance of dirty sheep and goat skins, some sewed into coats; two or three iron pots, and one or two of brass or copper; some iron spoons, a churn for tea, not for butter, and some wooden milk pails

The rest of the shepherd's equipment is carried about his person, as his teacup, pipe, tobacco pouch, chakmak, or flint and tinder, knives, and a small spoon, with several needles."*

The home manufactures of Ladakh consist of coarse blankets and woollens, and of black mohair tents, from the hair of yaks. But Lé is also the entrepôt of a considerable trade between the countries around it. Shawl wool of the finest sort is now imported from Yarkand, as well as Chanthan. Brick tea, in square lumps of 8lbs. weight, is brought by caravans from L'hassa. Borax, received from Puga, is refined at Kulu and Chamba, and bought by the silversmiths and braziers from the plains ; sulphur and black salt are imported from Chan-than ; charas, tobacco, felts, steel, Russian leather, brocades, and boots from Yarkand ; opium and red goat-skins pass through from the British territory to Yarkand ; shawls and saffron from Kashmir ; chintzes and copper tinned vessels from the Punjab.

The people of the north are active traders, proceeding to Lé for charas, and to Gardokh for shawl wool, giving in exchange money, clothes, and spices. The mountain paths are scarcely practicable for laden mules, and merchandise is carried chiefly on the backs of sheep and goats. An annual fair is held in November at the capital, Rampúr, on the Sutlej. The town is of some importance, as the point where the commercial routes from Lé, Gardokh, and Simla meet, and also as a seat of the pashmina manufacture. In 1840 the value of *pashm* imported was valued by Cunningham at about 90,000 rupees.

The Government agency established at Kotgurh in 1820 was intended to encourage the export of shawl wool to the British territory, whence it was sent to England to be manufactured. In exchange, small quantities of copper, steel, chintzes, and woollens were bartered. The project did not succeed, and was abandoned. Since that time extensive manufactories have arisen in the Punjab itself, and compete with those of Kashmir for the supply of *pashm.*

Silk is produced in the western parts of the country, and great quantities are exported from Bukhara for the Indian markets.

Wool obtained from the fat-tailed variety of sheep is used in the manufacture of cloths and carpets, and also exported to India. Kilat and the surrounding country produces sheep's wool in great abundance. It is a remark of Burnes " that our early commercial connexion with the countries on the Indus was sought to find vent for British woollens, while the existing trade is almost confined to cottons ; and this is the more singular, as there is good reason to believe that in return for those cottons we shall shortly receive raw wool from the countries of the Indus." This anticipation has now been completely fulfilled.

At different times colonies of Kashmiris have emigrated and settled in the British dominions, where they pursue the manufacture of

* Moorcroft, Vol. II., pp. 46-48.

shawls. They are to be found in considerable numbers at Amritsar and Nurpur, as well as at Ludianah, Tiloknath, and Jalalpur; but the shawls made at these places are inferior to those of Kashmir. The value of shawls sold at the annual auction in London is reported to have risen from 103,000*l.* in 1850 to 264,586*l.* in 1860. A temporary depression has resulted from increased production, repetition of the same patterns, and inferior work.

The interests of the Maharaja and his manufacturers are identified in the endeavour to retain the monopoly of the shawl-wool; consequently none of the Túrfani wool from Yarkand, which is the finest, is allowed to pass into British territory, which is entirely supplied from Chan-than.

It is probable that on the whole the demand for shawl-wool has of late years much increased. Native accounts represent that the use of the Túrfani wool has arisen within the last quarter of a century. It is evidently of the highest importance that the supply of the raw material of the exquisite manufacture peculiar to Kashmir and the Punjab should be effectually facilitated and protected. There is no doubt that it is inexhaustible; and it is impossible not to admire the felicitous conjunction in the same region of a natural product so valuable and of workmen so artistic.

The shawl-goat thrives in Spiti, though the wool is not reckoned equal to that of Chan-than. The Maharaja was, in 1847, excused from rendering shawl-goats under the stipulation of the treaty, in consequence of the animals dying at Dhurmsala, where they were kept. It is apprehended that sufficient pasturage for any large number could not be found in Spiti.

The mountain paths between Rampur and Spiti are so precipitous that sheep, more sure-footed than larger beasts, are commonly used to carry burthens of from 16 to 20 lbs. "The sheep are driven from village to village with the wool on, and as the required quantity is cut from their backs, they are laden with the grain which is received in exchange, and which, when the fleece is all disposed of, is carried into Chinese Tartary and sold at a profitable rate." * "It is the custom for the shepherds of Chumurti to give an order while the crops are yet green, and on the ground, for any amount of grain they may require, which, when the crop is ripe, is stored up by the cultivator until the summer of the ensuing year, when the shepherd arrives with his flock, gives the wool in exchange, and receives his grain, which he puts into small bags, and drives back his flock thus laden." † "Many of these sheep were formerly purchased by the British Government, by an agent appointed for that purpose at Kotgurh, but the speculation was aban-

* "Journal of a Trip into Kunawur," by Captain Hutton. 'Journal Asiatic Society,' Part I., p. 192.

† Ibid. p. 498.

doned. A difficulty existed in inducing the Tartars to sell to the British agent, they preferring to trade with the people of the higher tracts. At present the Tartars would gladly supply any amount required. Had the agent, instead of remaining in the lower hills, paid an annual visit to Tartary, and purchased his wool directly from the shepherds themselves, instead of taking it from the hands of the traders, he would not only have procured a better, but a cheaper article. The speculator would not probably be allowed to enter the country under the protection of China, but he might with ease and safety every summer repair to Hungrung or to Spiti, where the Chinese shepherds would not fail to meet him by appointment, and furnish any quantity of wool he might have ordered in the preceding year. He would thus be able to select his own fleece, and see it shorn before him. For carriage it would be necessary to purchase a large flock of sheep, which during the winter season would find an abundant pasture in the lower tracts, or even in the plains, and in the summer or rainy season would be roaming over the grassy tracts of the upper hills. With the flock might be taken flour, grain, salt, iron, ghee, butter, cloth, sugar, and other articles in demand among the people." *

In the commodities brought from Yarkand there has of late years been an increase of shawl-wool. This is the produce of the Karakoram, Pámir, and Mazát or Mastau mountains, of which Captain H. Strachey remarks—" Mr. Wood's description of Badakhshan and Pamir presents a remarkable likeness to a province of the Indian Himalaya (such as Kunawur), communicating by a valley gorge (as that of Tsotso) with a Thibetan upland (like Rúpshú). On both the summits we have 15,000 feet lakes embedded in 19,000 feet mountains, with the same zoology of domestic yak and wild sheep, and the Kirghiz even is cousin-german of the Champa of Nari." Moorcroft reports that the fleeces of the shawl goats of Khutan are at least equal to those of Ladakh. The Pashm from Yarkand, known as Turfani and Khuchari, is of the finest description, and is entirely consumed in the manufacture of the best shawls in the Maharaja's territories. It has there to a certain extent superseded the Chan-than wool, which is less fine. It is stated that the art of cleaning the raw wool has only been communicated to the Yarkandis since the Dogra conquest of Ladakh ; hence the increased export.

The shawl trade of Amritsar bears the highest value, and the profits seem to be equally divided between the Maharaja's and our own territory. It might be thought impossible for the manufacturers of Kashmir, who have to pay not only a heavy stamp duty on their shawls, but also a customs' duty on export, to compete with the free industry of the looms in the Punjab, but the fact is that the fabrics of the valley have

* "Journal of a Trip into Kunawur," by Captain Hutton. 'Journal Asiatic Society,' Part I., pp. 500-502.

as yet retained the preference of European purchasers. It is said that the weavers in Kashmir are more skilful, their wages lower, and the water and air of Kashmir conservative of the brilliancy of the dyes and the softness of the wool; and it is certain that the genuine Kashmir shawls far surpass those made in the Punjab, both in beauty of design and fineness of texture. But, on the other hand, it does not appear that the manufacturers in the Punjab have directed their efforts to the fabrication of *chefs d'œuvre.* They have as yet found it more profitable to produce a number of coarse shawls. It is in evidence that the quantity of shawl-goats' wool imported into Amritsar has for several years past decreased. In its stead sheep's wool from Kirman, in Persia, has been largely introduced into the manufacture of shawls. This wool is fine of its kind, and long in the staple. It is much more easily and quickly worked than the more delicate goat-wool. It is largely used in Persia in the fabrication of *jamewars,* which have superseded the use of Kashmir shawls in that country. Being more or less mixed up by the Punjab weavers with the genuine *pushm,* inexperienced persons have some difficulty in detecting the inferiority of the shawls made from it, particularly before they are washed, though the greater weight and coarseness may raise suspicion; and it was only in the year 1861 that the decided distaste of the English merchants was manifested. At the last auctions there was a fall of from 30 to 50 per cent. in the prices realized; and the loss thus caused will probably lead to a greater use of goat's wool in the better kind of shawls.

The silk trade is third in point of value, being nearly 200,000*l.* This is an important branch of manufacture at Amritsar, and still more so at Lahore and Mooltan; the raw silk being imported from Kokand, Bukhára, Balkh, Khulm, Akhcha, Shibberghaum, Andkho, and Kashmir; from Saidabad, Moorshedabad, Rampoor Baolia, and Radhanagri in Bengal; and from China, *viâ* Bombay. No silk has been imported from Khutan for the last four or five years. The raw silk is sent from Amritsar to all parts of the Punjab for manufacture. Silk fabrics to the value of three lakhs are manufactured at Amritsar. Those imported from Europe, Lahore, Bukhára, Bengal, and Benares, are rated at 4,000*l.*, 3,500*l.*, 8,500*l.*, and 2,500*l.* respectively.

Raw silk is the great staple import by way of Kabul, and pushmina fabrics from Kashmir; and these items exceed half the value of the trade of both countries. Nearly one lakh's worth of fine wool comes from Bukhára by way of Kabul; about the same value of dried fruits, half a lakh's worth of madder, a quarter of a lakh of drugs and spices, together with a few bales of Bukhára silk cloths; gold thread from Russia, and a little saffron from Persia.

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