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EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

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An Account of some Experiments on certain Sea-Weeds of an Edible kind. By JOHN DAVY, M.D., F.R.SS. Lond. & Ed., &c.

The subjects of the experiments I am about to give an account of have been four, Carrigeen Moss (*Chondrus crispus*), Dulse or Dylisk (*Rhodomenia palmata*), Sloke or Laver (*Porphyra laciniata*), Tangle (*Laminaria digitata*), Doughlaghman (*Fucus vesiculosus*).

The results I have obtained are fewer and more imperfect than I could wish; I can offer them only as a small contribution, with the hope that they may induce others more favourably situated to engage in and extend the inquiry concerning a class of substances which certainly have not yet received the degree of attention they deserve, especially from the analytical chemist.

1. *Of Carrigeen Moss* (Chondrus crispus).

That which I have examined has been from Ireland, and in its bleached state,—the state in which it is sent into the market, and is coming into use for the purpose of feeding stock.

It is of a light-yellowish hue, of a crisp feel, and of a faint peculiar flavour, without saltness, having been steeped and washed in fresh water preparatory to bleaching.

It appears to be composed principally of three substances; one analogous to gum, soluble in cold water, and having most of the properties of mucilage as represented by gum-arabic; one analogous to gelatine as existing in isinglass, soluble in boiling water; and the third neither soluble in cold nor boiling water, the nature of which remains to be ascertained. Judging from one trial, these exist in the following proportions:—

28·5 Gummy matter.
49·0 Gelatinous matter.
22·5 Insoluble matter.

The gummy matter was separated by repeated infusions of cold water, the gelatinous by repeated decoctions, changing the water each time till no more matter was dissolved; and the quantity of each was determined by weighing the matter abstracted, obtained by evaporation of the several infusions and decoctions, and the loss was considered as representing the undissolved matter, the quantity of which remaining nearly agreed with this estimate.

Of the mucilaginous and gelatinous ingredients, I may briefly mention that the former is precipitated from its solution by subacetate of lead and alcohol, but not, like the latter, by infusion of nut-galls.

The gelatine from *Chondrus crispus*, it is worthy of remark, even exceeds isinglass in its power of coagulating milk on cooling after boiling. Thus, 1 grain of it boiled and dissolved in 127 grains of milk, on cooling formed a pretty firm coagulum: repeating the experiment, substituting 1 grain of isinglass, the result was a less firm coagulum, and requiring a longer time to form. Further, when the alga-gelatine is dissolved in such a proportion of water as not to gelatinize on cooling, as 2·3 grains in 130 of water, milk poured into it immediately coagulated, became liquid on boiling, solidifying again on cooling; but isinglass in the same proportion had no immediate effect on milk.

Chondrus crispus burns with flame, and yields a considerable quantity of saline ash; in one trial it amounted to 10 per cent., 7 of which were soluble in water with an alkaline reaction, and consisted chiefly of common salt, with a little sulphate of lime and a minute quantity of an iodine compound. The portion insoluble in water was found to contain phosphate of lime, with some carbonate of lime and magnesia, with which was mixed a small quantity of siliceous sand. The carbonate of lime and sand may be considered as accidental and extraneous, the former derived from some minute coral adhering to the weed, the latter mechanically entangled in it.

Iodine appears to be an intimate ingredient of the plant. I have found it both in the ashes of the mucilaginous portion, when that has been incinerated apart, and also in the ashes of the gelatinous and of the residual insoluble portion.

When subjected to destructive distillation, this alga affords an empyreumatic fluid, which, mixed with lime, gives off a strong smell of ammonia. In the sequel I shall state the proportion of nitrogen which this and the other species of algæ named were found to contain, for which I am indebted to my friend Dr Apjohn, the distinguished professor of chemistry in Trinity College, Dublin.

2. *Of Dylisk or Dulse* (Rhodomenia palmata).

The specimens which I have examined of this alga were procured from Galway and Letterkenny in Ireland, and in the state in which they were brought to market for sale. That from the former town had small mussels mixed with it adhering to the fronds ; that from the latter, which was chiefly the subject of my experiments, was free from them.

Both were unbleached and unwashed, and consequently retained their purple colour, and tasted salt. That from Galway, besides the salt taste, had a flavour not unlike that of oysters, which it might have derived from the juice of the shell-fish. When well washed, the alga is almost tasteless ; chewed,—the manner in which it is commonly eaten by the peasantry without being dressed,—it has a mucilaginous feel in the mouth, with a slight acrid after-taste. Its smell, which is best perceived in its infusion, resembles not a little that of violets.

The colouring matter of the alga is soluble in water. By boiling in water the colour of the plant is changed to green, as is also that of its infusion. It is capable of combining with alumine; thus, if alum be added to the coloured aqueous infusion, and the alumine be precipitated by ammonia, the colouring matter is carried down with and retained in the precipitate. It appears to be insoluble in cold alcohol. Fronds have been kept many days steeped in alcohol without the spirit acquiring any colour, or the alga losing its colour; but when boiled a partial solution has taken place; the colour of the fronds has changed to greenish-brown, and the spirit has acquired a tint of green. It may be worthy of remark, that on cooling the fronds recover their original colour, but little impaired.

This alga appears to be composed of a gummy matter soluble in cold water, of a matter soluble in boiling water having some of the properties of gum, and of a matter insoluble in both. Twice infused, and during about twenty-four hours, in water at 50° Fahrenheit, the infusions evaporated yielded about 16 per cent.; afterwards boiled for many hours, the decoction, strained and evaporated, left 36 per cent.

The solution obtained both by infusion and decoction is rendered turbid by infusion of nut-galls, and is precipitated by subacetate of lead. The alga does not coagulate milk; boiled in milk, the milk remains fluid on cooling.

Freed from adhering salt, it burns with flame, and is readily reduced to a gray ash, equal to about 6 per cent., of which 5·4 were found to consist principally of phosphate of lime, and of carbonate of lime and magnesia, with a trace of iron and a minute quantity of silica, chiefly derived from infusoria, the forms of which were distinct under the microscope. The saline matter of the ash, separated by water, had an alkaline reaction; it consisted principally of common salt, with a minute quantity of an iodine salt. The indication of the presence of iodine was distinct by the starch test with aqua regia; even in the first washings of the weed to remove the adhering salt, iodine was detected.

3. *Of Sloke or Laver* (Porphyra laciniata).

The specimen of this alga which I have examined was from Ireland, but I am ignorant of its exact locality. Like the last-mentioned, it tasted salt, showing that it had not been washed. Rapidly washed, and the water evaporated, the saline matter obtained was chiefly common salt; a trace of iodine was detected by the ordinary test.

In its colour this alga differs but little from the preceding. Its colouring matter, like that of the Rhodomenia, is soluble in water; is capable of combining with alumine; is changed to green by boiling; and is in much the same manner acted on by boiling alcohol. A slight difference is exhibited as to colour on comparing the infusions: by reflected light, its infusion appears to be a rich orange; by transmitted, a bright purple,—a difference less marked in the infusion of the Rhodomenia. Further, when dried its fronds become black, as seen by reflected light; whilst those of the former appear only of a darker and duller purple.

In composition too, from the few trials I have made, this alga seems to be very similar to the last. It yields but little matter to cold water, about 6·5 per cent., of the nature of gum; to boiling water—the decoction continued many hours —it gives up a large proportion, about 43 per cent., also having most of the properties of gum. What remains after infusion and decoction—about 50 per cent.—is of a dark green, of soft consistence, like spinach, and nearly tasteless. It becomes black and brittle on drying. It yielded about 5·5 per cent. ash, consisting of about 2 saline matter, and 3·5 matter insoluble in water. The former was composed chiefly of common salt, with a trace of iodine; the latter of phosphate and carbonate of lime and magnesia, in nearly equal parts. Both the infusion and decoction are rendered turbid by infusion of gall-nuts, by subacetate of lead, and in a slight degree by the acetate. It has not the property of coagulating milk. Iodine was detected in the ash obtained by burning the matter both of the infusion and decoction. The indication of it in the former was very faint; in the latter it was less so.

4. *Of Tangle* (Laminaria digitata).

For a specimen of this alga I am indebted to a friend in Edinburgh. It was taken from the coast of the Firth of

Forth, and, not having been washed, was impregnated with salt. In the washings to remove the salt, however rapidly made, iodine could be detected, subjecting the saline matter obtained by evaporation to the ordinary test. Digested in cold water, the fronds impart to it a brown colour. The infusion is precipitated neither by corrosive sublimate nor infusion of nut-galls, but both by the subacetate and acetate of lead. The precipitate by the latter is peculiar, of a gelatinous consistence, and viscid, admitting of being drawn out in threads, mucus-like. The infusion evaporated yields a matter transparent like gum, and adhering to the capsule. It burns with flame, and its coal burns with partial, bright scintillations, as if from the presence of a nitrous salt. By boiling the fronds after infusion, a decoction of the same colour as the infusion is obtained. No gelatine or analogous substance could be detected in it; it was not rendered turbid by infusion of nut-galls, nor did the fronds, after boiling with milk, coagulate it on cooling.

The washings of the stalk of this alga were found to be even more rich in iodine than the fronds. The saline matter, of course, was chiefly common sea-salt. By infusion in cold water, this part of the plant was found to yield about 5·8 per cent. brownish mucilaginous matter, and, by decoction, about 8 per cent. of similar matter, about 86·2 remaining undissolved. The dried matter from the infusion afforded 54 per cent. of ash, consisting of saline matter soluble in water about 50 per cent., and of matter soluble in nitric acid about 4 per cent., composed chiefly of phosphate and carbonate of lime, with a little magnesia. The saline matter was very rich in iodine, and contained also bromine. The extract, by boiling water, yielded about 54 per cent. also of ash, of which about 26 were soluble in water, and 28 (the greater part of it) were soluble in nitric acid. The latter was composed chiefly of phosphate of lime with some magnesia. The former had a strong alkaline reaction, and, like the salt from the cold infusion, abounded in iodine, and contained some bromine. The portion that resisted infusion and decoction burned with a bright continued flame, and was pretty readily reduced to ash. It yielded about 13·3 per cent., composed of about 7·3 saline matter soluble in water, and of about 8 of matter insoluble in water, but in great part soluble in nitric acid. The latter consisted principally of carbonate of lime, with some phosphate of lime and a little magnesia. The former was very rich in iodine salt, and contained also bromine; so small was the proportion of common salt, that its flavour was hardly perceptible.

5. *Of Doughlaghman* (Fucus vesiculosus).

Of four kinds of sea-weed which are used for food on the coast of Donegal, the species above named, I am informed, is in greatest estimation. The specimen I have examined was from that coast, gathered from the rocks below Gweedore,—rocks which at high tide are covered with water, and at low tide are left dry. It had not been washed.

Like the other sea-weeds, it gave up a portion of its substance to cold water infused on it for many hours, and more on decoction. Neither its infusion nor decoction was precipitated by an infusion of nut-galls; both were copiously precipitated by sub-acetate of lead. When the infusion was boiled, a few flakes formed as if from the coagulation of a minute portion of albuminous matter. And when the fronds, unwashed, were boiled in milk, a very partial coagulation of the milk took place, adhering to the vesicles of the alga, and to them only, as if they contained a trace of gelatinous matter. By infusion for many hours, there were abstracted 16 per cent.; by subsequent decoction, about 44; about 39 per cent. resisting both processes.

The infusion evaporated afforded a brown transparent brittle matter, which burnt with flame. The ash about 2·8 per cent. consisted of about 1·7 saline matter, soluble in water, and of 1·1, soluble for most part in nitric acid. The former had an alkaline reaction, contained a large proportion of common salt, and afforded a distinct trace of iodine. The latter consisted chiefly of phosphate of lime, with a little carbonate of lime and magnesia. The decoction evaporated yielded a brown brittle matter, which burnt with flame. The ash it left, about 10·5 per cent., consisted of about 7·5 saline matter, soluble in water, and of about 3 soluble in great part in nitric acid. Both were similar in composition to the preceding; the proportion of iodine in the first was very small. The matter remaining after the infusion and decoction was black and brittle, burning with flame and leaving about 4·5 per cent. ash, of which about 8 was soluble in water; the remainder for most part in nitric acid. These too in composition were very similar to the preceding. Iodine in very minute quantity was detected in the soluble salt.

In concluding, I beg to offer a few general remarks:—

1. In none of these algæ have I been able to detect any starch, sugar, or oily matter. The *Fucus vesiculosus* had besides a taste of common salt, a faint one, as it appeared to me, of sweetness. This induced me to make a special search for saccharine matter; but the result was negative. Alcohol digested on the dried fronds, decanted and evaporated, yielded a minute quantity of extract totally destitute of sweetness.

2. Of the proximate principles of which these algæ are composed, I need hardly say that further research is required to establish their nature in a satisfactory manner; and I would beg that the few terms I have employed, such as mucilage and gelatine, may be considered merely as provisional. When we reflect on the many varieties which are known to exist of oils and fats, of starch and gums, it seems not improbable that each species of algæ may possess proximate principles though nearly allied, somewhat different, and the existence of which can only be determined by experiments made expressly for the purpose. A like remark applies to the inorganic elements. As to the portion insoluble both in cold and boiling water, to which I have given no name, I am disposed to think that it is different from woody fibre; in the instance of one, *Chondrus crispus*, I found that, like the entire plant, when subjected to destructive distillation, it gave off a good deal of ammonia.

3. To recur to the results;—in the instance of each alga, by washing, however rapidly performed, the sea-weed was deprived not only of adhering saline matter belonging to the

Experiments made by Dr Apjohn in August 1854.

	Water.	Dry Matter.	Per cent. of Nitrogen in Dry Matter.	Protein contained in Dry Matter.
Chondrus crispus, bleached, (from Bewly & Evans)...	17·92	82·08	1·534	9·587
„ *crispus*, unbleached, (Ballycastle)	21·47	78·53	2·142	13·387
Gigartina mammillosa, (Ballycastle)	21·55	78·45	2·198	13·737
Chondrus crispus, bleached, (Bewly & Evans) 2d expt.	19·79	80·21	1·485	9·281
„ *crispus*, unbleached, (Ballycastle) 2d expt.	19·96	80·04	2·510	15·687
Laminaria digitata, or Dulse Tangle, (Ballycastle)...	21·38	78·62	1·588	9·925
„ *digitata*, or Black Tangle, (Ballycastle)	31·05	68·95	1·396	8·725
Rhodomenia palmata, or Dylisk, (Ballycastle)	16·56	83·44	3·465	21·656
Porphyra laciniata, or Levre, (Ballycastle)	17·41	82·59	4·650	29·062
Iridæa edulis, (Ballycastle)	19·61	80·39	3·088	19·300
Alaria esculenta, or Murlins, (Ballycastle)	17·91	82·09	2·424	15·150
Means......................	20·42	79·58	2·407	15·045

N.B.—The amount of *water* given in this Table is considerably less than what belongs to the algæ when fresh from the sea, for they had all undergone a partial drying preparatory to being sent up from Ballycastle to Dublin for analysis.

"*Per-centage of Nitrogen in various edible substances dried at* 212°. (J. A.)

	N.
Potatoes, . .	·541
Flour of first quality, . .	1·817
Beet roots (Mean of 13 experiments),	1·848
Mangolds (Mean of 3 experiments),	1·781
Swedish turnips (Mean of 5 experiments),	1·843
Means, .	1·567 "

These results are so unexpected, that could there be any doubt (which I have not) of their accuracy, it might be questioned. The mean of them shows that the proportion of nitrogen these algæ contain exceeds that not only of the ordinary articles of vegetable food, but even that of wheaten flour of the first quality, being as 2·407 to 1·317.

5. Are not, I would ask, these esculent sea-weeds, on account of the iodine and bromine which they more or less contain, deserving of more general use? Nowhere, I believe, where they are in common use, is bronchocele known; and, as far as I have been able to ascertain, scrofulous complaints are rare, and even pulmonary consumption;—whilst, on the contrary, in inland districts, even in our own country, bronchocele and scrofula are more or less prevalent, especially

amongst the labouring class, who rarely have the benefit of articles of food known to contain iodine. And this remark applies to our troops, whose dietary hitherto has been regulated with such a marked neglect of medical science. In the West Indies, phthisis was unusually prevalent whilst I was there in the 88th regiment, the Connaught Rangers,—a fine body of men, raised chiefly in the province the name of which it bears —men who at home, we are tolerably certain, made use of sea-weed occasionally and of sea-fish, whilst in foreign service their diet was almost exclusively bread and meat, with a scanty addition of vegetables.

In relation to use, these vegetables have most of them the recommendation of cheapness, so as to be within the reach of the poorest; and their not being liable to spoil by keeping, when dried, is another circumstance in their favour; and another, I may add, is that they are grateful to the palate, and some of them—dulse, for instance—even in their undressed state. The blanc-mange that is made, substituting *Chondrus crispus* for isinglass, is hardly distinguishable from that prepared with the more costly article, and is in common use in Ireland at the tables of the opulent.

6. Every where, where sea-weeds are easily obtained, they are in repute as manure. Their fertilizing powers are quite in accordance with their composition, the large proportion of azote, and the considerable portion of the inorganic substances which they contain, and which are equally the elements of our cultivated crops, especially phosphate and carbonate of lime, and one or both of the fixed alkalies.

7. The part which these marine plants perform in the economy of nature, we are sure, is considerable, and probably is little less important than that exercised by terrestrial plants. May they not be considered as purifiers of sea water, tending always to remove excess of carbonic acid, and probably of azote? and may they not be viewed as the restorers (they certainly are the collectors) of substances possessed of excellent medicinal qualities,—viz., iodine and bromine, which so specially belong to them, and in them seems providentially saved and stored up for the use of man.

LESKETH HOW, AMBLESIDE, *February* 8, 1856.

Exposition of the Mechanical Inventions of Dr Robert Hooke. By ALEXANDER BRYSON, F.S.A. Scot.*

The possession of two such men as Newton and Hooke is rarely granted to one generation. They were not equal, however, in their greatness. But, while ample justice has been done to the genius of Newton, the labours of Hooke have been sadly overlooked. Hooke's misfortune lay more in his nearness to one whose greater glory paled his lesser light, than in any dimness in his own effulgence. But his nearness in time to Newton was not the only obstacle to his fame. He wanted method. His brain was too busy and ready to devise more than his hands could execute or his pen describe, and the eager student of his works, while ready to grasp a new fact or full-grown thought, is too often doomed to disappointment by his quaint remark, "But of this by and by." This *by and by* rarely comes, or if ever, almost always in the wrong place. In a discourse of earthquakes, for instance, we find descriptions of a new telescope, the exact orientation of Westminster as evideucing the variation of the compass, and observations on the setting of the sun-dial in the Privy Gardens at Whitehall!

That Hooke merited a larger share of the admiration of posterity than has hitherto been awarded to him, I hope the following rough outline of his life and labours will sufficiently show.

Robert Hooke was born at Freshwater, in the Isle of Wight, on the 18th of July 1635, and baptized on the 26th of the same month by his father, who was minister of the parish. In his infancy he was so weak that his parents had small hopes of rearing him; but his constitution, after his seventh year, seemed to gain strength, and, though never able to share in the ruder sports of his fellows, he was sharp and lively. His mechanical genius, the strongest intuition of his nature, was first developed. In a short extract from his diary Waller says, "Being subject to headache, which hindered his learning, his

* Read, at the request of the Council, before the Royal Scottish Society of Arts, 12th November 1855.

father laid aside all thought of breeding him a scholar, and finding himself also grow very infirm through age and sickness, wholly neglected his further education, who, being thus left to himself, spent his time in making little mechanical toys, in which he was very intent, and, for the tools he had, successful; so that there was nothing he saw done by any mechanic but he endeavoured to imitate, and in some particular could exceed. His father, observing by these indications his great inclination to mechanics, thought to put him apprentice to some easy trade (as a watchmaker or limner), he showing most inclination to those or the like mechanical performances. For making use of such tools as he could procure, seeing an old brass clock taken to pieces, he attempted to imitate it, and made a wooden one that would go." So far his diary.

His taste for the fine arts seems to have recommended him to the notice of Sir Peter Lely, with whom he served but a short time, as the odours from the oil colours produced aggravation of his headache, which beginning as he tells us in his earliest years, continued more or less to afflict him through life. This was perhaps, both for his fame and for science, a fortunate adversity, as nowhere can I find that his artistic talent was other than a slight accomplishment.

In the year 1653 Hooke, then in his 18th year, went to Oxford, and by his mechanical genius soon gained the favour of the famous Robert Boyle. Here he seems to have found society and employment suited to his tastes, and he met with nearly all the philosophers of his generation, who afterwards founded the Royal Society of London.

Under the roof of Boyle, and amid the congenial society which there met, Hooke commenced his labours. In his diary he says, "At these meetings, which were about the year 1655, divers experiments were suggested, discoursed, and tried with various successes, though no other account was taken of them but what particular persons perhaps did for the help of their own memories; so that many excellent things have been lost. Some few only by the kindness of the authors have since been made public. Among these may be reckoned the Honourable Mr Boyle's Pneumatic Engine and Experiments, first printed in the year 1660; for in 1658 or 1659 I continued and perfected the air-pump for Mr Boyle, having first seen a contrivance for that purpose made for the same honourable person by Mr Gratorix, which was too gross to perform any great matter."

That Hooke made the air-pump an efficient instrument there can be no doubt; he supplied valves which before were merely stop-cocks worked by hand at every rise and plunge of the piston. He also made its action double; in short, he contrived the air-pump. It is unnecessary here to dwell on the advantages which physical science has derived from the air-pump. Nor can it be urged against the fame of Hooke that Otto von Guericke, the Burgomaster of Magdeburg, had already performed wonderful experiments with his gigantic pneumatic apparatus, which I had the pleasure two years ago of seeing in the Royal Library at Berlin. Had Guericke's instrument remained without Hooke's improvements, pneumatics would have made but little progress.

In this same year, 1659, Hooke contrived many machines for the celebrated Dr Wilkins, to aid him in his futile attempts at flying, all of which ended like the wings of Icarus, shall I say also as those of our ingenious townsman, Mr John Howell.

About this period, or as Hooke says two years before, though described later in his diary, he invented the balance spring, an improvement of the first importance in the art of time-keeping.

Prior to this invention watches were regulated by increasing or relaxing the power of the mainspring, a very rude and unsatisfactory method; but as most watches had but an hour hand, a deviation of many minutes per day was scarcely appreciable. In the year 1675 a watch was presented to King Charles the Second, bearing the inscription, "Robert Hook invenit 1658, T. Tompion fecit 1675."

This watch had the balance-spring applied to a duplex escapement with a double balance. There is every reason to believe that for this invention Hooke applied for a patent, under the auspices of the Lord Brouncker, Mr Boyle, and Sir Robert Moray. The agreement, in the handwriting of Sir Robert Moray, between these gentlemen and Hooke, seems highly favourable to the latter, and is in these terms, "That

Robert Hooke should discover to them the whole of his invention, to measure the parts of time at sea as exactly and truly as they are at land by the pendulum-clocks invented by Mr Huygens: That of the profit to be made thereby, not exceeding six thousand pounds, Robert Hooke was to have three-fourths; of whatever was made more of it, not exceeding four thousand pounds, Robert Hooke was to have two-thirds; of the rest, if more could be made of it, he was to have one-half, and Robert Hooke to be publicly owned the author and inventor thereof."

As Hooke is called master of arts in this agreement, it could not have been drawn up before 1663, in which year that degree was conferred on him at Oxford, by the favour of Sir Edward Hyde, then Chancellor of that University. His expectations of advantage from this invention were disappointed. "Their treaty," says he, "with me had finally been concluded for several thousand pounds, had not the inserting of one clause broke it off, which was: That if, after I had discovered my inventions about the finding the longitude by watches or otherwise, they, or any other person, should find a way of improving my principles; he or they should have the benefit thereof during the term of the patent, and not I. To which clause I could noways agree, knowing it was easy to vary my principles an hundred ways, and it was not improbable but that there might be made some addition of conveniency, to what I should at first discover, it being *facile inventis addere.*"

That Hooke did not do himself justice in this transaction is evident. In 1658, as we have seen, he had invented and nearly perfected both the balance-spring and duplex-escapement, (an advance on the old verge-watch, without either spring or minute-hand) which, however rude in their construction, must at that period undoubtedly have gained the prize of 100,000 florins held out by the States of Holland for ascertaining the longitude at sea. And he might have obtained, through the interest of Lord Brouncker and Sir Robert Moray, some portion of government aid, which afterwards in the reign of Queen Anne was so liberally offered for the same object, to the amount of £20,000. Yet did Hooke conceal for many years this invention, which now forms, with the addition of the compensation-balance, the best pocket watch of modern times.

While at Oxford, Sir Christopher Wren suggested to Hooke a series of observations of the barometer, for the purpose of testing the truth of the hypothesis of Des Cartes, that the tides resulted from the pressure of the moon upon the air in its passage by the meridian.

Hooke found that the oscillations of the mercurial column did not comport themselves according to the moon's motion, but were due to the varying density of the air. Thus the barometer became, in the hands of Hooke, not merely the Torricellian tube, but a weather-glass, or, as he quaintly calls it, the "weather-wiser."

We have said that Hooke made the Torricellian tube virtually a barometer. But he did much more; he invented and perfected, with one exception, every form of that instrument now in use (of course I do not allude to the aneroid). To him we owe the double barometer, the four-legged barometer, the wheel barometer, the diagonal barometer, and the marine barometer. The last has been improved by Mr Adie senior, who applied to it the name of Sympiesometer. In four of these five forms Hooke contrived to enlarge the scale, with a view to increase the sensibility of their indications; so that while in the straight barometer of Torricelli a tenth of an inch only indicated that precise quantity, in Hooke's they were multiplied ten times. It were indeed an idle ceremony to describe here instruments so well known to all. But I cannot leave the barometric labours of Hooke, without adverting to the ingenuity he displayed in devising his marine barometer, the cause of his failure, and the success which attended the labours of our venerable townsman, Mr Adie senior, in rectifying Hooke's instrument, and rendering it the truth-telling, steady friend of the seaman.

Hooke's marine barometer consisted of a tube with two bulbs, bent into the shape of a syphon. The upper bulb contained air, and was closed; the lower was open and free to the pressure of the atmosphere, and was filled with water. The air was so rarified in the upper bulb as to allow the water to stand half up the tube at the nominal pressure of the atmo-

know) Hooke was the inventor. By the revolution of this conical pendulum, Hooke was enabled to divide a second into many parts. He contrived a series of thin vibrating springs touched by the ball in its rotation; and each giving a different tone, he was able to note the passage of a star to a small fraction of a second.

In the year 1660, the Royal Society was founded, and two years after Robert Hooke was made curator. In April of the succeeding year Hooke described his discovery of the rising of fluids in capillary tubes. He also discovered that mercury was not subject to the same law, but was depressed in tubes in the ratio of their diameters. He also here hinted, what was afterwards discovered, that mercury in tubes made of different kinds of glass has a different ratio of depression. This law, so well investigated by Ivory, the illustrious uncle of our present judge, Lord Ivory, is an element of correction in every measurement of the heights of mountains by the barometer. About this period Hooke contrived the telegraph,—not the cumbrous, unshapely machine, with three or four arms, formerly used under the name of Semaphore; but one more approaching to our present electric telegraph in swiftness of communication. He proposed to connect between distant stations a wire, acted on by a series of vibrations or musical notes, and thus communicate almost instantaneous intelligence. This invention has not been put in practice. In our time it were indeed useless; not in his. He was in this, as in many other of his inventions, far before his generation.

Hooke's next invention is one in which I have much interest,—the watch-wheel cutting-engine. This he seems to have invented between the years 1661 and 1663. In this valuable instrument, as in many others, no change has been made since its first construction by Hooke. The only improvements which have been made on this essential tool in the workshop of the watchmaker is greater rapidity of motion, and the cutter, in its descent against the wheel to be cut, is now let down by a perpendicular instead of a circular motion. This invention was the first which gave accuracy to the art of watchmaking. In this same year Hooke fixed the standard or zero of the thermometer at the freezing point of water, and also a method of supplying air to an operator after leaving the diving-bell.

In July 1664, he exhibited an experiment to demonstrate that the vibrations of a wire making 272 vibrations in one second of time, sounded G, SOL, RE, UT, in the scale of all music. Also, in this year, he invented a method of grinding spectacle lenses, by means of which more than 100 could be ground at once to the same focal power. This ingenious contrivance is daily used in our manufactories at Sheffield for the production of this indispensable aid to failing vision, in utter ignorance of its inventor. On the banks of the Avon you will often be asked the question, Who was William Shakspeare? and in the workshop of the optician, Who was Robert Hooke? This year was also rendered conspicuous in the life of our author by his invention of an instrument to determine the refractive index of fluids.

This year, 1664, was ushered in by a circumstance highly flattering to Hooke, and which for some years brought him solid advantage in the shape of a salary of L.50 a year, though perhaps he might have better wanted both the office and the salary. Sir John Cutler having founded a lecture, in connection with the Royal Society, and settled an annual stipend upon Robert Hooke, M.A., of L.50 during life (intrusting the president, council, and fellows of the said Society to direct and appoint the said Mr Hooke as to the subject and number of his lectures), the Society ordered several of their members to wait upon Sir John Cutler with their thanks for "his particular favour to a worthy member, and for that respect and confidence he hath hereby exprest towards their whole body." This appointment at first urged Hooke to the publication of many original papers of his own and others, which might have been lost had he not been appointed Cutlerian lecturer. But, through some misunderstanding, which I have not been able to trace, in a few years we find Hooke pursuing Sir John Cutler for his annual allowance, and giving vent to spleen and vexation of spirit by no means in accordance with that placidity with which true philosophy ever delights to dwell. This was one of many acid drops poured into the cup of Hooke's life, and which, with all his philosophy, he knew not how to neutralize. But he found a true peace, as we shall find, " by and by," to use his own expression.

At this time, 1664 or 1665, Hooke read general astronomical lectures, and described many instruments. The most important is one which has since his days been the constant companion of the mariner,—the quadrant. Invention with Hooke seems almost the pabulum of his life; there is no forcing, no labour in his thought. His very dreams seem fraught with good to mankind. In his enunciation of this invention, there is nothing found but the simple description of his method of reflection and joining the two images into one. We can imagine with what delight Hooke would contemplate the modern sextant, as improved by Newton and Hadley, how he would exult, if, permitted to gaze into our time, he could see his improved instrument in the hands of a mariner, "enabling him almost to plant mile-stones in the deep.

His proposal of a weather-clock is very remarkable, and as no copy is in any of our public libraries, I willingly transcribe it. "The weather-clock consists of two parts; *First*, that which measures the time, which is a strong and large pendulum-clock, which moves a week with once winding up, and is sufficient to turn a cylinder (upon which the paper is rolled) twice round in a day, and also to lift a hammer for striking the punches once every quarter of an hour. *Secondly*, Of several instruments for measuring the degrees of alteration in the several things to be observed. The first is the barometer, which moves the first punch, an inch and a half serving to show the difference between the greatest and least pressure of the air. The second is the thermometer, which moves the punch that shows the differences between the greatest heat in summer and the least in winter. The third is the hygroscope moving the punch, which shows the differences between the moistest and driest airs. The fourth is the rain-bucket, serving to show the quantity of rain that falls. This hath two parts or punches; the first to show what part of the bucket is filled when there falls not enough to make it empty itself; the second to show how many full buckets have been emptied. The fifth is the wind-vane; this hath also two parts; the first to show the strength of the wind, which is observed by the number of revolutions in the vane-mill, and marked by three punches. The first marks every 10,000, the second 1000, and the third every 100; the second to show the quarters of the wind. This hath four punches; the first with one point, marking the north quarters, namely, NN. by E., N. by W., NNE., NNW., NE. by N., and NW. by N., NE., and NW; the second hath two points, marking the east and its quarters; the third hath three points, marking the south and its quarters; the fourth hath four points, marking the west and its quarters. Some of these punches give one mark every 100 revolutions of the vane-mill.

"The stations or places of the first four punches are marked on a scroll of paper by the clock-hammer falling every quarter of an hour. The punches belonging to the fifth, or wind-vane, are marked on the said scroll by the revolutions of the vane, which are accounted by a small numerator standing at the top of the clock-case, which is moved by the vane-mill."

No description could make clearer the anemometer proposed by Mr Osler of Birmingham, and communicated to the British Association about fifteen years ago; yet was there no mention made of the name of Robert Hooke. It was the reading of the description now quoted which suggested to my late father the self-registering barometer now on the table.

Sir Alexander Keith (the donor of our Keith Prize, so worthily awarded to Professor George Wilson last session, and this night to be presented) contrived a self-registering barometer, which he described to the Royal Society of Edinburgh, in which the marker or pencil exerted a continuous friction, thereby constraining the free action of the mercury in its travels in the tube. But Hooke suggested punches indicating that there was no friction during the interval of a quarter of an hour. This hint served my late father in the construction of his barometer, where the marker only exerts a lateral friction once in the hour, leaving the float free to rise or fall with the varying pressure of the atmosphere.

On the 20th of March 1664, Hooke succeeded Dr Dacres as Geometry Professor in Gresham College. Besides his duties as Professor of Geometry, he had charge of a large collection of natural and artificial curiosities. John Ward, who was Professor of Rhetoric in Gresham College, says of Hooke, in a short biography he has written of him, in his Lives of the Gresham Professors: "A person of less abilities than he, would have found it difficult to discharge the duty of these several employments at once with reputation; but so great was his industry, so accurate his skill in any province he undertook, and his mind so fruitful of new inventions, that he went through them all with great reputation."

Hooke was not long in his office and apartments in Gresham College, when we find him, with his usual energy, engaged in forming the first fixed transit instrument. Mr Grant, in his admirable History of Astronomy, claims this invention for Roemer the Danish astronomer; I claim it for Dr Robert Hooke on the following grounds: Hooke entered Gresham College, as we have seen, in 1664, the very year when Roemer was born at Copenhagen. In this or the following year, Hooke completed his instrument for observing the transit of the stars, in order to discover their parallax.

His description is short, and I will therefore transcribe it: "I opened a passage through the roof of my lodgings, and therein fixt a tube perpendicular and upright of about 10 or 12 foot in length and a foot square, so as that the lower end thereof came through the ceiling, and was open into the chamber underneath. This tube I covered with a lid, housed so as to throw off the rain, and so contrived as I could easily open or shut it by a small string. Within this perpendicular tube I made another small square tube fit, so as to slide upwards and downwards as there was occasion, and by the help of a screw to be fixt in any place that was necessary. Within this tube, in a convenient cell, was fixed the object-glass of the telescope (that which I made use of was 36 foot in length, having none longer by me but one of 60 foot, and so too long to be made use of in my rooms)." Cutting a hole through the upper floor to permit the rays to pass below, he fixed his eye-piece raised above the level of the lower floor, so as to admit his person to observe the passage of the stars. With this instrument Hooke imagined he discovered a sensible parallax in the star γ Draconis, which afterwards

Bradley discovered to have been caused by the aberration of light.

This instrument of Hooke was, of course, a fixed transit, and could only take cognizance of stars passing the zenith of Gresham College. But we have authority for stating (and that authority Mr Grant himself), that Hooke made the first moveable transit instrument in nearly its present form for Greenwich Observatory. Roemer may have made the instrument traverse; but Hooke certainly had the priority of invention. In the year 1666, the great fire of London, though it disturbed the labours of the Royal Society, increased those of Hooke. On the 19th of September, we find him presenting before the Society a model for the rebuilding of the city, with which, as their Journal informs us, they were very well pleased. The Court of the Lord Mayor and Aldermen preferred it to one designed by the city surveyor, and desired it might be submitted to the king. "What this model was," says Waller, "I cannot so well determine; but I have heard that it was designed in it to have all the chief streets, as from Leadenhall corner to Newgate and the like, to lie in an exact straight line, and all the other cross streets turning out of them at right angles; all the churches, public buildings, market-places, and the like, in proper and convenient places, which no doubt would have added much to the beauty and symmetry of the whole."

How this came not to be accepted I know not; but it is probable it might contribute not a little to his being taken notice of by the magistrates of the city, and soon afterwards made surveyor. In this situation Hooke laid out the ground to the several proprietors for rebuilding the city, and acquired most of his wealth; none of which, it is believed, he ever used, as it was found filling a huge chest after his decease. About this time Hooke entered into his famous controversy with Hevelius, regarding the superiority of telescopic over naked sights in astronomical instruments. Into this controversy I do not enter,—suffice it to say, that it gained for Hooke a character for great irascibility; but the present practice of astronomers has proved Hooke to be right.

The invention of the reflecting-telescope has been awarded to

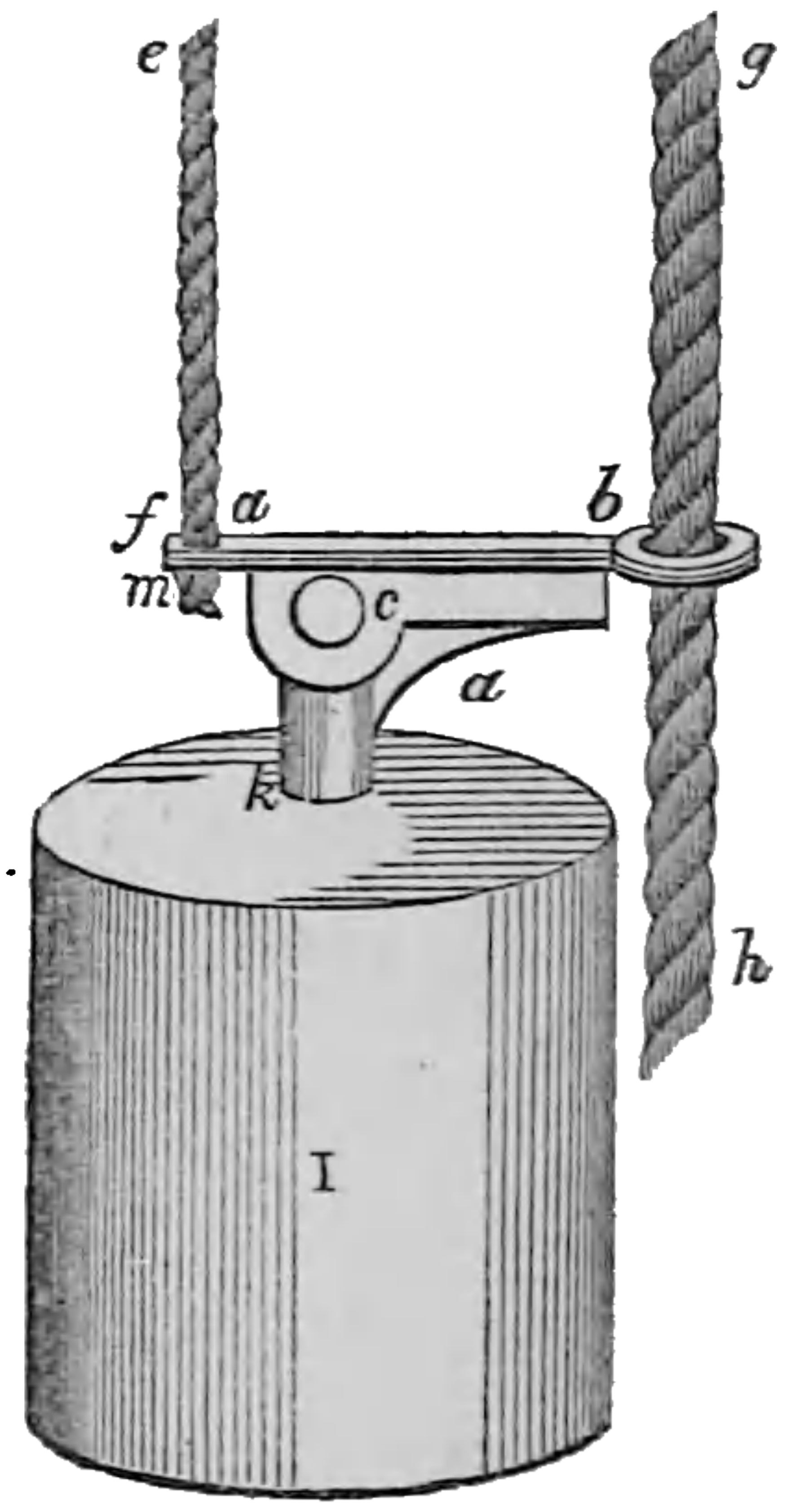
Newton, to Gregory, and Hooke. The share which our author took in this invention was in perforating the larger speculum; thus enabling an observer to view the object directly. In a discourse on a Method of improving Natural Philosophy, he clearly indicates the stethoscope. He says, "By the sound they make, one may discover the works performed in the several offices and shops of a man's body, and thereby discover what instrument or engine was out of order. I have been able to hear very plainly the beating of a man's heart; and 'tis common to hear the motion of wind to and fro in the guts; and the stopping of the lungs is easily discovered by the wheezing."

This hint, so valuable to the physician, lay unappropriated until Laennec applied it in the year 1816. As Hooke invented at this time the hearing trumpet, there can be little doubt he had applied it to the discovery of the sounds of the human body.

But I must hurry on to a conclusion, and merely catalogue his inventions. He invented the spring-balance, now known as Salter's Spring-Balance. Instead of at once communicating this instrument to the world, he hid it for some years, under the anagram, C D E I I N N O O P S S S T T U U, which, being rendered, means, *Ut pondus, sic tensio;* As is the weight, so is the tension.

In his tracts he describes a very ingenious method of supporting a weight after the rope has broken by which it was suspended.

Hooke's method of preventing heavy weights falling.



"This was effected by a small arm extended out from the top of the weight to the side with a hand or pipe, at the end thereof, which grasped or inclosed another rope or chain, extended from the top to the bottom, which hand or pipe was so wide as to slip freely upon the said rope so long as the weight was suspended by its own rope; but so soon that any way failed the hand grasped the side rope fast and hindered the weight from descending to the bottom."

He discovered that the awn or beard of the wild oat served

I have now endeavoured, more as a catalogue than a description, to give a short view of the mechanical labours of Hooke. As an astronomer he has done much; and his discoveries have been fairly and fully explained by Mr Grant, in his excellent History of Astronomy. As a naturalist he has yet to be considered; and a more complete treatise on his life and discoveries will, I hope, soon appear from the prolific pen of our President-elect, Professor George Wilson.

In regard to Hooke's personal appearance, Waller, his biographer, says: "As to his person he was but despicable, being short of stature, very crooked, pale, lean, and of a meagre aspect, with lank brown hair, which he wore till within three years of his death; his eyes gray and full, with a sharp ingenious look when younger; his nose but thin, of a moderate height and length; his mouth meanly wide, and upper lip thin; his chin sharp, and forehead large. He went stooping and very fast (till his weakness before his death hindered him), having but a light body to carry." Surely, after such a description as this, there should be no wonder that I have failed to obtain a portrait of Hooke. His temperament is described by Waller as "restless, indefatigable, even almost to the last, and always slept little to his death, seldom going to sleep till two, three, or four o'clock in the morning, and seldomer to bed, oftener continuing his studies all night, and taking a short nap in the day. His temper was melancholy, mistrustful, and jealous, which more increased upon him with his years."

But his sense and love of truth was the greatest feature of his life. He was no bigot; but his religious feelings are ever strong, and are finely evinced by one incident in his life by Waller.

I have indicated his quarrel and law-plea with Sir John Cutler, which for many years disturbed his peace. On the 18th of July 1696, being his birth-day, his Chancery suit was decided in his favour. In his diary, he shows his sense of it in these terms, D O M S H L G I S S A, which I read thus —DEO OPT. MAX. SIT HONOR, LAUS, GLORIA, IN SECULA SECULORUM. "I was born on this day of July 1635, and God has given me a new birth. May I never forget His mercies to me.

Whilst He gives me breath, may I praise Him." Nor was this a passing sentiment of his thankfulness for this special favour. We find him, ever and anon, using at the end of any of his descriptions of a new machine which he had perfected, an anagram expressive of his utter dependence on the Divine Being.

I hope that this short statement of the more important of Hooke's mechanical inventions will justify me in the remark with which I began, that Hooke stood very near to Newton. They are twin stars, forming, when casually seen, but one luminary, and that luminary Newton, but when more carefully observed, differing in their brightness "as one star differeth from another star in glory." Had Hooke been born fifty years after Newton, Newton would not have been less. Had he been born fifty years before the great philosopher, Hooke would have been more exalted. Yet was Hooke the forerunner of Newton's glories, the precursor of one who made many crooked things straight.

On the Rare Lichens of Ben Lawers. By Hugh Macmillan, F.R.S.E.

Continued from Vol. III. No. 2, page 268.

Squamaria lanuginosa, Hook. On the rocks in the wood, at the foot of the hill on the east side. This interesting lichen, which is common in shady, subalpine regions in Europe and America, is distinguished by its white pruinose thallus, and by the dense tomentose bluish-black fibres which clothe the under surface of the crenated lobes of the circumference. The apothecia, which are minute, a little elevated above the thallus, of a pale rufous-fuscous colour, and furnished with an inflexed pulverulent thalline margin, very rarely occur. I have frequently gathered specimens of this species in very shady situations, in which the whole thallus was reduced to a leprous byssine mass, not unlike the *Lepraria alba* of Acharius.

Parmelia fahlunensis, Ach.
Parmelia stygia, Ach. } Abundant on rocks near the summit; also common on the European and North Ame-

rican mountains, extending as far northward as Greenland and Melville Island. These two lichens are too nearly related to each other to be kept distinct; intermediate states very frequently occurring even on the same stone. This view was entertained by Wallroth, Fries, Schaerer, and Meyer.

Parmelia ambigua, Ach. Sparingly in rugged hollows and cracks in the bark of pine trees, at the foot of the hill on the east side. It occurs in a fertile state on trunks of trees and dead wood, in the subalpine districts of North America, and on the birch and pine in Sweden and Germany. It has also been found in these countries on rocks, but invariably destitute of fructification. The thallus is usually very imperfect and fragmentary, sometimes only a few segments being present, closely applied to the bark, and sometimes only an aggregation of the soredic warts, constituting almost a mealy crust-like surface. It is generally ochroleucous or greenish straw-coloured; but old specimens frequently occur even on the same tree, of a dull grayish-white colour, to which Fries refers the *P. hyperopta* of Acharius. I have never seen native specimens in fruit. To me it appears to be merely a tree form of *Parmelia conspersa*, and Bluff and Fingerhuth were of the same opinion. From *P. aleurites*, with which Mougeot and Nestler, in their magnificent " Stirpes Cryptogamicæ Vogeso-Rhenanæ" have confounded it, the farinose-sorediferous warts which cover its surface, and the elevated scutellæ sufficiently distinguish it.

Parmelia incurva, Fries. Sparingly distributed over boulders, both at the foot of the hill and at a considerable elevation, generally preferring such as are of quartz formation. It resembles very closely certain states of *Squamaria saxicola*, or a young plant of *Parmelia conspersa*, for both of which it has very likely been often mistaken; but the presence of the yellow globuliferous warts with which its surface is almost always thickly covered, as well as its peculiar appressed habit, very narrow multifid laciniæ, recurved at the apices and black and fibrillose on the under side, afford constant distinguishing characters. Perhaps the lichen to which in form and appearance it most nearly approximates, is the *Squamaria cæsia*, Hook.; but from that species too the colour of its thallus and apothecia distinguish it. The specimens found at a high elevation on Ben Lawers are of a much darker colour than those found at the foot of the hill, and their segments are generally much broader and more rugose. Several very fine specimens of the normal form occur on boulders by the road side, near Cluny Ferry, about two miles east from Aberfeldy. I have several times gathered the closely-allied *Parmelia Mougeotii* of Schaerer, on pure white quartz, in the Breadalbane mountains; and I have received very fine specimens from my friend Mr Mudd, found on sandstone rocks, near Cleveland, Yorkshire. Although long known to our lichenists, it has not hitherto received a place in the British Flora as a native of this country.

Solorina crocea, Ach. Abundant along the ridge on the summit. The normal height of this beautiful lichen on the Scottish mountains appears to be 3600 feet, but solitary unfructified specimens occur much lower down on Ben Lawers; and on other mountains of the same elevation, even although forming part of a connected range or chain, it is rare to find a single individual. It seems to prefer micaceous soil in very moist situations; and, for this reason, it is much more common and abundant on the Breadalbane range than on any other mountains in Scotland. On the Swiss Alps it occurs in profusion, from an elevation of 5000 feet; and in Lapland it occurs everywhere in the utmost abundance in the pinewood and exposed fields, but chiefly in a barren state. It extends as far northward as Greenland and Point Lake.

Solorina saccata, Ach. In the damp shady clefts of rocks, in the hollow near the summit. This is a much more common species than the *S. crocea*, and is not nearly so alpine; isolated specimens occurring in many parts of Scotland, England, and Wales, at a very low elevation. The apothecia also are very different. When first developed, they burst out from beneath the cortical layer of the thallus, and receive a slight, somewhat irregular, border from it; at this stage they bear a great resemblance to those of the *S. crocea*, but when they become more mature, they sink into the thallus and form these deep holes or sockets which have given rise to its very appropriate specific name. In Dr Menzies' herbarium, in the Edinburgh Botanic Gardens, a minute and closely-allied species occurs, gathered on the Pacific coast, and named *S. orbiculata.* In a vertical section of the thallus, we first find a layer of large globose cells, with walls of very irregular thickness; beneath this layer we find another of very dense tissue, composed of smaller polygonal cells, with very thin and transparent walls, in which are developed ovoid grains of a bright green colour, and less solid than those developed in the gonidial layer of Peltidea and Nephroma. These grains are perfectly free in their parent cells, the smallest pressure being sufficient to discharge them. The spores are ellipsoid, bilocular, of a very brown colour, and furnished with a very thick obscurely granulose integument. In germinating, they send out at each of their obtuse extremities, a colourless, very slender filament, which lengthens and ramifies considerably.

Peltidea venosa, Ach. Most abundant on the turfy top of a wall by the road-side, about two miles east from Killin; and very sparingly in the moist shady clefts of the rocks in the hollow near the summit of Ben Lawers. This lichen is very widely distributed, and occurs in very dissimilar localities; for while it is found occasionally on the summits of the Scottish hills, as well as at a considerable elevation on the mountains of the United States, Canada, Sweden, Lapland, and the higher Alps of Switzerland, its favourite situations appear to be the sides and tops of mossy earth-covered rocks, either in the bed of streamlets, or exposed to the spray of waterfalls; indeed very much the same situations as its congener *P. aphthosa* affects. In Hooker's *Cryptogamia antarctica*, the *Peltidea venosa* is stated to have been found on tufts of moss on the hills of Kerguelen's Land. The specimens observed, however, were stunted and barren, and otherwise in a very unsatisfactory state, presenting, in this respect, a great resemblance to dwarf individuals found on the summits of the Scottish hills, and in the arctic regions, with the difference only of a smoother thallus, and occasional buds on the margin.

Peltidea horizontalis, Ach. Common on moist mossy rocks at a considerable elevation above Loch-na-Cat. The spores are linear-oblong, attenuated at the two extremities. They are formed of a transparent membrane, everywhere very thin, and their cavity is ordinarily divided into four compartments by three transverse partitions, which it is often difficult to distinguish from the granulose matter with which the whole lamina proligera is filled. They are scattered about the beginning of February on the moist soil, and produce, at each extremity, extremely slender, long, and somewhat branched filaments. This lichen has been found in abundance on wet moss in Kerguelen's Land, and on the summit of the Pic du Midi, one of the peaks of the Pyrenean range, about 9000 feet in height. I may notice here that I observed on the thallus of a specimen of *Peltidea canina,* gathered near the foot of the hill, that minute and interesting parasite the *Scutula Wallrothii,* Nob., which appears to the naked eye a mere black point. Tulasne discovered in this plant stylospores, or isolated spores, borne upon short simple stalks, and produced in conceptacles, to which he applied the name of *pycnidia.*

Gyrophora erosa, Ach.
Gyrophora cylindrica, Ach.
Gyrophora proboscidea, Ach.
} On rocks near the summit, plentiful, and very variable. Spermogones indicated by small, very black, elevated spots upon the upper surface of the thallus, and figured by Hedwig as the male parts of fructification, are very common on the three species. Those who wish to investigate this difficult and protean genus thoroughly, should consult Flörke's elaborate Monograph of the Gyrophoræ, or the able paper in the *Lichenographia Britannica.*

Gyrophora pellita, Ach. On rocks at a low elevation. This is the least alpine species of the genus, occurring on the moorland rocks above Aberfeldy, at a height of from 300 to 400 feet. In this species the *tricæ* are frequently transformed into elevated, irregular clusters of much-branched, minute black fibres. Mr Brunton supposes this transformation to take place only after the *tricæ* have discharged their spores.

Cetraria sepincola, Ach. On pine trees in the wood at the foot of the hill on the east side, very sparingly, and generally occurring as single isolated individuals.

Cetraria islandica, Ach. Most abundant from an elevation of 1500 feet to the very summit, but very rare in fructification, only one specimen having been found in that state. Dr Hooker says that it is " one of the most Arctic of plants, having been collected on Ross Islet, the northernmost known land in Europe (81° N.), and on Melville Island (76°), on the limits of Arctic American vegetation. It inhabits the level of the ocean only within the Arctic circle, or in the extremely cold plains of Central Russia (as Moscow, 55° N.) ; Dahuria, in Asia, 50° N. ; and in North America (as Labrador, 55° N.); thence, in progressing south, it ascends, attaining the tops of our Scotch Alps, 4000 feet (56° N.); about 10,000 feet on the Swiss Alps (46° N.), 9000 feet on the top of the Pyrenees, and 4000 feet on the mountains of North Carolina and Virginia (in 36° N.). The last locality is the lowest latitude it attains in the northern hemisphere; in the southern, it reappears only at the extreme point of South America, and there is confined to the pinnacles of the very highest mountains. There is perhaps no vegetable common to both hemispheres more typical of extreme cold than this lichen."

Citraria nivalis, Ach. Very diminutive, and very rare on the west shoulder of the hill, near the top. This lichen, which is very scarce on the Breadalbane mountains, occurs in the utmost profusion on the summits of the Braemar and Cairngorm range. It is almost as widely distributed over the surface of the globe as the *C. islandica*.

Cornicularia tristis, Ach. Abundant on rocks at a cousiderable elevation. This lichen, which Schaerer, Meyer, and Wallroth were disposed to consider merely a variety of *Parmelia fahlunensis*, Ach., is said by Tulasne to approach very closely in its structure to *Ramalina scopulorum*, from which, in its external form and appearance, it differs so widely. The spermogones are precisely similar as regards their form and position in both, being developed towards the top of the compressed branches, or on their obtuse edges, and consisting of round prominent tubercles, dehiscing as usual by a terminal pore. With regard to the present plant, Tulasne says, " Sur la coupe du thalle pratiquée en un sens quelconque, elles des-

the older botanists; for Lightfoot, in his *Flora Scotica*, evidently alludes to it when he says,—"In one specimen we observed these tubercles, and the little holes (*cyphellæ*) among the down, of a bright yellow colour." This lichen has a very wide geographical range, being found on the mountains of New England, in North America, in Jamaica, along the western slopes of the Andes, in the Sandwich Islands, down to the Straits of Magellan, Cape Horn and the Falkland Islands, in New Zealand, Van Diemen's Land, and Australia. It occurs very frequently on the larger trees; and I possess magnificent specimens gathered on the summit of Table Mountain, Cape of Good Hope, where they grew on tufts of *Racomitrium lanuginosum* and *Grubbia rosmarinifolia*. In Europe, it is found in Great Britain and Ireland, Spain, Greece, Turkey, and Germany. Hooker states that it attains its northern limit at Inverary in Scotland (lat. 56° N.), which singularly coincides with the latitude of the most southern habitat, Cape Horn. A variety occurs especially at the Cape of Good Hope—the *β gilva* of Acharius—which differs from the typical plant in the margins of the *laciniæ* being of the same colour as the rest of the thallus, and in the absence of the yellow pulverulent lines on the upper surface, which have given the species its appropriate name. This powder is very abundant and very yellow in New Zealand and South American specimens; but the Scottish plant is very often bare, while the *cyphellæ* alone are filled with a pale lemon-coloured powder. Sometimes, too, specimens occur in which the *rimæ*, on the upper surface, are of a white colour, when it is somewhat difficult to distinguish it from the *S. limbata*, and others of its congeners. The scattered fuscous brown apothecia are very rare in the normal plant, but very frequent and abundant, according to Acharius, in the variety *gilva*. Like the other species of the magnificent genus Sticta, it fructifies more freely and uniformly in tropical than in temperate regions.

Ephebe pubescens, Fries. Common on wet rocks by the side of the shady stream that flows down the east shoulder of Ben Lawers, sometimes covering them with its broad, loose, irregular, very dark-green tufts. This curious production—the *Cornicularia pubescens* of Acharius—usually referred to the genus *Stigonema* of Agardh, and in its barren state, and in several of its protean forms, described by Kutzing and others as different species of rupestral algæ, is now included by Fries, Nylander, and other eminent lichenists, with the well-known Lichinas of our sea-coasts, among the angiocarpous lichens, under the family of *Lichineæ.* Its microscopic structure is extremely curious, and will well repay a careful examination. Each filament is found to consist of three layers of tissue; the outermost one, which is of a cartilaginous texture, presenting no peculiarity; the intermediate layer, formed of spherical or angular cells, which resemble gonidia in colour and appearance, and are disposed differently in different filaments—irregularly heaped together in the more slender ones—and in more developed individuals, ranged in transverse dotted septa, separated from each other by tissue of a lighter colour; and the central or medullary layer in which the conceptacles and spermogonia are developed. These forms of fructification are produced on different filaments; the presence of conceptacles being externally indicated by fusiform swellings towards their extremities, and that of the spermogonia by subterminal spheroidal dilatations. The conceptacles open by a terminal pore, and are lined internally with clavate thecæ, each containing eight linear-oblong uniseptate sporidia; while the spermogonia dehisce by a similar ostiole, and contain numerous linear acrogenous spores or basidia, bearing somewhat oblong spermatia, of extreme tenuity, lying motionless in a mucilage of such great transparency that in some cases it can hardly be observed at all. To those individuals who are inclined to adopt the hypothesis of the sexuality of lichens, the presence of these organs on separate individuals seems to prove the diœcious nature of the fructification of the plant. The *Ephebe pubescens,* I may add, has been made the subject of minute investigation by Bornet, Berkeley, Brown, Von Flotow, and Fries, to whose admirable papers I refer the student for fuller information.

Isidium oculatum, Ach. Running over mosses and on the bare soil of the west shoulder of the hill at a considerable elevation, very sparingly. Specimens of this rare lichen were gathered during the "Antarctic Voyage" on Hermit Island, the Falkland Islands, and Kerguelen's Land, on the bare earth; but they were either in too young or imperfect a state for accurate determination, and were merely referred provisionally to this species. It is extremely doubtful whether this plant has any claim to be considered a true Isidium. Mr Sowerby depicts in the very admirable and characteristic figure he gives of it in "English Botany," the peculiar thecæ found only in the scutellate lichens; while Schaerer was disposed to regard the whole plant merely as a monstrous isidioid form of *Lecanora subfusca*, running over moss, and altered from its usual appearance by the peculiar nature and circumstances of its place of growth. It is well known indeed, that various species both of *Parmeliœ* and *Lecanorœ*, in a young and undeveloped state, and especially in abnormal situations, are scarcely distinguishable from one another, and have been referred by various writers to this very accommodating species.

Cladonia vermicularis, Decand. No lichen occurs in such immense profusion on Ben Lawers as this species, particularly on that part of the hill which faces Loch Tay. It covers the bare turf in exposed situations from an altitude of 1200 feet up to within a short distance of the summit where it terminates, or at least occurs in very small quantity. In wet weather it becomes so conspicuous as to attract the notice of even the most unscientific observer. It appears to be no less frequent on the high continental mountains, and especially on the Rhaetian, Pennine, and Lepontine Alps, where Schaerer mentions that it occurs everywhere, either on the bare earth or among grass or moss. Tuckerman also records it as a common species on the higher hills of North America; while Dr Hooker found abundant specimens at an elevation of nearly 17,000 feet on Donkia, one of the loftiest peaks of the great Himalayan range. In the "Cryptogamia Antarctica" likewise, it is described as "a highly arctic and antarctic plant, in the northern regions advancing to the extreme limits of vegetation, in islands beyond Spitzbergen, and in the southern occurring abundantly on Hermit Island, Cape Horn, and the Falkland Islands; being also common on the Andes of Peru and Columbia." The fructification has never yet been gathered in this country. Dickson represents, in his figure of the plant, globose lateral tubercles; and Mr Menzies' American specimens, we are informed by Sir J. E. Smith, were furnished with what seemed the young shields of a Parmelia. Robert Brown also, in "Parry's First Voyage," Appendix, p. 307, mentions that he observed in some arctic specimens, "apothecia lateralia, sparsa, atra, thallo innata, eoque submarginata, apotheciis Rocellæ aliquo modo accedentia." Fries does not consider it a genuine and distinct species at all, but merely a degenerate or monstrous form of *Scyphophorus gracilis*, Hook., produced by growing in moist situations at a great altitude. To all appearance, indeed, it seems a spurious form of some Scyphophorus; either of the above species or of *alcicornis* or *endiviæfolia*, which are well known to be exceedingly protean in their forms.

On Ben Lawers we have very distinct regions of altitude, marked by lichens which prevail in them, and which seldom or never occur either at higher or lower elevations; and this hill, from its great height and bulk, represents tolerably well the distribution of similar species, not only on the other mountains in Britain but also on those of foreign countries. These regions or zones of altitude are somewhat analogous to, and very nearly as well defined as those of the phanerogamous plants; and the same names I think might be employed to designate both. For instance, at the base of the hill we have the lichens peculiar to the plains and the valleys, of which *Parmelia saxatilis*, *Evernia prunastri*, and other saxicolate, terricolate, and tree species too numerous to mention, may be considered as the representatives. This zone might be called the Agrarian Zone; the plants which compose it, in general, seldom ascending higher than a few hundred feet, but are widely dispersed over the level surface of the globe. It contains by far the largest proportion not only of species but of individuals. The next, the middle zone, comprises such lichens as *Parmelia omphalodes*, *Cladonia rangiferina*, *Lecanora ventosa* and *tartarea*, *Lecidea geographica*, *Gyrophora polyphylla* and *pellita*, *Cornicularia tristis* and *aculeata*, *Isidium corallinum*, and *Stereocaulon paschale*. Some of these lichens are very erratic, occurring at very high and low altitudes, and in some instances occupying the very last outposts of vegetation on the lofty snow-crowned mountains of the globe; but in general they are found in the greatest quantity and luxuriance in portions of the mountains commencing at an altitude of 800 feet, and terminating at that of 2000 feet, and, like the lichens of the zone beneath, are very widely distributed, some being even cosmopolitan; and in some countries occurring in such immense profusion as to give quite a peculiar character to the scenery. The next zone, beginning at a height of 2000, and terminating at that of 3000 or a few more hundred feet, which may very appropriately be termed the Arctic Zone, as its plants are eminently northern species, contains, among several others, *Isidium oculatum*, *Cladonia vermicularis*, *Cornicularia lanata*, *Cetraria islandica*, *Solorina saccata*, *Gyrophora proboscidea*, *deusta*, and *erosa*, *Parmelia fahlunensis*, *Squamaria leucolepis* and *gelida*, and *Lecidea fusco-lutea*; and the highest or Super-arctic Zone comprehends *Verrucaria Hookeri*, *Lecanora frustulosa*, *Solorina crocea*, *Parmelia stygia*, and *Cetraria nivalis*. It will thus be seen, I think, that the lichens in general are congregated in such a way as to form distinct regions or zones of altitude, which have remained unchanged as long as we have any record. It is indeed much easier to indicate precisely the geographical range and distribution of the lichens, both as regards altitude and latitude, than it is of the mosses, although both, from the thousand varied and unaccountable circumstances which operate in their dispersion, may seem to obey no constant controlling or regulating laws.

Displacement and Extinction among the Primeval Races of Man. By DANIEL WILSON, LL.D., Professor of History and English Literature, University College, Toronto.*

Among the many difficult problems which the thoughtful observer has to encounter, in an attempt to harmonize the actual with his ideal of the world as the great theatre of the human race, none assumes a more intricate and inexplicable aspect than the displacement and extinction of races, such as the Anglo-Saxon has witnessed on the American continent for upwards of two centuries. In all ages history discloses to us unmistakeable evidence, not only of the distinctions which civilization produces, but of the fundamental differences whereby a few highly favoured races have outsped all others; triumphing in the onward progress of the nations, not less by an innate constitutional superiority, than by an acquired civilization, or by local advantages. And if we are still troubled with the perplexities of this dark riddle, whereby the colonists of the New World only advance by the retrogression of the Red Man, and tread, in their western progress, on the graves of nations, it may not be without its interest to note some unmistakeable evidences of this process of displacement and extinction, accompanying the progress of the human race from the very dawn of its history.

One, and only one record supplies any authoritative or credible statement relative to the origin of the human race. Geology has indeed, by its negative evidence, confirmed in its response the inspired answer of the patriarch,—"Enquire of the former age, and prepare thyself to the search of their fathers, for we are but of yesterday;" but it is to the Mosaic record we must turn for any definite statement on a subject concerning which the mythologies of all nations have professed to furnish some information. Every attentive reader of the Bible must have observed that the Book of Genesis, or the Beginning, is divided into two separate and perfectly distinct histories: the first, an account of the Creation, and the general history of mankind till the dispersion: the Genesis, pro-

* Read before the Canadian Institute, 1st Dec. 1855.

perly so called, extending over a period of considerably more than two thousand years, and contained in the first ten chapters and nine verses of the eleventh; while the remaining chapters, and indeed nearly the whole of the historical Books of the Old Testament, are exclusively devoted to the one selected race, that of Abraham and his descendants.

Looking then to the first of these, and to its narrative in relation to the immediate descendants of Noah, the recognized protoplasts of the primary subdivisions of the human family, we perceive that certain very marked and permanent differences are assigned to each. Ham, the father of Canaan, by negation is left without a blessing, while Canaan is marked as the progenitor of a race destined to degradation as the servant of servants. The blessing of Shem is peculiar, as if it were designed chiefly to refer to the one branch of his descendants, " to whom pertained the adoption, and the glory, and the Covenants, and the giving of the Law, and the service of God ;" but to his various descendants a special rank is assigned in the world's future; special, predominant in relation to some branches of the human family; but yet inferior and of temporary duration when compared with the destinies of the Japhetic races, who, enlarging their bounds, and encroaching on the birthright of the elder nations, are destined to " dwell in the tents of Shem," and Canaan shall serve them.

Thus from the very first we perceive that one important subdivision of the human family is stamped, *ab initio*, with the marks of degradation; while another, the Semitic, is privileged to be the first partaker of the blessing, to be the originator of the world's civilization, and to furnish the chosen custodiers of its most valued inheritance, through the centuries which anticipated the fulness of time; yet the nations of this stock are destined to displacement, for " Japhet shall be enlarged, and shall dwell in the tents of Shem."

Thus, also, from the very first we perceive the origination of a strongly marked and clearly defined distinction between diverse branches of the human family; and this, coupled with the apportionment of the several regions of the earth to the distinct types of man, distinguished from each other not less clearly than are the varied *faunæ* of these regions, seems to

appellations of historic or surviving races and kingdoms; of some of them, indeed, it appears, from their dual or plural number, or their peculiar Hebrew termination, that they are used in the Mosaic record, not in reference to individuals, but to families or tribes out of which nations sprung. Some of those have disappeared, or been transformed beyond the possibility of tracing the relations between their ancient and modern names; but of the most remarkable of the Hamitic descent we can be at no loss as to their geographical areas. The Canaanites occupied the important area of Syria and Palestine; and Nimrod, the son of Cush, moving to the eastward, settled his descendants on the banks of the Euphrates; so that, of the distinctly recognisable generations of Ham, it is in Asia, and not in Africa, that we must look for them, for centuries after the dispersion of the human race.

But the Semitic races were also to share the Eastern Continent before they enlarged their area, and asserted their right to the inheritance of the descendants of Ham. By Nimrod, the grandson of Ham, the settlements along the valley of the Euphrates were originated, "and the beginning of his kingdom was Babel, and Erech, and Accad, and Calneh, in the land of Shinar;" all sites of ancient cities, which recent exploration and discovery seem to indicate as still traceable amid the graves of the East's mighty empires. But the eponymous of the rival kingdom on the banks of the Tigris was Asshur, the son of Shem, and in that region also it would appear that we must look for the locality of Elam (Elymais?), as well as others of the generations of the more favoured Shem; while nearly the whole habitable regions between their western borders and the Red Sea appear to have been occupied, from this very dawn of human history, by the numerous Semitic descendants of Joktan, the protoplast of a branch of the human family to whose pedigree a special and curious attention is devoted in the Sacred Genealogies. By an expressive figure of speech, Shem is spoken of as the father of all the children of Eber, of whom came Joktan and his sons, "whose dwelling was from Mesha, as thou goest unto Sephar, a mount of the East," and of whom as surely descended Mohammed and the Semitic propagators of the monotheistic creed of the Koran;

as came the Hebrews, according to Jewish belief, and through them the great Prophet of our Faith, from Eber, the assumed eponymus of those whom we must look upon, on many accounts, as important above all other Semitic races.

Deriving our authority still from the Sacred Records, we ascertain, as the result of the multiplication and dispersion of one minutely detailed generation of the sons of Ham, through Canaan, that for eight hundred years thereafter they increased and multiplied in the favoured lands watered by the Jordan, and stretching to the shores of the Levant; they founded mighty cities, accumulated great wealth, subdivided their goodly inheritance among distinct nations and kingdoms of a common descent; and upwards of eleven hundred years thereafter, when the intruded tribe of Dan raised up the promised judge of his people, the descendants of Ham still triumphed in the destined heritage of the seed of Eber. At length, however, the Semitic Hebrew accomplished his destiny. The promised land became his possession, and the remnant of the degraded Canaanite his bond-servants. For another period of like duration, a period of more than eleven hundred years, the Semitic Israelites made the land their own. The triumphs of David, the glory and the wisdom of Solomon, and the vicissitudes of the divided nationalities of Judah and Israel, protracted until the accomplishment of the great destiny of the princes of Judah, constitute the epos of those who supplanted the settlers in the historic lands lying between the mountains of Syria and the sea, when first "the Most High divided to the nations their inheritance, when he separated the sons of Adam, and set the bounds of the people." Then came another displacement. The Semitic Hebrews were driven forth from the land, and, for eighteen hundred years, Roman and Saracen, Mongol Turk and Semitic Arab, have disputed the possession of the ancient heritage of the Canaanite.

For very special and obvious reasons, the isolation of the Hebrew race, and the purity of the stock, were most carefully guarded by the enactments of their great Lawgiver, preparatory to their taking possession of the land of Canaan; yet the exclusive nationality, and the strictly defined purity of race admitted of exceptional deviations of a remarkable kind.

While the Ammonite and Moabite are cut off from all permissive alliance, and the offspring of an union between the Hebrew and these forbidden races is not to be naturalized even in the tenth generation, the Edomite, the descendant of Jacob's brother, and the Egyptian, are not to be abhorred; but the children that are begotten of them are to be admitted to the full privileges of the favoured seed of Jacob in the third generation.

This exception in favour of the Egyptian is a remarkable one. The ostensible reason, viz., that the Israelites had been strangers in the land of Egypt, appears inadequate fully to account for it, when the nature of that sojourn and the incidents of the Exodus are borne in mind, and would tempt us to look beyond it to the many traces of Semitic character which the language, arts, and civilization of Egypt disclose. Mizraim, the son of Ham, and the brother of Canaan, is indeed ordinarily regarded as the first inheritor of the Nile valley, and this on grounds fully as conclusive as those on which other apportionments of the post-diluvian earth are assigned; but along with the direct evidence of Scripture, we must also take the monumental records of Egypt, which show that that land was speedily intruded on by very diverse races, and that by the time its civilization was sufficiently matured to chronicle, by pictorial and idiographic writings, the history of that cradle-land of the world's intellect, its occupants stood in a relation to each other precisely similar to that in which we find the Semitic and Hamitic populations of Palestine in the days of Joshua. The ethnological affinities of Egypt are certainly Asiatic rather than African, although she stands isolated, and in some important respects unique, in relation alike to the ancient and the modern world. The ethnologist must be tempted to look for the congeners of the ancient Egyptian rather among the Semitic Asiatics, speaking and writing a language akin to her own, than among the Berber, Ethiopian, or Negro aborigines of Africa. But around the shores of that expressively designated *Mediterranean* Sea, how striking are the varied memorials of the world's past. A little area may be marked off on the map, environing its eastern shores, and constituting a mere spot on the surface of the globe, yet its history is the whole ancient history of civilization, and a record of its ethnological changes would constitute an epitome of the natural history of man. All the great empires of the old world clustered around that centre, and as Dr Johnson remarked in one of his recorded conversations: "All our religion, almost all our law, almost all our arts, almost all that sets us above savages, has come to us from the shores of the Mediterranean." There race has succeeded race; the sceptre has passed from nation to nation, through the historical representatives of all the great primary subdivisions of the human family, and "their decay has dried up realms to deserts." It is worthy of consideration, however, from its bearing on analogous modern questions, how far the political displacement of nations in that primeval historic area was accompanied by a corresponding ethnological displacement and extinction.

It is in this respect that the sacred narrative, in its bearings on the primitive sub-divisions of the human family, and their appointed destinies, seems specially calculated to supply the initiatory steps in relation to some conclusions of general, if not universal application. However mysterious it be to read of the curse of Canaan on the very same page which records the blessing of Noah and his sons, and the first covenant of mercy to the human race, yet the record of both rest on the same indisputable authority. Still more, the curse was what may strictly be termed an ethnological one. Whether we regard it as a punitive visitation on Ham in one of the lines of generation of his descendants, or simply as a prophetic foretelling of the destiny of a branch of the human family, we see the Canaanite separated at the very first, from all the other generations of Noahic descent, as a race doomed to degradation and slavery. Nevertheless, to all appearance, many generations passed away, in the abundant enjoyment, by the offspring of Canaan, of all the material blessings of the "green undeluged earth;" while they accomplished, as fully as any other descendants of Noah, the appointed re-peopling, and were fruitful and increased, and brought forth abundantly in the earth, and multiplied therein, even as did the most favoured among the sons of Shem or Japhet. When some five centuries after the Canaanite had entered on his strangely burdened heritage, the progenitor of its later and more favoured inheritors was guaranteed by a divinely executed covenant, the gift to his seed of that whole land, from the river of Egypt to the great river, the river Euphrates, the covenant was not even then to take place until the fourth generation, because the iniquity of the Amorites—one of the generations of Canaan, used by synecdoche for the whole—was not yet full. When that appointed period had elapsed, and only the narrow waters of the Jordan lay between the sons of Israel and the land of the Canaanites, their leader and lawgiver, who had guided them to the very threshold of that inheritance on which only his eyes were permitted to rest, foretold them in his final blessing: "The eternal God shall thrust out the enemy from before thee, and shall destroy, and Israel shall dwell in safety alone." No commandment can be more explicit than that which required of the Israelites the utter extirpation of the elder occupants of their inheritance: "When the Lord thy God shall bring thee into the land, and hath cast out before thee seven nations greater and mightier than thou, thou shalt smite them and utterly destroy them; thou shalt make no covenant with them, nor shew mercy unto them." Nevertheless we find that the Israelites put the Canaanites to tribute, and did not drive them out; that the children of Benjamin did not drive out the Jebusites; but, according to the author of the book of Judges, they still dwelt there in his day; and so with various others of the aboriginal tribes. So also, the Gibeonites obtained by craft a league of amity with Israel, and they also remained—bondmen, hewers of wood, and drawers of water, yet so guarded by the sacredness of the oath they had extorted from their disinheritors, that at a long subsequent date we find seven of the race of their supplanters, the sons and grandsons of the first Israelitish king, sacrificed by David to their demand for vengeance on him who had then attempted their extirpation.

Even more remarkably significant than all those evidences of a large remnant of the ancient Hamitic population, surviving in the midst of the later Semitic inheritors of Canaan, is the appearance of the name of Rahab, the harlot of Jericho, in the genealogy of Joseph, as recorded by Matthew. The purity of descent of the promised seed of Abraham and David was most sacredly guarded all through the generations of their race, yet even in that line a singularly remarkable exception is admitted; and the son of Ham, and the seed of Canaan, have also their links in the genealogy of the Messiah.

Turning to another portion of the same subject, we trace in the Noahic genealogies the primitive occupants of ancient Phœnicia among the descendants of Ham; while looking to other and independent sources of evidence pertaining to the people of historical Phœnicia, we find them a race philologically Semitic, but in so far as their mythology and legislation, and those of their Carthaginian offshoots, supply data, we should class them as a race psychologically Hamitic. The legitimate inference would seem to be, that in Phœnicia, as in Palestine, the Semitic and Hamitic races were brought together by the extension of the former over the area primarily occupied by the latter; and that then, unrestrained by any of the checks which so materially circumscribed the tendency to intermixture between the conquerors and the conquered, in the inheritance of the Hebrews, a complete amalgamation took place, though with such predominancy of the later intruded Semitic conquerors, as history supplies abundant illustrations of in the well-detailed pages of more recent national annals.

From all this it would seem to be justly inferred that ethnological displacement and extinction must be regarded in many, probably in the majority of cases, not as amounting to a literal extirpation, but only as equivalent to absorption. Such doubtless has been the case to a great extent with the ancient European Celtæ, notwithstanding the definite, the distinct historical evidence we possess of the utter extinction of whole tribes both of the Britons and Gauls, by the merciless sword of the intruding Roman; and such also is being the case with no inconsiderable remnant of the aboriginal Red Indians of this continent. Partially so it is the case even with the Negro population of the United States, in spite of all the prejudices of caste or colour. It is impossible to travel in the far West of the American continent, on the borders of the Indian territories, or to visit the reserves where the remnants of the Indian tribes displaced by us in Canada and the States linger on in passive process of extinction, without perceiving that they are disappearing as a race, in part at least, by the same process by which the German, the Swede, or the Frenchman, on emigrating to the Anglo-Saxonized States of America, becomes, in a generation or two, amalgamated with the general stock.

I was particularly impressed with this idea during a brief residence at the Sault Ste. Marie this summer (1855). When on my way to Lake Superior, I had passed a large body of Christianized Indians, assembling from various points both of the American and the Hudson's Bay territories, on one of the large islands in the river Ste. Marie, and while waiting at the Sault a considerable body of them returned, passing up in their canoes. Having entered into conversation with an intelligent American Methodist Missionary who accompanied them, I questioned him as to the amount of intermarriage or intercourse that took place between the Indians and the whites, and its probable effects in producing a permanent new type resulting from the mixture of the two very dissimilar races. His reply was, "Look about you at this moment, comparatively few of these onlookers have not Indian blood in their veins;" and such I discovered to be the case, as my eye grew more familiar with the traces of Indian blood. At all the white settlements near those of the Indians, the evidence of admixture was abundant, from the pure half-breed to the slightly marked remoter descendant of Indian maternity, discoverable only by the straight black hair, and a singular watery glaze in the eye, not unlike that of the English Gypsey. The Indian may remain uncivilized, and perish before the advance of civilization, which brings for him only vice, famine, and disease, in its train; but such is not the case with the mixed race of a white paternity. Much, perhaps all, of their aptitude for civilization may come by their European heritage of blood, but the Indian element survives even when the all-predominating Anglo-Saxon vitality has effaced its physical manifestations.

In this manner, the ancient Celtic element of European ethnology doubtless still asserts no inconsiderable influence. The Briton of Wales retains nearly all his early characteristics; his philological and physiological peculiarities are alike

distribution of the ascending sap, and the liquid of the cortical parenchyma, leads to the belief that currents continually circulate in vegetables, from the bark to the pith." . . . "The leaves act like the green part of the parenchyma of the bark; that is to say, the sap which circulates in their tissues is negative with relation to the wood, to the pith, and to the earth, and positive with regard to the cambium." . . . . "The chemical actions are the first causes, it cannot be doubted, of the electric effects observed in vegetables."

"In the roots," says Wartmann,* "the stems, the branches, the petioles, and the peduncles, there exists a central descending current, and a peripherical ascending current; I call them *axial* currents." . . . . "In most leaves the current proceeds from the lamina to the nerves, as well as to the central parts of the petiole and the stalk. In certain fleshy plants, it is directed from the medullary or cortical portions of the stalk towards the mesophyllum, and from the latter towards the superior and inferior faces." . . . . "They arise from an electro-chemical action between the liquid substances brought into contact by the tearing of the tissues. The weak residual current (which is the normal current) owes its origin to the interposition of the porous vegetable walls between juices of different concentration, and proceeds through them from the densest to the least dense liquid."

The results of these inquirers would lead us to suppose that the effect upon the needle is due to what may be called *secondary actions*—viz., to the reaction of the different vegetable juices upon each other, and to the reaction of the fluids upon the surface of the platinum electrodes. The very fact,

Chimie et de Phys. 3me Serie, tome xli., p. 198. The general conclusion that Professor Buff appears to have arrived at is the following:—"*The roots, and all the internal portions of the plant filled with sap, are in a permanently negative condition; while the moist or moistened surface of the fresh branches, leaves, flowers, and fruits, are permanently positively electric.* . . . . The electromotive action arises from the moist surface of the plant on the one hand, and the liquids which are in its interior on the other."

We may refer also to Becquerel's original memoir in the Mémoires de l'Académie des Sciences de Paris, tome xxiii., p. 301, 1853, and to a valuable paper by Professor Goodsir in the Edinburgh New Phil. Journal, Oct. 1855.

* Phil. Mag., 1851.

however, that a difference in the fluids exists, proves also that a force capable of causing this difference must likewise exist; and the question naturally arises, are not these *primary actions* accompanied with the development of electrical actions?

The *primary actions* we refer to are those of *secretion*, *nutrition*, and *absorption*. Now, as the leaves and the roots perform some of the most important functions in plants, it appeared probable that it would be in these organs that we might obtain a solution of our problem; and the two following questions now occurred—1*st*, What would be the effect if the *external* surface of the leaf, and the *sap* flowing from it, be formed into a circuit? and, 2*dly*, What would be the effect if the *external* surface of the root (the spongioles), and the *fluid* ascending from it, be formed into a circuit?

§ I. *On the manifestation of Electric Currents in the Leaves of Plants during Vegetation.*

The galvanometer, and mode of employing it, has been already described in the Phil. Trans. for 1852, p. 279.

The mode of conducting the experiments was as follows:—The leaf was placed upon a clean piece of glass, and the extremity of one platinum electrode, to the extent of half an inch or an inch, was placed upon the upper or under surface of the leaf; a small notch was cut in the petiole, and, as the sap flowed out, the extremity of the other electrode was placed in contact with it.

We may just remark, that after having worked for some time upon plants growing in pots and in London, we were led, from the unsatisfactory results that were obtained, to repeat the experiments upon plants growing in the open air and in the country; and it soon became evident that, in order to obtain anything like satisfactory results, strong, healthy, and vigorous plants should be employed.*

Experiment 1.—Vegetable marrow. A healthy middle-sized leaf, and the sap from the petiole; the latter *positive*† 3°.

* The experiments were performed during the months of July, August, and September, 1852.

† Some difficulty is experienced in comprehending the results obtained by

A large leaf slightly tinged with yellow, and dry, and the sap from the petiole—no effect. Various leaves were tried with similar results; when any effect was obtained, the sap was *positive*. The surface of the leaf was occasionally moistened with water, with doubtful results as to the effect being increased. If the leaf had been separated from the plant for any time before the circuit was formed, no effect occurred.

As several of the experiments were carried on in the open air, one or two circumstances occurred which it was necessary to guard against. If the weather was at all boisterous, it became utterly impossible to continue the experiments, the slightest breeze being sufficient to shake the instrument. To obviate this difficulty, the galvanometer was firmly fixed upon a heavy block of wood, and sheltered. We were, however, perplexed by another circumstance. Working during a fine and calm day, it occasionally happened that just upon the point of completing a circuit, the needle would move to the extent of 10° or 15°, or more, without any apparent cause, the needle up to that time having been perfectly steady, and the circuit not yet completed. After some time it was noticed to occur just after a cloud had passed over the sun, and it was thought to be due to a slight breeze that might be then produced; but we are now disposed to consider it as owing to the heating effect of the sun's rays upon the glass shade of the instrument creating a motion of the air within the shade. Some facts bearing upon this question have been noticed by Prof. Tyndall * in reference to some experiments of Dr Goodman.

We may just mention another fact worthy of notice. As

different inquirers in reference to the *direction* of the current; it is uncertain to which of the circles, the simple or compound, reference is made for illustration, hence arises an apparent contradiction in the results. The *direction* of the current is of the utmost importance in accounting for the results. We always allude to the simple elementary circle for illustration; if zinc, platinum, and dilute acid, are formed into a circuit, the current goes from the zinc *to* the platinum; the platinum is the *positive* electrode. In the *combination* of an acid with an alkali, the electrode in contact with the *acid* is the *positive* electrode.

* Phil. Mag., Feb. 1852.

the instrument was frequently obliged to be moved into the neighbourhood of the plant, it would sometimes happen, from the altered position of the instrument, that the plane of the coil would be in the reverse direction to that of the needles to which it had been previously; hence contradictory results would very readily be supposed to be obtained.

To avoid unnecessary repetition, we shall generalize the results that were obtained in the following experiments. They were conducted in the same manner as in the first experiment, and upon leaves of different varieties of the following plants: —Cucumber, vine, lettuce, cabbage, nasturtium, convolvulus, rose, ivy, hop, walnut, geranium, fuchsia, strawberry, bean, apple, ficus elastica, ficus carica, lemon, orange, oleander, eutaxia, camellia, mesembryanthemum, lily, marvel of Peru, pirus japonica, tropæolum, wistaria, elder, sycamore, hollyhock, arum, hydrangea, thistle, and dahlia. In some the effects were null, in others but slight; the greatest effect obtained amounted to about 2° or 3°; the electrode in contact with the sap *positive.* The most satisfactory results appeared with the firm, compact leaves, such as the camellia, vine, elder, and sycamore, and when the electrode was in contact with the under surface. It frequently happened, that, in experimenting with different leaves of the same plant, effects might be obtained with one leaf but not with another, although in other respects perfectly similar.* This circumstance may be adduced as showing that the effect upon the needle cannot be entirely referred to the changes which occur in the sap from exposure to the air, and the question now arises, to what actions can we refer these effects? Is the sap *acid*, or does the sap contain a *cation?*

We shall not enter into any discussion as to the functions of leaves, whether they may be considered as organs of respiration, digestion, or absorption, but refer to works on physiological botany. That oxygen gas or carbonic acid gas is given

* It is probable that the circumstance of not obtaining any result upon some of the leaves, might depend upon the leaves not being always in the same state of action. Some experiments on *the Respiration of the Leaves of Plants*, by Mr Pepys, bearing upon this question, will be found related in the Phil. Trans. for 1843, p. 329.

off by the leaves of plants, we may consider as having been experimentally proved.

If we break off the petiole of a leaf, and just touch a piece of litmus paper* with the divided surface, in the majority of instances the sap will be found to have an acid reaction; in some succulent plants the effect will be null or very trifling, whilst in other plants, such as the vine, it will be very apparent. In the latter instances, the effects upon the needle may be fairly referred to the *acid* reactions of the secretions of the plant, but can we refer them to the same action when the sap does not present an acid reaction? Are we sure that the sap is acid? May not this acid reaction upon the litmus arise from the acid *secretions* of the plants which become mixed with the sap upon the tearing asunder of the tissue of the plant?

The difficulty which arises in solving some of these questions occurs from the fact that there is not that distinct circulation in plants as in animals; the sap, as it passes from one spot to another, may undergo a series of progressive changes, and in the tearing and cutting of the tissues, a mixture of sap from different parts and of secreted products must naturally occur. We cannot place our electrodes at the real *acting point;* there may be several acting points between the electrodes; and the resulting effect upon the needle may be that of a *differential* or of a *combined* current, according to circumstances.

Two solutions, one *acid*, consisting of 8 drops of strong sulphuric acid to one ounce of water, the other *alkaline*, consisting of 120 drops of the liq. potassæ (*Phar. Lond.*) to one ounce of water, were prepared, and used in the following man-

* In the employment of litmus as a test, we must bear in mind that a compound might show an acid reaction, without possessing at the same time an excess of acid. According to Berzelius, " the colour of litmus is naturally red, and it is only rendered blue by the colouring matter combining with an alkali. If an acid be added to the blue compound, the colouring matter is deprived of its alkali, and thus, being set free, resumes its red tint." Now, on bringing litmus paper in contact with a salt, the acid and base of which have a weak attraction for each other, it is possible that the alkali contained in the litmus paper may have a stronger affinity for the acid of the salt, than the base has with which it was combined; and in that case the alkali of the litmus being neutralized, its red colour will necessarily be restored.—*Turner's Chemistry*, p. 671, 5th Edit.

ner: The electrode to be placed in contact with the sap was dipped into a portion of the *alkaline* solution, and then applied to the cut petiole; this electrode was still *positive* to the other, the effect, however, was not increased; if the effects were due in the former experiments to the acid reactions of the sap, we should now have expected the electrode to be *negative.* The experiment was repeated upon another leaf, but with the *acid* solution; the effect was now very much increased, and the electrode in contact with the sap *positive.* Several other experiments of the same nature were performed, the results of which we shall generalize by stating that, whenever the electrode was coated with the *alkaline* solution, whether it was that in contact with the surface of the leaf, or that in contact with the sap, with but few exceptions, there was no decided difference as to the effect upon the needle; but that whenever one of the electrodes was dipped into the *acid* solution, this was always *positive* to the other.

If the leaf was gathered, an electrode being inserted into the petiole, and the leaf then plunged into a glass of water containing the other electrode, it frequently happened that the electrode in contact with the water was *positive* to the other, even if the water was rendered alkaline. It appeared to occur principally with the leaf of the bean (Windsor), and the strong-scented leaves, such as the geranium, &c.

In judging of the results obtained by means of these solutions,* we must consider their effect under two points of view; 1*st*, as producing their own chemical effect; and, 2*dly*, as forming a better conducting medium for the current. When the *acid* solution was employed, there can be no doubt that the current then obtained was due to the immediate action of the acid upon the tissue and juices of the plant—it always indicated its *positive* condition, and with increased effect; but how shall we account for the action of the *alkali?* This should have indicated a *negative* condition, if the current was due to its own immediate action; it was generally found, however, to indicate a *positive* state when in contact with the cut surface of the petiole: and here we cannot help believing,

* We need scarcely point out the importance of paying particular attention in the use of towels, and to cleanliness especially of the fingers and hands, when employing these solutions.

but that it must have acted, under these circumstances, as a *conducting* liquid.

From these experiments we may deduce the following conclusions :—

1*st*, That when the electrodes of a galvanometer are brought into contact, one with the surface of a leaf, and the other with the sap flowing from the same leaf, an effect occurs upon the needle, indicating the surface of the leaf and the sap to be in opposite electric states.

2*dly*, That these effects cannot be referred entirely to ordinary electro-chemical actions; but that,

3*dly*, They may be referred in part to the organic changes which take place in the leaf during vegetation.

Before quitting the subject in reference to the leaves, we shall make one or two observations. We have generalized the results of our experiments, and therefore, in their repetition, the same precise result must not always be expected. We must bear in mind, that in these experiments we are obliged to have a fresh subject for every experiment, and it is almost impossible to meet with that identity of circumstances we could wish; here the physical philosopher possesses advantages which are denied the physiologist. The problem we are endeavouring to solve is connected with the *vital actions* of the part; these terminated, nothing but difficulties then arise.

§ II. *On the manifestation of Electric Currents in the Roots of Plants during Vegetation.*

Becquerel* states that "currents exist going from the pith and the wood to the bark, by the mediation of the roots."

According to Wartmann,† "when the soil and any part of a plant, visible or underground, is placed in the circuit of the rheometer, we find a current directed from the plant to the soil, which is thus positive with relation to it." . . "The superficial layers of the soil are frequently positive relatively to those which surround the spongioles."

In several experiments, the facts observed by Becquerel and Wartmann were obtained, viz., the electrode in contact with the soil was *positive* to that in contact with the plant; but that the effect was in a great measure due to the soil, was

* Phil. Mag. 1851. † Ibid.

to the other. The whole root was taken out of the soil and washed gently in water so as to remove the earth, then placed in water, and the circuit reformed; the electrode in contact with the soil was still *positive*. According as the surface of the root in the water was greater, so was the effect upon the needle increased. The sap in the roots reddened litmus paper.

Hyacinth and narcissus bulbs were made to vegetate in the usual glass vessels. The electrode in contact with the water and at the extremities of the roots was *positive* to the other when inserted into the stem or bulb. The bulb was raised so as to leave the fibrillæ alone in the water; the effect was much diminished and almost null. The water was rendered slightly alkaline by means of potash; the effects were still the same.

The sap in the fibrillæ and bulb reddened litmus paper.

The same experiments were made as with the leaves, namely, coating the electrodes with acid or alkaline solutions. Whichever electrode was coated with the acid was always positive to the other.

Becquerel* has made the following remark:—"On obtient peu ou point d'effet, lorsque l'une des aiguilles est dans le ligneux, près de la moëlle, et l'autre dans la terre."

According to Lindley† Brugmans has ascertained that some plants exude an acid fluid from their spongioles.

Some experiments are also related by Becquerel‡ in which it would appear that an acid is formed during the germination of the seeds.

If any difficulty occurred in pointing out the *electro-positive element* in the leaves, the same difficulty meets us here, and the question arises,—Are not the results which we have obtained with the galvanometer rather the results of *secondary reactions*, in the majority of instances, than those of the *primary actions* (the normal results), and which we obtained but in a few instances, viz., when the sap indicated a *positive* condition? The very circumstance of an acid being secreted or formed at the root would indicate that an *electro-positive* element must

* In his first Memoir.

† Introduction to Botany, p. 229.

‡ Traité de l'Electricité, tome iv., p. 185.

have appeared somewhere, and why not, it may be asked, might it not have been absorbed by the plant? Might not those instances in which we obtained no effect upon the needle arise from the *two* currents being so equally balanced that the resulting effect upon the needle was null? In judging of the effect obtained by the needle* it appears to us that very erroneous conclusions would be arrived at if the greatest amount of effect were to decide in each case; we must take into cousideration the assumed *origin* of the current, and see whether the effect bears any proportion to the amount of force in action, and also those circumstances which are likely to influence the normal result, before drawing our final conclusions.

From these results we may deduce the following conclusions:—

1*st*, That when the electrodes of a galvanometer are brought into contact, one with the external surface of the spongioles of a plant, and the other with the sap ascending from the roots, the sap and the external surface are in opposite electric states; and 2*dly*, That the effects which are observed with the galvanometer may, in the majority of instances, be due to ordinary electro-chemical actions, but that, in some instances, the effect cannot be referred to these actions, but may be referred to the organic changes which occur in the fluids in the roots during vegetation.

§ III. *On the manifestation of Electric Currents in the Petals of Flowers during Vegetation.*

According to Wartmann,† "the currents are feeble in flowers."

Circuits were formed between the surfaces of the petals and the sap from the peduncles, in the following plants:— Geraniums, *various;* nasturtium; balsams, single and double; fuchsia; hollyhock; convolvulus; vegetable marrow; and cucumber. The effects obtained were but slight, and in many

* There is also something to be observed in the *motion* of the needle, which can only be obtained by practice, when judging of slight results. Far more correct results are indicated when the needle moves steadily and in a constant and definite manner, than when a sudden and great amount of motion is obtained.

† *Op. cit.*

instances null. Whenever the effects were obtained, they indicated the sap to be *positive*. The greatest effect appeared with the fuchsia.

It may be a question whether the results were not due more to the changes which the sap might undergo from exposure to the air than to the changes which might occur in the petal.

§ IV. *On the manifestation of Electric Currents in Fruits and Tubers.*

Becquerel,* Donné†, and Wartmann,‡ have shown that when the electrodes are inserted into different parts of a fruit or tuber, effects upon the needle occur, amounting to 15° or 30° or more, depending upon the parts in which they are inserted and the kind of fruit. In some tubers, such as the potato, the beet-root, and in the carrot, the external layers were *positive* to the internal. In the *Tropæolum tuberosum* and the *Ullucus tuberosus* the effects were inverse.

Some experiments were made upon the vegetable marrow and cucumber whilst attached to the plant. The electrode in contact with the external surface was slightly *positive* to the other when inserted into the centre. Similar experiments were made upon the apple, pear, and plum, when attached to the tree, or fresh gathered, or some time after they had been gathered. The greatest effect appeared with some of the apples, depending, however, upon the parts in which the electrodes were placed. No definite effects could be obtained; and as the effects might be referred to secondary actions, we do not think it necessary to particularize the results. Becquerel,§ in speaking of some similar results obtained by Donné, adds: "Les courants ne doivent pas être attribués à la présence d'un acide et d'un alcali, mais bien à l'hétérogènéité des parties constituantes des fruits."

In the potato, carrot, and beet-root, similar effects to those observed by Becquerel were obtained. In radishes the external surface was *positive* to the centre.

The following general conclusions may be deduced from the foregoing experiments:—

* In his second Memoir. † Traité de l'Electricité, tom. iv., p. 164.
‡ *Op. cit.* § Traité de l'Electricité, tom. iv., p. 164.

1st, That when the electrodes of a galvanometer are brought into contact, one with the surface of the leaf, and the other with the sap flowing from the same leaf, an effect occurs upon the needle indicating the surface and the sap to be in opposite electric states. These effects cannot be referred entirely to ordinary electro-chemical actions, but may be referred, in part, to the organic changes which take place in the leaf during vegetation.

2d, When the electrodes are brought into contact, one with the external surface of the spongioles of a plant, and the other with the sap ascending from the root, the sap and the external surface are in opposite electric states. The effects which are here observed with the galvanometer may, in the majority of instances, be due to ordinary electro-chemical actions, but in some instances the effect cannot be referred to these actions, but may be referred to the organic changes which occur in the roots during vegetation.

3d, That with the petals of flowers slight currents were obtained; and,

4th, In fruits and tubers powerful currents may be occasionally obtained, but these effects are evidently *secondary* results, due to the reaction of the different vegetable juices upon each other.

Concluding Remarks.

Previous to bringing these inquiries* to a close, we may just make a few concluding remarks in reference to the manifesta-

* We refer to the papers published in the Phil. Trans. for 1848 and 1852, and in the Phil. Mag. for Sept. 1855 and Jan. 1856. Objections have been raised by some as to the mode of conducting the experiments in these researches. We have no hesitation in stating that we feel the force of these objections. Our great object, however, has been to establish *facts*, and, if possible, to endeavour to remove the prejudices which exist in reference to the subject of our inquiry; and to show, at the same time, that that difficulty which some might be led to entertain in reference to the prosecution of the experiments does not exist. We refrain, as we have already stated (Phil. Mag., Sept. 1855), from noticing objections, from whatever quarter they may arise, unless supported by *experimental* evidence. Discussion as to matters of opinion may satisfy the demands of the indolent inquirer, but could only lead to unprofitable controversy, which we wish to avoid; discussion as to matters of fact we desire, as by these means truth will be eliminated.

tion of electrical action in the organic compared to that which appears in the inorganic world. The general conclusion we have arrived at is the following:—viz., That *during* those *actions* which are termed *organic*, such as *secretion*, *absorption* (*lacteal*), and *nutrition*, there is then manifested the same power as is observed during ordinary *chemical actions*—a manifestation of electrical action. If we wish to have a clear view as to the resemblance between these actions—between the *organic* and the ordinary *chemical* actions—we must refer to the changes which occur in the *decomposing cell* of an ordinary voltaic battery, or to those which occur in a simple voltaic circle. And here we cannot refer to a more beautiful experiment than the one recorded by that eminent philosopher Wollaston* for the sake of illustration. The difficulty which might exist in some minds of perceiving the resemblance may naturally arise from the circumstance, that in the ordinary voltaic circle we have metals, and it requires, consequently, some mental effort to perceive clearly the resemblance which can exist between those actions (*secretion*) which occur, for instance, in the mucous membrane, and those which occur in the simple voltaic circuit. Although in the ordinary simple voltaic circle one of the metals is usually acted upon chemically, we should bear in mind that they serve principally as *conductors*, and that they are not *essential* for the development of the power. Again, the resemblance which occurs between those actions which take place when two fluids (an *acid* and an *alkaline*) are separated by a membrane and those which occur during secretion, however similar in their nature, nevertheless, in some respects differ: take for instance the secretion in the kidney or liver; here we have the fluid (blood) on one side only, whilst the secreted product passes through; in the former case, with the acid and alkaline solutions, we have *combination* between the two fluids; in the latter case, during secretion, a *separation*—not a mere *transudation*, however, but a *secreted* product; nevertheless, during the formation of this secreted product and its separation from the blood, the same effects are produced, the same actions occur upon the needle of the galvanometer as would occur if we cause the *separation*

* Phil. Mag., vol. xxxiii., p. 488.

of an *acid* from an *alkali* when in combination with each other—in short, a *decomposition;* and this is what actually takes place either in the *decomposing* cell of a voltaic battery or in that beautiful experiment of Wollaston in the simple voltaic circle. And as we say that the power in the voltaic circle is brought about by *chemical** means, so may we say that the same power is brought about in the animal body by *organic* means. But it may be asked, what do we understand by *organic* means? In what do they differ from *chemical* means? What is the real difference between *organic* action and *chemical* action? And to these questions we have no hesitation in saying that we believe them to be both *polar* in their character; and as we speak of *chemical polarity* so may we speak of *organic polarity*, and consider that *organic* force and *chemical* force are both POLAR,† and so far identical.

Since this paper was presented to the Royal Society we have had the opportunity and extreme pleasure of perusing the valuable researches of Professor Graham on *Osmotic Force.*‡ The chemical character which Professor Graham assigns to *osmose* is of extreme interest to the physiologist; and the analogy which exists between the changes which occur in the organic world during the *absorption* and *secretion* of fluids and during ordinary *osmose*, is too remarkable to be overlooked.

* The dispute in reference to the *origin* of the power in the voltaic circle, whether by *contact* or *chemical change,* will make no difference to our argument. As far as we can make out, the dispute, in most instances, arises more from the meaning of the terms employed and the extent of their meaning, than from any real difference of opinion.

† We have spoken of organic polarity in connection with chemical polarity, inasmuch as we are able to prove, by *experiment*, the resemblance between these two powers. Other polar phenomena may also occur in the organic world which might differ as much from chemical polar phenomena as magnetic polar phenomena do from the latter. In other words, the organic *form* of force might differ from the chemical *form* as much as the magnetic *form* does from that of the latter, or from *that* of heat, light, and electricity; nevertheless, they are mutually connected and correlated. That the *force* manifested during organic actions is *polar* we may consider as established upon *experimental* evidence.

We might refer to several authorities who have suggested the idea, or even pointed out the polar character of some of the organic actions; to Todd and

‡ Phil. Trans. 1854.

In ordinary *osmose* the employment of two fluids is apt to prevent the resemblance between it and *secretion* or *absorption* to be at first sight clearly perceived; but when the existence of *osmose* is made to depend upon the changes which occur *in* the membrane or any other porous septum, the necessity of *two* fluids is removed, and we then obtain clearer views as to the analogy or even resemblance between the processes which occur in the organic and inorganic kingdoms, between *osmose* on the one hand, and *secretion* and *absorption* on the other.

On the Occurrence of Scalariform Tissue in the Devonian Strata of the South of Ireland. By ROBERT HARKNESS, F.R.SS. L. & E., F.G.S., Professor of Geology, Queen's College, Cork. (Plate I.)

The existence of vegetation in the form of ferns, during the period of deposition of the strata which now constitute the Devonian formation in the South of Ireland, was first recognised by Mr Jukes and the officers of the Irish Geological Survey. The announcement of this took place at the Belfast meeting of the British Association, and these fern remains were referred by the late Professor E. Forbes to a new form of the genus Cyclopteris, the *C. hibernicus;* a plant which was subsequently observed by the same distinguished palæontologist among strata of this age in Scotland.

Besides these distinct remains of the *C. hibernicus*, which consist of a rachis having leaflets attached thereto, and which are common in the sandstones of Kiltorkan and the neighbourhood of Cork;* there are found in some of the higher beds of the Devonians of the South of Ireland great quantities of

Bowman's Physiological Anatomy, vol. i. p. 237, *et seq.*, and especially to Dr Carpenter's valuable paper on the Mutual Relations of the Vital and Physical Forces in the Phil. Trans. 1850, p. 727, for further arguments in support of the same idea. Dr Todd, however, appears to us to have been the first to give the most precise and definite idea in reference to *nervous polarity* that we are aware of (*vide* Art. on the Physiology of the Nervous System in the Cyc. of Anat. and Phy.); and also to a small work, entitled "The Anatomy of the Brain and Spinal Cord," by the same author.

* Jukes, in the Journal of the Geol. Soc. of Dublin, vol. vi., p. 266.

These two features when combined, would, to some extent, render doubtful the Filicine nature of many of the plants, which have been regarded as appertaining to this tribe of vegetables. The discovery, in connection with one form of these plants which has not exhibited organs of fructification, of decided fern-tissue renders the absence of these organs a matter of small importance, and we must regard this absence as resulting either from the easily detached state of the organs themselves, or from some circumstances in their constitution which render the preservation of the fructification difficult.

Mr Jukes, to whom I am indebted for the information concerning the position of the strata at Abbey Mahon, informs me that the plants are not confined to the upper Devonian. They also occur in the Coomhola grits of the Irish Geological Survey, which form the base of the Carboniferous formation, and in which are found *Orthocerata*, *Modiolæ*, *Avicula Danmoniensis*, *Spirifer cuspidatus*, and *Encrinites*; these fossils being confined to the carboniferous, while the upper Devonians are devoid of marine remains.

Although these ferns cannot be regarded as strictly Devonian forms, still their occurrence in strata of this age indicates that they owe their position in these beds to different causes from those which have mingled them with the marine ferns of the succeeding carboniferous; and many geologists have regarded their presence as indicating the existence of fresh-water or estuary conditions during the latter portion of the Devonians; a circumstance which is still further confirmed by their being, in some localities, associated with beds containing the remains of the *Anodon Jukesii*. Whether or not they have been carried into fresh-water lakes, in which flourished the shell just alluded to, is a matter which, until further evidence is obtained, will remain doubtful. We have, however, quite sufficient proof that a luxuriant vegetation clothed the surface of the Devonian land, and that this vegetation had principally a fern character.

The geological structure of a considerable portion of the South of Ireland shows, that during the deposition of the Devonian beds, there was, above the surface of the sea, a large tract of land on which probably grew the vegetation occurring imbedded in this formation. The unconformability existing between the Lower Silurians in the counties of Wexford and Waterford and the Devonians points out the existence of this land, and the conglomeratic character of some of the latter strata, composed of matter derived from the Silurian formation, still further indicates the occurrence of conditions capable of supporting terrestrial vegetation. This terrestrial vegetation was in part drifted into the waters, depositing the Devonians, and the lower Carboniferous, and consequently we have them among the sandy strata which seem to have been formed in lakes or estuaries of the earlier formation, and also associated with remains which lived in a marine habitat during the Carboniferous epoch.

Geology of the Southern Concan. By Lieut. A. Aytoun, Bombay Artillery. (Plate II.)

Introduction.

Several months of sick leave on the western coast of India in 1852–53 enabled me to visit in canoes nearly all the headlands from Goa to Viziadroog, and to make a connected section of the rocks which are exposed at their bases. I also landed and examined the rocks at many points between Viziadroog and Bombay in the great basaltic district.

In the following observations I shall attempt to give a general view of the structure and composition of the Southern Concan; but it may be as well to remark at the outset that my detailed examination was confined to the coast plateau, while I made hasty traverses across the Concan from Viziadroog, Malwan, and Vingorla to the Ghauts.

Within the limits of the great basaltic district I shall only briefly notice the rocks about Rutnagherry and Viziadroog, as regards their disposition and connection with the overlying laterite; the trap rocks of the Concan do not differ from those described by Colonel Sykes, in his "Geology of the Deccan," except in the larger amount of iron in the composition of some of them. The section along the coast which I have given in the Map embraces all the sedimentary rocks of the Concan.

North of Viziadroog the great basaltic tract extends to Bombay and onwards to the borders of Cutch, while to the south quartzites (altered sandstones and conglomerates) and the crystalline schists with plutonic rocks are developed to Goa,—and continued, I believe, to Cape Comorin—re-appearing in Ceylon.

The strike of the rocks or the axis of the schists is at right angles to the littoral section; but, as there are lines of eruptive rocks some distance inland, at right angles to the strike of the schists, it must not be supposed that the latter extend in unbroken continuity across the Concan.

A stranger might visit the western coast of India, and cross and recross the Concan between the sea and the Ghauts, at many different points, and come away with the impression that there was no rock in the district but a red ferruginous-looking one, which he would be told was laterite. The country is, as it were, covered with a mantle of this rock; and, as I shall have frequent occasion to make use of the word Laterite, I think it right to premise what I signify by a term which still retains a somewhat obscure meaning.

So much has already been written on the subject of laterite, that it would occupy considerable space to remark, however briefly, on the observations which have been recorded; and, as these have frequently been local and isolated, and apparently conflict with one another, no small amount of perplexity has arisen regarding the nature of this rock.

That explanation of "What is laterite?" which makes all the observations of all the observers harmonize and fit one into another, is deserving, I think, of more attention than has yet been accorded to it.

Major Wingate of the Bombay Engineers did for the Concan what Dr Clark and Captain Baird Smith had done for Mysore. He showed that the laterite was derived from the decomposition of all the rocks of the district; that granite, syenite, trap, the crystalline schists, and even sandstone and quartz rock had each of them contributed its quota to the so-called laterite of the Concan, at certain points corresponding to the development of the several mineral masses.

Before seeing Major Wingate's paper I had arrived at the same conclusion after a close examination of the coast section from Goa to Rutnagherry, where, at the bases of the headlands, all the above-mentioned rocks are met with in their undecomposed state. It is on this section alone that the laterite, in its relation to the other rocks, can be studied to advantage; for, in general, when we move from the coast, the laterite conceals every other rock, but the action of the waves lays bare the rocks at the foot of the headlands.

Jambut-ka-phuttr (the brick stone) is the native term along this coast for the stone exclusively used in the construction of temples, houses, and forts. The word is employed indiscriminately for clays (or rather soft stones) derived from the decomposition and subsequent concretion of trap, syenite, schist, and diluvium, provided they contain sufficient hydrous peroxide of iron to form a good concrete when cut into the shape of bricks and exposed to the atmosphere.

Dr Buchanan, who observed this stone first on the western coast of India, gave it the name of Laterite, retaining in Latin the native signification; and he, doubtless, like the natives, used the term generically, and applied it to the characteristic "red rocks" of the Malabar coast, all of which on being weathered exhibit externally a very uniform aspect. Were we to limit our definition of laterite to a stone derived from syenite decomposed *in situ*, we should have to strike out $\frac{99}{100}$ths of the laterite of the Concan, or what has hitherto passed for it: again, were we to adopt a volcanic brecchia as the true laterite, its development in the district under consideration would be extremely small.

But if, as we do find, there have been general causes acting on all the various rocks of the Concan to produce concrete ferruginous stones, and that all of these concrete stones have certain characters in common, I think we may venture to retain the term which was originally applied to them, instead of confining it to one or two varieties.

Now, in the undecomposed rocks of the Concan, wherever we encounter them, it is found that from some cause or other there is an extraordinary development of iron. In the great basaltic district, for example, at Rutnagherry, many of the trap rocks contain the magnetic oxide and peroxide of iron, to such an extent that they might advantageously be smelted. Further down the coast, at Malwan and its neighbourhood, the sandstone and quartz rocks are largely impregnated with iron, concentrated in beds and veins as centres of ferrugination, and minutely diffused through the mass of the rocks, at a distance from these centres; the schists, again, have beds among them, where their bands of iron and quartz alternate, like layers of felspar and quartz, in some kinds of gneiss. The syenitic and hornblendic rocks, of course, contain the metal largely, and where these occur, we have no difficulty in accounting for their concretionary power after decomposition. The black mica, in the granite and schists, appears also, on decomposition, to yield sufficient iron to tinge the mass, and sometimes to produce a concrete. But the diluvium also of the Concan, being derived from iron-impregnated rocks, is largely charged with the metal, and the same effects are exhibited on it; it decomposes and concretes into clays more or less ferruginous, and in this state cannot frequently be distinguished from the product of crystalline or sedimentary rocks decomposed *in situ*.

And it may be added, that the deposits now forming along the coast, being, like the diluvium, derived from rocks largely charged with iron, are ferruginous, and would, if elevated and exposed to the same influences, be included among the members of the Laterite family.

Further, in common with similar rocks in Brazil, the Malay Peninsula, Australia, and the Ural Mountains, those of the Concan have suffered disintegration to great depths,—in some places to the depth of 150 to 200 feet.

There are many stages in the process from the commencement of decomposition to concretion into laterite; when the constituents of the rock have reached a fine state of division, it is then in a condition to be formed into a concrete, by the action of the hydrous peroxide of iron, and the stage of laterite is reached.

In considering the causes which have produced so much laterite in the Concan, it must not be forgotten that, in addition to the action of the atmosphere and the contact of dissimilar rocks, both of which may be admitted as influencing decomposition, the Concan has a peculiar physical structure, which aids these primary causes. The capping of the coast plateau with a hard detrital laterite, is a shield to the decomposing rocks below, and arrests denudation; while moisture—an important agent in decomposition—is present throughout the dry season, even in the clays immediately below the hard cap.

I will conclude this introductory notice of laterite, by repeating that the presence of iron as a constituent, and the decomposition* of the rock, are the conditions which I regard as necessary for the production of laterite from every variety of rock in the Concan.

Physical Features, Extent, &c.

The South Concan is the narrow strip of land lying between the Syahdree range of mountains (commonly known as the Western Ghauts) and the sea, from the Bankot river on the north to the Portuguese territory of Goa. Its length is 150 miles, and its average breadth about 25. The Western Ghauts, which bound the Concan on the east, attain here an elevation of 2500 feet.† They rise, as is well known, with excessive ab-

* The atmosphere of a tropical climate acts with much greater intensity in decomposing rocks than that of a temperate climate like Europe, and I do not wish to undervalue the influence which the alternations of excessive heat and excessive moisture may have had in the disintegration of these rocks, yet I think we must admit another cause—perhaps a secondary one, dependent on the atmosphere—in accounting for a decomposition which, in the schistose rocks, as well as in the igneous, is analogous to the decomposition of granite in Cornwall and other parts of Europe. I think some remarks of Brongniart so applicable to the case of the rocks on the western coast of India, that I cannot do better than give an extract. Speaking of the decomposition of felspar when associated with ferruginous rocks, he says, "It seems chiefly ascribable to perhaps a hydro-electrical influence exercised on a neighbouring rock, which is always met with in close proximity to the spots where kaolin is found. This rock is of a red colour, in consequence of its containing a large quantity of iron. This circumstance was first remarked by Gehlen, when he examined the repository of kaolin at Passaw. Kühn has adduced another striking proof on this subject. Near Losa, in Saxony, where kaolin is found, a vein of quartz which cuts through the granite has on both sides a thick sahlbund (edge or border) of iron ore; and on both sides of the vein the felspar of the granite is converted into kaolin, which is of excellent quality." Brongniart further adds, that he has found kaolin invariably surrounded by a very ferruginous rock.

† Highest point of Ram Ghaut, determined by aneroid barometer, 2402 feet.

ruptness, and render the ascent to the table-land of the Deccan a matter of no small difficulty.

At present there are but two points in the whole length of the Southern Concan where the ascents can be made by wheel-carriages—viz., the Phoonda and the Ram Ghauts—and even there the roads are so steep that it is a good day's journey to reach the summit.

Except at a few other places where there are footpaths, the mural precipices of this singular range of mountains are a barrier to all communication between the low country and the high table-land.

Had the Ghauts thrown off long spurs towards the sea, the ascent might have been made as insensible as Sir Roderick Murchison describes that of the Ural Mountains; but there being no spurs of any length, and the elevation of the country immediately at the foot of the Ghauts being but a few feet above the level of the sea, it happens that the traveller, after passing an apparently endless succession of ascents and descents, of the most trying kind for carriages, in his passage across the Concan, finds (if he has no aneroid barometer with him) that he has still nearly the whole ascent of 2500 feet to surmount at once. The Phoonda Ghaut road, however, forms an exception to the above, in this respect, that, instead of the irregular and undulating features, we find a plateau 60 to 80 feet high, extending from the coast inland for five or six miles; and this is succeeded by another plateau, nearly 350 feet high, extending to within a few miles of the Ghauts; but here again we have to make a descent, and on reaching the foot of the Phoonda Ghaut we have gained but little in elevation above the sea.

In taking a view of the main features of the Concan, it may very well be divided into two zones parallel to its length. The west or coast zone is a plateau (or series of plateaux), bearing at many places on its surface, in the rounded and semi-angular conglomerates, evidence of being a raised bed of the sea. The east zone is composed of short ranges of hills, in general having a more or less east and west direction, with narrow valleys and streams between them. Single isolated hills are not uncommon in this zone, and some picturesque examples present themselves in the hill forts of Munohur and

Thus every two or three miles we find our journey retarded by a hill with a slope of 50° and upwards, the ascent of which must be made by a stair cut out of the laterite of the hill. Having gained the summit, we pass over a bare and flat sheet of laterite, sometimes not many hundred yards in breadth, and then commence an abrupt descent on the other side, by means of another stair. A narrow valley, covered with paddy-fields and coco-nut groves, is now before us; and flowing through it is a tidal stream, across which we must be ferried. We have no sooner passed this obstacle, when we again encounter another hill of precisely the same character as the first, and then a valley with its tidal stream, or, what is still more troublesome to the wearied traveller, a broad creek. In a distance of 30 miles, between Goa and Vingorla, there are seven creeks and tidal streams, two of which only are fordable on horseback at low water. The stairs up the hills being very steep, and the lading and unlading at the creeks causing great delay, beasts of burden are not used. In the transport of everything coolies are employed, and the progress of a *Sahib* in these districts is indicated by a long line of men carrying on their heads beds, boxes, baskets, chairs, tables, and even tents.

A reference to the map will show that nearly all the creeks and streams from Goa to Viziadroog have an E.N.E. or E. by N. direction; and this corresponds with, as it is probably determined by, the dominant strike of the schistose rocks within this area.

The coast-line is composed of headlands or promontories—parts of the plateau which jut out into the sea. They are either separated by broad creeks, as at Goa, Viziadroog, and Bankot, or connected by sandy beaches, with a narrow opening at one end for the embouchure of a tidal stream, as at Rairee, Vingorla, &c. &c.

On the side next the Ghauts the plateau has, in general, as steep slopes as towards the sea.

Geological Topography.

The great basaltic district of India, by far the largest area in the world covered by trappean rocks, has been computed to cover 200,000 square miles. It includes a considerable portion of the Concan, viz., from its northern border on the Bankot river to a line drawn from Achre across the Concan to the Phoonda Ghaut.

On the borders of the great basaltic district, both in the Concan and in the Southern Mahratta country above the Ghauts, the rock which first presents itself is the diamond sandstone;* and I think the one is merely a prolongation of the other. The sandstones and quartz conglomerates of this formation are more frequently in the Concan converted into quartzites, the pebbles of the conglomerate being only distinguishable by a difference of colour or by the weathering of the rock. These quartzites extend from Achre (or Atchera) down the coast as far as Neotee Point, a distance of 20 miles. At the Phoonda Ghaut, the lower features of the mountain are composed of sandstone, and the isolated hill at Pigallee also.

Elsewhere the lower beds of the diamond sandstone pass into soft, red-coloured, argillaceous schists, and these, again, into limestones. Between the Phoonda Ghaut and Malwan, I observed in a valley the red argillaceous schists; and Major Del Hoste gave me a specimen of limestone—discovered by by him below the sandstone at Pigallee—which I recognised as similar to that of the Kulludghee district. We thus find in the Concan all the members of what Dr J. G. Malcolmson has styled the "Argillaceous Limestone Formation."

South of Neotee Point, on the coast, the quartzites are succeeded by chlorite, talc, hornblende, and micaceous hornblende schists. There is a considerable development of trap about a mile south of Neotee; and it appears in one or more beds at most of the headlands to the south, as far as Goa.

At Vingorla, granite appears as a centre nucleus, with mica and talcose schist forming an anticlinal upon it. At Rairee, and for several miles to the south of it, the quartz rocks and schists are "iron masked,"† affording an inexhaustible supply

* So called because, mineralogically, it is the same in Golconda, Bundulkund, and other places where diamonds are met with in its debris. No organic remains have been found by which to determine its age.

† I adopt this very expressive term from Mr Logan in his Geology of Sincapore and part of the Malay Peninsula—a district possessing many striking resemblances to the western coast of India.—See London Geol. Society Pro., Quarterly Journal, June 1851.

of iron ores. The hydrous peroxide of iron so obscures the rocks at many places about Rairee that it is impossible to say what they are, except masses of iron ore.

At Ramgurh, ten miles inland from Malwan, beds of steatite occur associated with talc schist and quartz rock; granite appears in the immediate neighbourhood; talcose rocks and serpentinous greenstone are met with near the Toolsee Ghaut at Vingorla; granite, syenite, gneiss, mica schist, and iron-impregnated quartz occur between the Waghdongur and Tullowrie; hornblende rocks and iron-impregnated quartz are met with between Banda and Baitsee—much obscured by laterite. At the Ram Ghaut hornblende rock is the predominating one, and it reaches the height of 800 feet, when it is succeeded by mica slate, granite, and gneiss, and these by greenstone porphyry, basalt, and laterite. At the Phoonda Ghaut, the crystalline schists are developed in the nullahs or water-courses; then, in ascending, we meet with sandstone, amygdaloid, basalt, and on the top laterite.

Section from Goa to Viziadroog.

I must allow the section I have given to speak for itself, want of space not allowing me to describe each individual headland in detail. It will, however, be perceived, on referring to the section, that the headlands are all very much alike in structure; at the bases, where the waves clear away the debris, schists and other rocks are exposed in an undecomposed state. They strike eastward to the Ghauts and expose their edges to the sea. Twenty or thirty feet above the level of the sea they begin to decompose, and as we ascend still further we find them more and more decomposed until about half way up the hill they become resolved into fine clays—still retaining, in the case of schists, a lamellar structure coinciding with the beds below. About fifteen to thirty feet these clays terminate, and resting *unconformably* upon them there is a hard crust of laterite whose detrital origin can be traced at Vingorla, Viziadroog, Rutnagherry, Waghotun, and Funnusgaum. It is, in my opinion, the diluvium of the Concan which has been elevated by the upheaval of the plateau.

This crust is composed of detritus of the rocks of the district, which, subsequent to the formation of the conglomerate, have undergone decomposition—the iron with which the detritus is charged obscuring, except in rare cases, the original character of the fragments, and making them appear like cemented pieces of laterite. This cap of hard laterite presents a scarped face to the sea; and, where the soft clays below happen to get washed away, masses of it become detached and strew the steep slopes of the hill. While the soft clays below vary in colour and ferrugination, according to the mineral composition of the rocks at the foot of the headlands, the laterite on the summit retains a very uniform appearance at all the headlands which appear in the section.

To illustrate what has just been stated, I here give a few details regarding the structure and composition of Vingorla headland—by far the most instructive one on this coast. Here an anticlinal is formed by mica schist resting on granite. On the south side the schist appears in a small patch dipping south, and veined with granite; there are also one or two beds of the schist enveloped in the granite mass. On the north side there is a considerable thickness of mica and talcose schists. Garnets abound in most of the beds—and there are talc excrescences on some of the planes of foliation, which contain garnets—three inches in diameter, but imperfectly crystallized.

On the north side, where the dip of the beds of schist coincides with the slope of the headland, we have an excellent opportunity of studying the connection between the undecomposed rocks and the clays under the upper crust of laterite. We can trace all the stages of decomposition until we find the schist resolved into clay, the granites forming a red powder which partly fills the cavities formed by their decomposition.

So complete is this decomposition that the resultant clay contains scarcely any gritty particles, and is almost as fine as prepared kaolin clay from the granite of Cornwall.

The black mica of these rocks probably, like that of Siberia, contains magnesia; for, as soon as they begin to decompose, they have an unctuous touch, and the fine clays above have the same character. The clays often show slickensides. Leaving the schists, if we climb up the granite part of the headland, we find the clays of a different kind, being derived from the decomposition of the granite.

On the north side the clays have in some cases hardened from exposure, and blocks of this kind of laterite may here be seen. On this side also the diluvial character of the upper crust is well exhibited.

Before passing from the subject of the coast-section I may observe that ferruginous veins are not uncommon among the rocks at Neotee and elsewhere, and where they are decomposed they assume the appearance which laterite *en masse* has. Numerous examples present themselves among the quartz rocks, and they are particularly well marked from traversing rocks of a totally different colour. These veins may have been granite, syenite, trap, or even quartz loaded with iron, but now they are decomposed, and may be designated laterite veins.

At Rutnagherry, near the creek, and on the hill where the Adawbut is built, there is a conglomerate laterite capping the cliffs. The pebbles—of compact felspar principally—exhibit a flattish rounded form, like those of a shingle beach; they are perfectly smooth from the action of water. The conglomerate is seen at two elevations, 40 and 120 feet respectively above the level of the sea. The pebbles generally are decomposed and concreted together. Trap everywhere underlies the laterite about Rutnagherry, and the lateritic clays follow the character of the subjacent rocks, whether greenstone, basalt, or amygdaloid. At Seegaum, where spheroidal basalt occurs, the laterite may be observed in spheroids.

Silting-up of the Creeks.

Two or three thousand years ago the Concan must have possessed unrivalled water communication for small vessels like those now in use. Every few miles along the coast a creek communicating with a stream occurs, and many of the latter are even at this day navigable to within a few miles of the Ghauts, the tide affecting them to that distance from the coast. But we hear the same story from the native residents on all these creeks, that they are rapidly silting up, and that, even within their memory, the tonnage of boats ascending the creeks has been immensely reduced owing to this shallowing. In the narrow creeks the result of the silting-up process is very striking; many of them have been converted into alluvial plains, with embanked streams flowing through them.

Excavation of Valleys.

At Waghotun, Rutnagherry, and other places where there are creeks of considerable size, the streams from the Ghauts flow in deep gorges through the plateau, precisely similar to the Rhine, where it enters the hilly tract at Bingen and again at Andernach. Side valleys have also been excavated by streams which, despite the hard crust of laterite, have gained access to the clays below. The commencement of this process is still seen at Waghotun, where caverns are formed by the over-arching of the hard crust, from below which the stream has excavated the clay. As the cavern enlarges the roof will ultimately fall in from being unsupported; a ravine is then formed with hard blocks of laterite from the roof strewing its sides. The progress of excavation may be arrested by vegetation, but this never occurs at Waghotun, where the country presents all the features of an alluvial bank of a river eaten into by small rills.

Economic Geology.

Iron.—A few years ago the Court of Directors called on the local governments for information regarding the iron-ores of the Presidency, and the probability of their yielding a supply of metal for the projected railroads.

The district officers made out lists of the places where ore was smelted by the natives, and the information thus collected showed how very extensively the metal was distributed in the Bombay Presidency. There are few, if any, square miles in the Concan south of the basaltic district, where iron-ore fit for smelting may not be obtained. The western coast of India is, at this part, literally an iron-bound coast. I have seen in Germany iron-ore used for smelting which did not contain so much of the metal as the hard cap of laterite on the coast plateau. But, though diffused through immense masses of all the rocks of the district, we also find it concentrated at certain points. At Malwan veins nine inches thick of specular and micaceous iron-ore are visible on the beach. At Rairee there are beds forty feet thick of a quartzy iron-ore, and numerous bands of brown hæmatite. At the Ram Ghauts the schists and gneiss are loaded with iron. At Usya Mult, magnetic iron-ore in a quartzose matrix is associated with granite and greenstone dykes.

Generally speaking, the ores of the Concan are composed of magnetic iron in grains along with peroxide. The native smelters of the Concan do not separate the magnetic grains by washing, but use both oxides combined, and the iron produced is of first-rate quality. The blacksmiths at Belgaum, in the Southern Mahratta country, prefer the Sawunt Warree iron to the Taygoor, though the latter is more readily procured.*

Brown iron-ores, containing no magnetic iron grains, are used at Taygoor, and it is doubtless owing to the absence of the magnetic oxide that the iron smelted at that village is inferior to the metal of the Concan, which is obtained from schists charged with it. Thick bands of magnetic iron-ore possessing polarity do occur, and are very numerous at Taygoor and its neighbourhood, but being siliceous and very hard the natives do not attempt to smelt them. They are laminated, the quartz alternating with the iron. They strike pretty uniformly north 5° west, and dip at an angle of 80° to the east. Gold is found in the alluvium between the ridges or undulations which

* In the London Geol. Soc. Trans., 2d Series, vol. v., page 548, the following is stated in a note. "Iron which has been ascertained to be superior for many purposes to the best German iron, has been recently imported from the western coast of India, but the mines from which it was obtained have not been examined. Captain Jervis, of the Bombay Engineers, however, informs me that ores powerfully affecting the magnet exist in great quantity at Taygoor, a village of the Concan, not far from the part from which the iron in question was procured."

The writer of the above has fallen into a mistake regarding the localities. There is no village of that name in the Concan, and Captain Jervis must have referred to Taygoor above the Ghauts, between Belgaum and Dharwar. The iron in all probability came from the furnaces of the Sawunt Warree territory, where the smelters use the same kind of ore (decomposed schists containing magnetic oxide) which yields the Damascus steel in Central India, and from which also the Russians manufacture their finest kinds of iron.

ing, rather than the ore, which may be considered as everywhere abundant. The coast plateau is destitute alike of soil and vegetation, and we must look to the east zone of the Concan near the Ghauts for a supply of fuel.

Charcoal might undoubtedly be brought down the creeks in small boats to the coast, but the most eligible locality for smelting would be where the iron and wood are found together in the vicinity of a navigable creek. These conditions are met with in the Sawunt Warree territory on the frontiers of Goa. The jungle at the foot of the Ghauts in that part of the Concan is exceedingly dense, and under proper supervision might be made to furnish a never-failing supply of charcoal for many furnaces.

It may be a question—and it is now being practically worked out at Beypoor—whether Indian iron can compete with the English for the ordinary "plant" of a railway; but I conceive, from the cheapness of labour in India, there can be no question that iron of the finer kinds, like that of Russia and Germany, may be produced in any quantity at a lower price than it can be manufactured elsewhere. And I do not despair of seeing the day when it will find its way into the markets of Europe.

Cannon Foundry.

At the last meeting of the British Association in Glasgow, Mr Fairbairn, the eminent engineer, stated that government having found that the hot-blast iron of England was unsuitable for ordnance, had sent orders to Norway and Sweden, and to Nova Scotia, for iron smelted with charcoal. This will enormously increase the cost of ordnance, and it may perhaps lead to the establishment of a cannon foundry in India to meet the requirements of our own artillery there.

Steatite.—At the village of Asgunnee, about ten miles from Malwan, steatite is quarried, and turned on the native lathe, into domestic utensils and ornamental articles, such as vases, hookah bowls, and anything else of which a design may be supplied. It is a branch of industry capable of considerable development.

Manganese.—Compact manganese-ore occurs in thick veins, with brown iron-ore, in the laterite at Rairee Point. I picked up some pieces of the black oxide on the south side.

An ore of manganese also abounds at a village near the Phoonda Ghauts.

Copper.—In a quartz vein at Vingorla headland, sulphuret of copper and iron occurs. I found carbonate of copper having small cavities in a quartz vein adjoining a red felspar dyke, which traversed gneiss at the Ram Ghaut. The gneiss was immediately below greenstone porphyry. No one has yet explored the Ghauts in search of metals ; the dense jungle and precipitous face of these mountains render such a search no easy matter. Even during the hot weather, when the underwood is not so close, I experienced great difficulty in exploring many hundred yards.

Such a search is however quite practicable, if systematically set about, by selecting the proper season of the year, and bivouacking in the jungle.

General Remarks.

Scenery.—The view of the coast from the sea is most unpromising to the lover of the picturesque. Nothing meets the eye but flat-topped red headlands, without a trace of vegetation (except perhaps here and there a few screw pines where there happens to be a spring of water), and sandy beaches, behind which the tops of coco-nut trees are visible. But the scene is changed when the Pattemar (in which we shall suppose the observer to be) is run across the bar into any of the numerous creeks which intersect the plateau of the coast. Instead of the sterile headlands and sandy beaches which he has been witnessing from the rolling Pattemar, he finds himself suddenly introduced to a landscape of no mean attraction. The clear blue of the still creek water in which the anchor is dropped—the coco-nut groves on either side—the flat ground at the foot of the hills, now covered, it may be, with the emerald green of a second rice crop—the terraced sides of the hills, rich in mango and jack trees, the cashew-nut, the oondunce, the rutambee, and the graceful sooparee,—all these combined form a striking contrast to the monotonous and inhospitable coast line ; and their beauties are perhaps more appreciated when the observer, as has often been the case with me, has been beating up the coast all day in a native boat against a strong breeze of the north-west monsoon, and has at sun-set been compelled to seek shelter in the creek. The thickly-wooded hills near the Ghauts, with their round and pointed outlines, form picturesque landscapes. The bamboo in all its beauty may be seen near the Ram Ghauts, growing in large clumps, with its slender stems and feathery foliage topping the vegetation around it.

Influence of the Geology on the Inhabitants.

The poverty and wretched appearance of the Concanees may be laid in a great measure to the charge of the geological structure of the country; for, as agriculture is now to India what manufactures are to Manchester and Birmingham, when the people cannot obtain employment in this sole branch of industry they must starve or emigrate. A very considerable portion of the Concan is as barren as the Suez desert. In one of the best of the revenue divisions of the collectorate, out of 900 square miles, 186 are barren.

The summit of the coast plateau, which is composed of detrital laterite, containing so much iron as to render it intractable to vegetation, is utterly sterile, except where the natives have artificially collected soil by carrying it up in baskets and blankets.

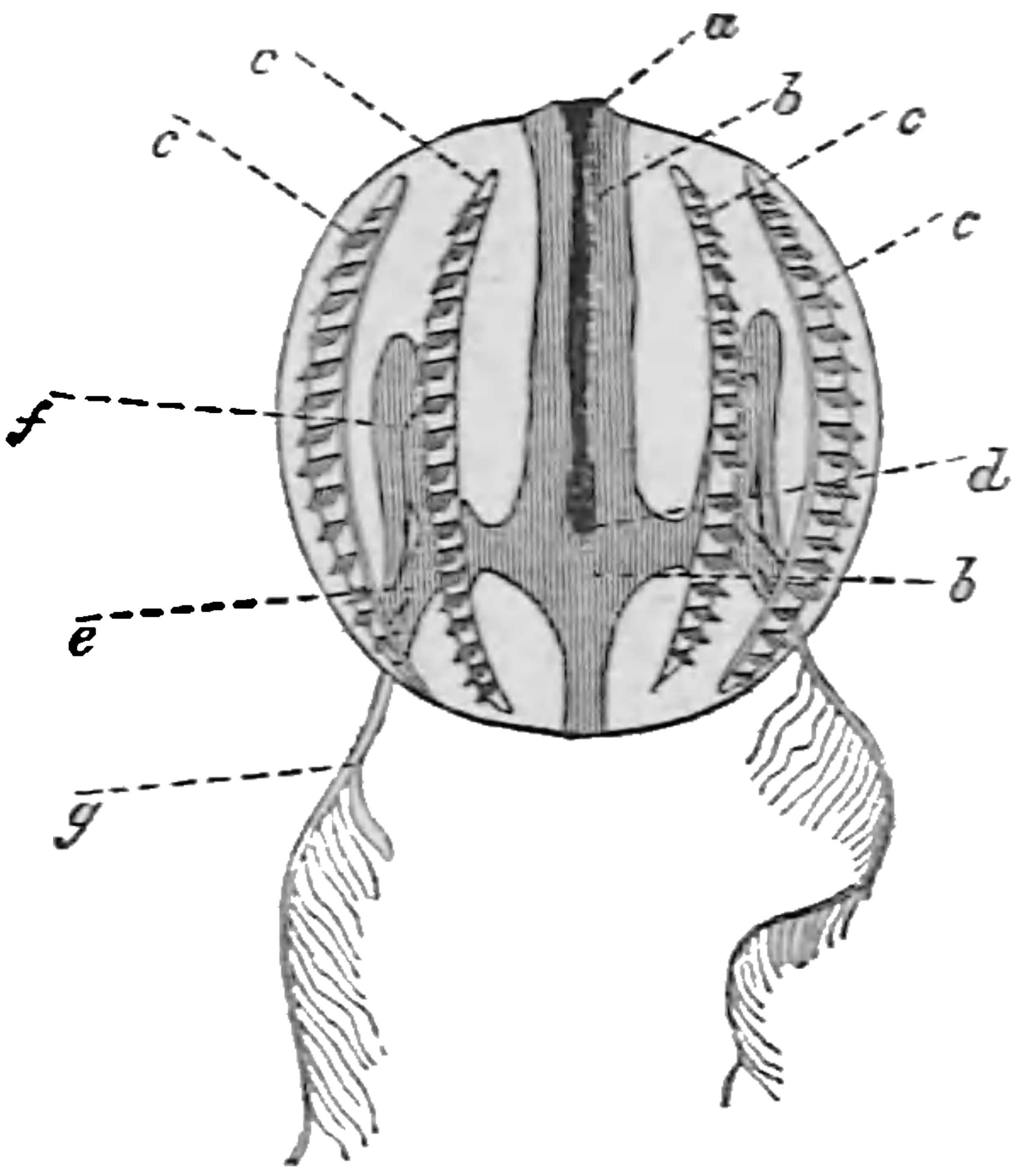
The appearance and condition of the Concan ryot, when compared with those of his brethren in Belgaum and Dharwar, form as striking a contrast as the sterile red laterite of the Concan to the rich black cotton soil of the Deccan plains.

The mineral resources of the country, when once in a fair way of development, may yet be found to afford employment, and relieve the distress of a population now greater than its agriculture can support.

On the Reproduction of Cydippe pomiformis. By T. STRETHILL WRIGHT, M.D., Fellow of the Royal College of Physicians, Edinburgh.*

Accounts of *Cydippe* may be found in every manual of Natural History and Comparative Anatomy. Those written by British authors are generally distinguished by a singular variety in error both of description and illustration. I have, therefore, thought it necessary to give to the Society a sketch of its anatomical structure, as maintained chiefly by Agassiz in his admirable work on the Acalephæ of North America, and which my own observations assure me is correct.

Fig. 1.



a. Mouth opening into stomach, which communicates at *d* with *b b* large central canal of water-vascular system. *c c c c* Longitudinal muscular bands carrying ciliary paddles, and covering the lateral water-vascular canals. *e e* Transverse water-vascular canals. *f* Receptacle of the tentacles *g*.

Cydippe (see fig. 1) may be briefly described as a transparent ovoid body of gelatinous consistence, having its surface longitudinally sulcated (like that of a melon) by eight furrows, in each of which lies a band of muscular tissue. These muscular bands serve as a basis of attachment to numerous flat paddles or comb-shaped fringes of cilia, which are ranged at nearly equal distances along the whole length of the bands, and form a locomotive apparatus by which the animal rows itself through the water with admirable swiftness and grace. In the allied acalephs, Beroe, Alcinoe, and Bolina, each of these paddles is a transparent plate, more or less divided or fringed only at its extremity, while in *Cydippe* the plate is entirely divided to its attachment into a fringe of separate cilia. Agassiz considers that the cilia are composed of a peculiar substance, but I find that their action on polarized light is proportionate to that exerted by a plate of horn of equal thickness. The cilia are, therefore, in all probability, setæ and their embryonic development, hereafter described,

* Read before the Royal Physical Society of Edinburgh, 28th February 1856.

indicates that they are analogous to the locomotive setæ of the Annelides. Immediately beneath, or internal to the muscular bands, and corresponding with them in length and breadth, are eight canals excavated in the gelatinous tissue of the animal, and connected by a system of transverse branches with a much larger cavity, which occupies the axis of the body along its whole length, and admits the sea-water by two orifices situated at its inferior extremity, capable of being opened or closed at the will of the animal. The whole of these canals form a water-vascular system, through which a constant circulation of fluid takes place, urged by the fine cilia with which the cavities are lined.

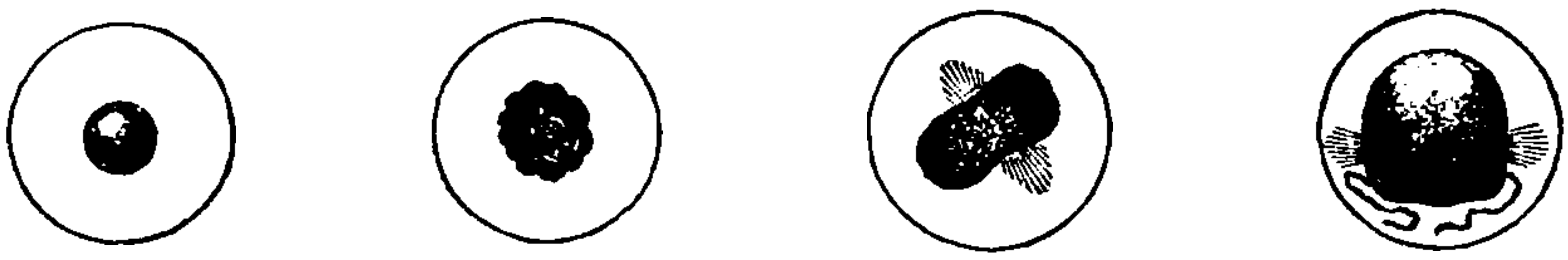
The digestive system consists of a flattened sac, about two-thirds the length of the animal, suspended within the large central canal of the water-vascular system. The upper extremity of this sac terminates in a linear mouth situated on the upper surface of the body, while its lower extremity opens into the large canal in which it is inclosed, so that the products of digestion are (as in Actinia) at once admitted into the main cavities of the body, in which the functions of nutrition and respiration are carried on together. There also exist two other large cavities in the body connected with the water-vascular canals, which serve as receptacles for the tentacular apparatus, the use of which has caused much difference of opinion amongst writers on this branch of Natural History.

As far as I have been able to ascertain, nothing is certainly known as to the reproduction of *Cydippe*. Siebold (in his work on Comparative Anatomy) has stated that Mertens has observed detached corpuscles from the body of Cestum and Cydippe swimming freely about and rapidly enlarging, but that his observations were there limited. Professor Grant has imagined that he has detected ovaries, consisting of two lengthened clusters of small spherical gemmules, of a lively crimson colour, extending along the sides of the stomach; but his description of the anatomy of Cydippe is so inaccurate, that his remarks on its ovarian system are not to be relied on. Mr Robert Paterson of Belfast (who has written an excellent monograph on this Acaleph) has not been able to verify Dr Grant's observation, although he has examined several hundred specimens; but he has seen numerous transparent gemmules in the water in which Cydippes were kept. Agassiz states, that although he had kept Cydippe alive for months during the spring, he had never seen in any of them anything like ovaries or spermaries. He also writes that although he has watched Bolina through six successive months, from December to June, he had never succeeded in discovering the sexual system even in its most rudimentary state, and that of their embryonic development nothing is known; and yet these Acalephs frequently swarm in the seas both of Europe and America. The reproductive processes in several species of the pulmograde Acalephæ have been investigated with great success by Sars, Dalyell, John Reid, Steenstrup, and others. The Steganopthalmata (of which *Aurelia aurita*, the common "jelly-fish" of the Firth of Forth, is an example) at certain seasons of the year pour forth from their ovaries multitudes of germs, which affix themselves to shells and other bodies, and became many-tentacled hydraform polypes. These polypes, after multiplying by gemmation for many months, perhaps years, begin to resolve themselves by transverse fissure into minute medusæ, which undergo many changes before they arrive at their adult form and size. The Gymnopthalmata (those tiny naked-eyed medusæ which, visible to the naturalist alone, swarm in immense multitudes around our coasts) emit ova which are developed into polypes of various form, either single, as *Corymorpha*, or united together by creeping fibres or stems, in colonies of plant-like form, as *Clava*, *Coryne*, *Tubularia*, *Campanularia*. In spring, these zoophytes put forth buds, either from their polyparies or from the polypes themselves. The buds rapidly enlarge, and are developed into bell-shaped medusæ, which, after remaining attached for a short time to the parent stem, become detached, and flap themselves away in the surrounding water. The reproduction of these plant-like animals bears, indeed, a remarkable resemblance to that of the true plant. The flower of the plant produces a seed, the medusa of the zoophyte an ovum; the seed grows into a stem and leaves, the ovum into a stem-like polypary and polypes; the plant multiplies itself by suckers and bulbils, the polypary by stolons and gemmæ; the plant puts forth flowers, the polypary medusæ, which alone have true reproductive organs.*

* *Note on diœcious reproduction in Zoophytes.*—I have stated the development of medusæ from polypes, in accordance with the elegant expression of the fact first given by Dr Carpenter, but there is still some obscurity with regard to this subject. It is not correct to state generally, that *Campanularia*, *Tubularia*, *Coryne*, and *Clava* produce medusa-buds, although some varieties of all these species do so. Schultze has observed in *Campanularia geniculata*, in place of medusa-buds, the production of capsules filled with spermatozoa. The production of ova, and their direct development into young polypes, has been noticed in the ovarian capsules of *Tubularia indivisa* by Mummery. I have repeatedly seen large polyparies of *Coryne glandulosa*, all the polypes of which bore buds containing spermatozoa, developed from a stalk traversing the axis of the bud, the whole polypary being, in each case, unisexual and male. While in other polyparies of the same zoophyte, the reproductive buds were filled with ova also developed from the exterior of a hollow central stalk, a diverticulum of the alimentary canal; the entire polypary in these cases being female. In some species of *Clava*, the polypes (which are not separate as hitherto described, but attached together by a fleshy basis, investing a horny polypidum somewhat similar to that of Hydractinia, or by a slender creeping thread inclosed in a membranous sheath) bear reproductive capsules, some of which contain spermatozoa and others ova; but the polypes bearing male capsules are never found grouped on the same polypary with those carrying female capsules. I may state that many, if not all, the composite hydroid zoophytes are not only unisexual with regard to their individual polypes, but also diœcious, the male and female reproductive organs being always situated on different polyparies. I have already observed diœcious reproduction in *Coryne glandulosa* (Dalyell), *Clava*, two species, *Hydractinia echinata*, *Sertularia cupressina*, *Plumularia falcata*, *Campanularia lacerata*, *Sertularia rosacea*, and several others. I hesitated for some time to agree with Drs Allman and Carpenter in considering the marcescent reproductive capsules, which in some of these zoophytes appear at first sight to be mere sacs, filled with spermatozoa or ova, as homologous with the budding medusæ, in which the organs of sensation, locomotion, nutrition, and even of reproduction, are highly developed and distinctly differentiated, which maintain an independent life long after the decay of the polype from which they have budded, and some of which multiply themselves indefinitely by gemmation before their true sexual organs appear; but I am convinced, after careful examination of many genera, that this is nearly a correct view of the case. The peduncle of the medusa-bud appears to me to be homologous with the entire reproductive capsule (of *Coryne glandulosa*, &c.), and the umbrella to be a superadded organ, having the nature of a polypary or cœnosarc (Allman). Very lately I have found at the Scougal Rocks, near North Berwick, a very interesting *Coryne*, in which each polype of the cluster bore a single long cylindrical medusa-bud without tentacles. The peduncle consisted of a thick white mass nearly filling the umbrella, and was found to consist of an inner and outer coat (endoderm and ectoderm) widely separated from each other by a mass of well-formed spermatozoa; the two coats were united at the mouth,

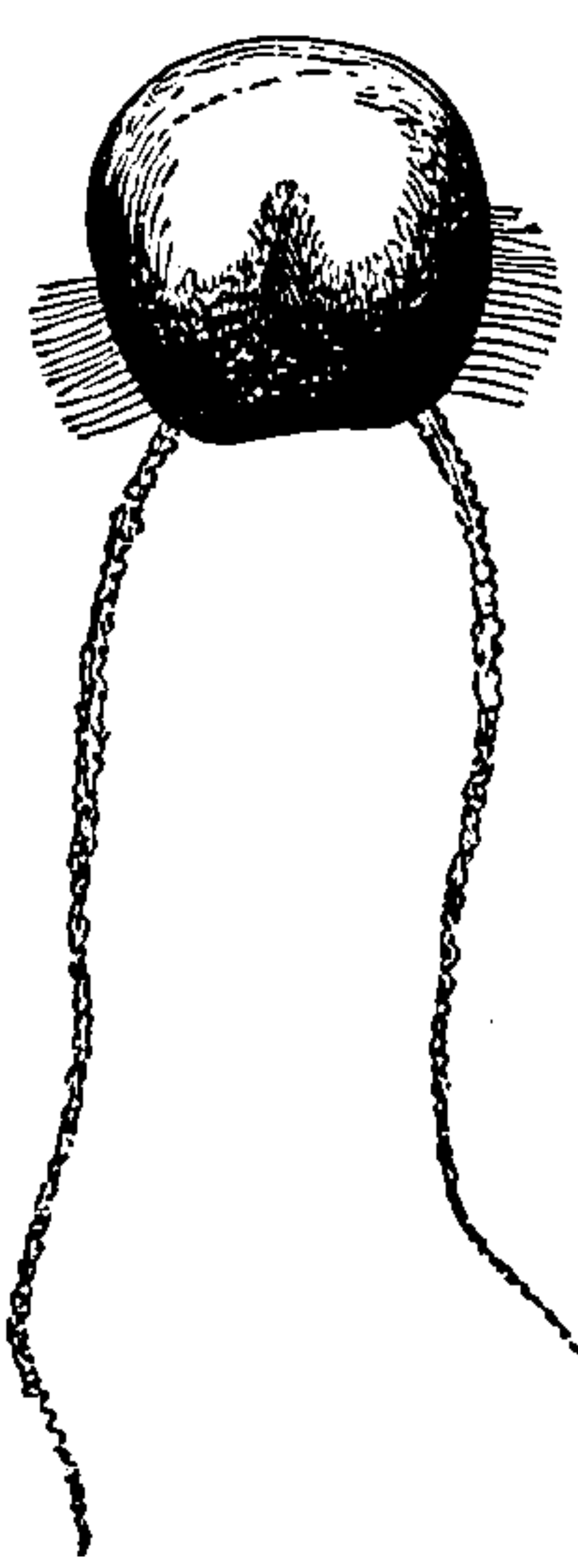
In fig. 4 the yolk has become irregular in shape by cleavage, granular, and opaque. In fig. 5 the embryo is elongated into an irregular cylinder, and is encircled by a wreath of long cilia, by which it is rapidly whirled round in the shell. In this stage it bears a close resemblance to the embryo of an annelid (Phyllodoce) when newly hatched. In fig. 6 the ciliary

Fig. 3. Fig. 4. Fig. 5. Fig. 6.



wreath of fig. 5 is broken up and divided into four bundles, the upper part of the embryo has become hyaline, by the gradual absorption of the yolk, and the tentacles have appeared, as simple granular threads, and destitute of the lateral cirri which adorn those of the adult. In fig. 7 (the newly-hatched Cydippe) the four bundles of cilia have extended themselves into short bands,—a still further absorption of the yolk has taken place; and the tentacles have become greatly lengthened. My observations were here arrested; all the young Acalephs died at this stage, which they attained in about five days. The Cydippe, when newly released from ovum, is still in a low state of development. I have not been able to detect in it either mouth or water-vascular canals; the ciliary bands are only four in number, instead of eight, as in the adult; the tentacles are not yet fringed; a considerable part of the yolk still remains to be absorbed, and is amassed at the lower extremity of the animal and about the ciliary bands, where the lateral tubes of the water-vascular system may be looked for. In this respect it bears a remarkable resemblance to the medusæ of some of the coryne-form polypes, in several species of which I have noticed that the walls of the radiating tubes, and those of the circular tubes round the mouth of the umbrella, are for some time after detachment, rendered opaque

Fig. 7.



by a layer of red granular matter, which is completely absorbed as the animal advances towards maturity. It is probable that the young Cydippe undergoes several changes before it arrives at maturity, but I was never able to find it again in its first or more advanced stages in the waters of Morecambe Bay. I had looked in vain for spermaries in several specimens of the adult in which there were no ova. It can, indeed, be scarcely said to possess even ovaries, as the eggs are not amassed together in groups, but are developed separately from the wall of the lateral tubes of the water-vascular system.*

This notice on the reproduction of Cydippe is, therefore, incomplete; but I have thought it advisable to bring it before the Society, as I may not have an opportunity of pursuing the inquiry farther, and it possesses some importance, in so far as it proves that the generative process in this class of acalephs is very different from that which obtains in the steganopthalmatous and gymnopthalmatous medusæ.

On the function of the tentacles.—The function of the tentacles in Cydippe has always been a *quæstio vexata* amongst naturalists. These magnificent appendages are generally found closely packed in two large canals communicating with the water-vascular system, and opening by wide apertures in the lower hemisphere of the body. When the Acaleph is floating at rest near the surface of the water, the tentacles are expanded, and depend from beneath, like long white curling plumes, to a distance of twenty times the length of the animal. Each of these organs consists of a single tubular thread, fringed on one side by numerous closely-set cirri, which are ranged parallel to each other like the teeth of a comb or the barbs of a feather. Their surfaces are crowded with minute thread cells, or stinging organs, and the whole apparatus is capable of being instantly retracted within its cell at the approach of danger. Blainville regarded the tentacles as instruments for the capture of prey. Patterson has contested this opinion, and believes that they

* Since the above was read to the Society, I have, through the kindness of Mr Goodsir, received the *Horæ Tergestinæ* of Will, who, in his account of the reproductive system of *Eucharis multicornis*, an acaleph allied to Cydippe, he describes the ovaries and spermaries as attached to opposite sides of the lateral water-vascular canals. He therefore makes these animals hermaphrodite, a fact which is open to doubt.

cannot be made to approach the mouth, as they are situated at the opposite extremity of the body. Dr Carpenter regards them as locomotive organs; but it is difficult to imagine how they can be used for that purpose. I had frequent opportunities of seeing these animals taking their prey at Morecambe Bay by the aid of their tentacles, and was delighted with the address they displayed in using these seemingly unmanageable appendages. The food of Cydippe was easily ascertained, as the stomachs of many of the specimens taken were packed with minute crustacea. To ascertain how the latter were captured, I threw one of them into a jar in which was a Cydippe which had evidently not dined that day. It was instantly caught by one of the tentacles. The Acaleph at once became very animated, and performed a series of somersaults until it had succeeded in hitching the tentacle which held its prey across the widely-gaping mouth as over a pulley. The tentacle was then contracted by successive jerks, until the morsel was hauled up to and dropped into the stomach. This experiment was frequently repeated, with precisely the same results, by myself and friends, with the same and other species of Cydippe.

38 Great King Street, 20th June 1856.

On two new Actinias. By T. Strethill Wright, M.D., Fellow of the Royal College of Physicians, Edinburgh. (Plate III.)

Actinia ornata.—*Body cylindrical, smooth, orange-brown, spotted with white; tentacles quinquiserial, four inner rows grayish-white banded with purple-brown, outer row half the length of inner rows, orange tipped with gray.*

I found this very showy Actinia in September last on the shore below South Corrigills, Isle of Arran. It inhabited small deep basins in the rock, situated nearly at high-water mark, and densely filled with a variety of algæ. When the algæ were pushed aside the brilliant colours of the Actinias rendered them very conspicuous, and at once assured me that I had discovered a new species. The largest specimens, when

ACTINIA BELLIS var. fusca.—*Disk and tentacles of a uniform brown.*

Actinia bellis, which is not described by Johnson as a native of Scotland, was found in great numbers in the rock-pools below South Corrigills. The common variety, with a variegated disk, described by Gaertner, Hassall, and Couch, was the more abundant; but a very beautiful one also occurred, the disk and tentacles of which were a pure unmixed brown of various shades. The body was white, pure pink, or pink marked with spots or crossing lines of white. This variety was very constant, and showed no disposition to diverge into the common one. In some of the pools these Actinias were assembled in large masses, and so closely packed together that their disks only were visible, and they were at first mistaken for a thick growth of algæ. They were never found intermingled with the other variety. In captivity both varieties proved very prolific; the young of the brown Actinia could be readily distinguished from the others by their dark disks, and by the brown lines with which their bodies were striated. These lines correspond to the internal longitudinal septa, and disappear with the increasing age of the animal.

38 GREAT KING STREET, 20th June 1856.

On the Double Salts of Cadmium and the Organic Bases.

By J. GALLETLY, Assistant to Dr ANDERSON, Glasgow University.

The double salts formed by combination of the simple salts of cadmium with those of other inorganic bases, which were first noticed by Croft,* have lately been extensively examined by Von Hauer† with interesting results; and Greville Williams‡ has shown that similar crystallizable compounds are formed with the organic alkaloids; but as he has not followed out the subject, I have considered it advisable to analyse several of these salts, to see whether their formulæ are uniform and similar to those of the inorganic salts.

* See Gmelin's Chemistry, vol. v.

† Chemical Gazette, June and Nov. 1855, and Jan. 1856.

‡ Ibid., Dec. 1855.

According to Von Hauer, all the known cadmium double salts may be arranged into the three following groups:—

I.	$2\,R\,Cl + Cd\,Cl + x\,HO$
II.	$R\,Cl + Cd\,Cl + x\,HO$
III.	$R\,Cl + 2\,Cd\,Cl + x\,HO$

in which R represents potassium or some other metal. None of the salts in Croft's last paper* form exceptions. Of the organic salts, several agree with the two latter formulæ; but it will be seen that in general they form compounds with much larger proportions of chloride of cadmium.

Lutidine Salt.—This salt appears in thick groups of short feathery crystals, easily got from concentrated solutions. It is very soluble. On analysis

I. { 7·849 grains dried at 212° gave
5·737 ... carbonic acid,
1·852 ... water.

In a new preparation

II. { 9·150 grains substance gave
6·781 ... carbonic acid,
2·060 ... water.

A different preparation gave

III. { 6·015 grains substance,
8·220 ... chloride of silver.

	Experiment.			Calculation.		
	I.	II.	III.			
Carbon,	19·93	20·21	—	20·10	C_{14}	84
Hydrogen,	2·62	2·50	—	2·39	H_{10}	10
Nitrogen,	—	—	—	3·35	N	14
Chlorine,	—	—	33·81	33·97	Cl_4	142
Cadmium,	—	—	—	40·20	Cd_3	168
				100·00		418

the formula being $C_{14}\,H_9\,N, HCl + 3\,Cd\,Cl$; and there is no loss at 212°. As this does not agree with any of Von Hauer's, I tried to get salts of a different composition by using the

* Chemical Gazette, April 1856.

hydrochlorate of lutidine in large excess; but always where a salt separated, its analysis showed it to have the composition stated above. In one experiment I used a very large excess of the hydrochlorate of lutidine, and left the concentrated mixture over sulphuric acid for weeks, but without any appearance of crystallization.

Nicotine Salt.—The nicotine was dissolved in hydrochloric acid, chloride of cadmium added, and the mixture left over sulphuric acid; the salt lines the beaker in dense short tufts. It is readily soluble in water and recrystallizes without decomposition. It loses no water at 212°. The analyses were

I. { 9·704 grains substance gave
6·075 ... carbonic acid,
2·174 ... water.

A different preparation—

II. { 8·733 grains gave
5·480 ... carbonic acid,
1·937 ... water.

A portion was burned with soda lime for nitrogen—

III. { 9·773 grains substance gave ammonia to neutralize 23 measures sulphuric acid, each equivalent to ·01609 nitrogen.

IV. { 7·835 grains gave
11·018 ... chloride of silver.

	Experiment.				Calculation.		
	I.	II.	III.	IV.			
Carbon,	17·07	17·11	—	—	17·33	C_{20}	120
Hydrogen,	2·49	2·46	—	—	2·31	H_{16}	16
Nitrogen,	—	—	3·79	—	4·04	N_2	28
Chlorine,	—	—	—	34·83	35·89	Cl_7	248·5
Cadmium,	—	—	—	—	40·43	Cd_5	280
					100·00		692·5

The formula being $C_{20}H_{14}N_2, 2HCl + 5CdCl$.

Toluidine Salt.—This salt separates in small shining scales, which radiate from a centre if the crystals are slowly formed. They are very soluble. In the water-bath they lost 1·15 per

giving the formula

$$C_{46}H_{25}NO_{16}HCl + CdCl + 2HO.$$

The air-dried salt would appear to contain another atom of water,

$$\begin{cases} 1{\cdot}529 \text{ grains lost at } 212^\circ \\ {\cdot}151 \quad \ldots \quad \text{water.} \end{cases}$$

equal to 2·00 per cent., the theory being 1·55 for the formula

$$C_{46}H_{25}NO_{16}HCl + CdCl + 3HO.$$

Morphia.—The results with morphia were so variable that I only made one or two experiments. The first combustion approached the formula

$$C_{34}H_{19}NO_6HCl + 7CdCl + 4HO.$$

	Experiment.	Theory.
Carbon,	20·87	20·44
Hydrogen,	2·82	2·40

This was probably a mixture. The second salt which was made with chloride of cadmium in considerable excess, appeared in white silky crystals like the muriate of morphia. They lost no water at 212°, and gave the carbon and hydrogen of the formula

$$C_{34}H_{19}NO_6HCl + 2CdCl + 5HO.$$

	Experiment.	Theory.
Carbon,	37·08	37·12
Hydrogen,	4·65	4·55

In another experiment I mixed the salts in the proportion required for the above formula, and found the salt which crystallized out to give carbon 60·43 per cent., hydrogen 6·58, numbers nearly theoretical for muriate of morphia.

Piperine.—The product with piperine, which requires that the materials be dissolved in alcohol, was in tufts of long straw-coloured needles. The analysis agrees with the formula

$$C_{68}H_{36}N_2O_{10}2HCl + 9CdCl + 6HO,$$

the results being

	Experiment.	Theory.
Carbon,	27·08	27·16
Hydrogen,	3·19	2·93

As these numbers could not be reduced to a more probable formula, and the preparation of the salt was somewhat difficult, I did no more with it.

In the preparation of these salts, except where otherwise stated, I mixed the materials at random, generally aiming at keeping the chloride of cadmium in excess, and except in the case of morphia, always appeared to get the same salt again and again.

Before finishing this paper, I have to thank Dr Anderson, in whose laboratory I analysed these salts, for affording me every facility in their examination, and for portions of the pure alkaloids from his specimens.

A different salt—

II. { 8·730 grains dried at 212° gave
9·115 ... chloride of silver.

	Experiment. I.	Experiment. II.	Calculation.		
Carbon,	41·22	—	41·24	C_{40}	240
Hydrogen,	4·95	—	4·81	H_{28}	28
Nitrogen,	—	—	4·81	N_2	28
Oxygen,	—	—	5·50	O_4	32
Chlorine,	—	25·81	24·40	Cl_4	142
Cadmium,	—	—	19·24	Cd_2	112
			100·00		582

The formula of the salt dried at 212° being

$$C_{40}\,H_{24}\,N_2\,O_2\,2\,H\,Cl + 2\,Cd\,Cl + 2\,HO.$$

The crystals contain in addition four atoms of water.

{ 9·243 grains air-dry, lost at 212°
·513 ... water.

equal to 5·55 per cent., and 5·82 is required by theory for the formula

$$C_{40}\,H_{24}\,N_2\,O_2\,2\,H\,Cl + 2\,Cd\,Cl + 6\,HO.$$

Cinchonine Neutral Salt.—When neutral hydrochlorate of cinchonine is added to chloride of cadmium, this body separates as a white sticky mass, which, on standing for a day, passes into large transparent crystals, resembling cinchonine itself. It is a very insoluble salt.

I. { 5·226 grains, dried at 212°, gave
10·268 ... carbonic acid
2·711 ... water.

A new salt—

II. { 7·760 grains gave
5·033 ... chloride of silver.

	Experiment.		Calculation.		
	I.	II.			
Carbon,	53·58	—	53·93	C_{40}	240
Hydrogen,	5·91	—	5·84	H_{26}	26
Nitrogen,	—	—	6·29	N_2	28
Oxygen,	—	—	5·39	O_3	24
Chlorine,	—	16·04	15·96	Cl_2	71
Cadmium,	—	—	12·59	Cd	56
			100·00		445

The formula being

$$C_{40}\ H_{24}\ N_2\ O_2\ H\,Cl + Cd\,Cl + HO.$$

The air-dried crystals contain four atoms more water.

8·320 grains lost at 212°
·560 ... water,

equal to 6·73 per cent., and 7·48 is required for the formula

$$C_{40}\ H_{24}\ N_2\ O_2\ H\,Cl + Cd\,Cl + 5\,HO.$$

Strychnine Salt.—This compound precipitates in the form of small white scales. It is only slightly soluble in cold water, and not much more so in boiling water, from which it crystallizes either in long needles or groups of large transparent prisms. It loses no water at 212°.

I. { 5·804 grains substance gave
9·810 ... carbonic acid,
2·300 ... water.

A new preparation—

II. { 5·696 grains gave
9·543 ... carbonic acid
2·354 ... water.

Another salt gave

III. { 3·700 grains substance
2·850 ... chloride of silver.

	Experiment.			Calculation.		
	I.	II.	III.			
Carbon,	46·09	45·69	—	45·53	C_{42}	252
Hydrogen,	4·40	4·59	—	4·16	H_{23}	23
Nitrogen,	—	—	—	5·06	N_2	28
Oxygen,	—	—	—	5·78	O_4	32
Chlorine,	—	—	19·06	19·24	Cl_3	106·5
Cadmium,	—	—	—	20·23	Cd_2	112
				100·00		553·5

rentrés à partir de la base, et dilaté sur le reste ; à double carène en dessus, se joignant à l'énorme crochet qui le termine et qui est très acère ; mandibule supérieure légèrement convexe, l'inférieure très retroussée, aussi tranchante que la supérieure dans laquelle elle s'emboite, la majeure partie de sa base emplumée en dessous, excepté vers l'angle, ou se trouve une peau nue qui s'élargit davantage derrière la supérieure, mais qui se termine en dessus du niveau de l'œil dont les paupières sont également nues. Front emplumé jusqu' au bord du bec ; narines percées en fissures très étroites en deça de chaque carène. Dessous du bec garni d'une peau membraneuse, dénudée seulement de deux pouces vers le bout. Ailes longues, amples, à 3^{me} rémige la plus longue, dépassant la 2^{e} de 2 centimes ; les plus rapprochées du corps aussi longues que les primaires, larges, et toutes terminées en pointe, atteignant à 4 cent. ½ de l'extrémite de la queue : cette dernière composée de 12 rectrices larges et terminées en pointe. Tarses et doigts longs, la jambe emplumée sur la moitié de sa longueur ; le reste réticulé ainsi que la majeure partie des doigts dont la partie supérieure seule est garnie d'écailles. Point de membrane à la base de ses derniers dont le médian est le plus long ; l'interne plus court que l'externe ; pouce très long et au niveau de la plante ; ongles moyens, lisses et tranchants sur la partie interne de celui du milieu surtout. Occiput garni de plumes assez longues, pointues, à barbes lâches comme celles des oreilles et du cou, simulant une huppe.

Tête, et généralement toutes les parties supérieures, couleur d'ardoise plus ou moins foncée, tirant sur le vert dans certaines parties ; devenant d'un gris cendré sur toutes les inférieures à partir du dessous du bec, les plumes du bas du cou et du thorax qui sont plus longues que les autres, sont plus ou moins flammèchées de couleur ardoise au centre, et toutes bordées de cendré très clair, parfois même blanchâtre ; celles du thorax, et surtout des côtès de cette partie sont d'une teinte plus foncée et ont cette même coloration verte du dos, teinte qui à une certaine lumière parait poudreuse. Sur la partie supérieure du dos on remarque un bon nombre de plumes bordées de cendré plus ou moins clair ; plumage qui rappèle en quelque sorte celui du *Nycticorax violaceus* de l'Amérique, surtout sur les ailes et les scapulaires. Les rémiges et les rectrices sont d'un ardoise uniforme et aussi poudreux que sur les autres parties suivant la lumière, mai le dessous est plus cendré, et il en est de même pour leurs couvertures inférieures. Celles du dessous de la queue qui en atteignent les trois quart, sont d'une nature molle et décomposée, simulant un peu, dans leur milieu surtout, celles des *Leptoptilus*, avec lesquels cet oiseau a la plus grande analogie, car il représente dans cc groupe ce que représente dans celui des *Ardea*, le genre *Cancroma* d'Amérique :—

	Cent.	Mill.
Longueur totale depuis le bout du bec jusqu' à l'extrémité de la queue en suivant la courbure du crochet, ...	139	0
Plumes formant la huppe occipitale, dont le nombre est assez restreint, longues de 10 cent, sur les plus allongées, mais variant de taille. Les nouvelles qui étaient encore courtes, portaient au centre cette teinte d'ardoise foncée avec un reflex vert qui s'observe sur d'autres parties, mais plus terne qu'ailleurs :—		
Longueur du bec à partir du bout du crochet en suivant la ligne du dessus, ...	23	0
Do. sur les côtés jusqu' à l'angle, ...	23	5
Do. de la base de la mandibule supérieure en dessus d'un angle à l'autre, ...	14	0
Do. du milieu de la mandibule supérieure, prise d'un bord à l'autre, .	13	4
Do. du bout de la mandibule inférieure jusqu' à l'angle en suivant la courbure, ...	21	3
Do. de la base en passant par dessous dans la partie la plus large et mesurée au bord de la partie tranchante, ...	16	3
Do. de l'extrémité prise en dessous d'un tranchant à l'autre, . .	4	0
Do. du dessous au milieu jusqu' à la peau nue qui la recouvre, .	3	2
Hauteur de la peau nue qui se trouve entre le front et la commissure, ...	4	3
Largeur de la même en avant de l'œil, ...	1	5
Longueur de celle de la mandibule inférieure qui va en mourant jusqu' aux plumes, ...	1	5
Longueur de l'aile fermée, ...	67	0
Do. de la queue, ...	27	0
Do. de la jambe avec les plumes, ...	30	0
Do. depuis les plumes, ...	12	0
Do. du tarse, ...	24	0
Do. du doigt du milieu avec l'ongle, ...	17	4
L'ongle, ...	2	5
Do. externe avec l'ongle, ...	15	5
L'ongle, ...	2	3

	Cent.	Mill.
Longueur du doigt interne avec l'ongle, ...	13	0
L'ongle, ...	2	5
Do. du pouce avec l'ongle, ...	9	5
L'ongle, ...	3	0

" Cette description repose sur un sujet venant du Nilblanc, mais sans désignation de sexe. Par la composition de son plumage, il est à présumer qu'il n'était pas encore arrivé à son état parfait, car il était facile de remarquer que dans les nouvelles plumes les bordures étaient plus blanchâtres et plus étroites, excepté dans celles des parties latérales du thorax, ou la bordure parait rester plus large.

" Dans cet individu, le bec qui avait un fond jaunâtre plus ou moins foncé et plus ou moins lavé de brun-roussâtre, portait un grand nombre de taches brunes et même noirâtres irrégulièrement distribuées, le bout du bec qui formait un énorme crochet à la mandibule supérieure et qui paraissait rajouté comme dans les *Diomedea*, était d'un brun plus foncé qui se répétait sur l'extrémité de l'inférieure ; il était facile de voir, que comme dans ces derniers, la base de la mandibule inférieure était sujette à une grande dilatation, et que la peau du dessous du bec était également susceptible d'accomplir la même fonction. L'œil, qui comme nous l'avons dit, est assez grand et entouré d'une paupière dénudée, à l'iris d'un brun foncé.

" Nous ajouterons que cet oiseau ne se rencontre généralement que par paire; que son habitat parait assez limité, et qu'il fréquente les plaines marécageuses, là ou se trouvent les tortues qui forment la base de sa nourriture. Comme les *Leptoptilus*, ces oiseaux ont des heures fixes et réglées pour leur deplacement, et cela, suivant les saisons. Il n'est donc pas rare de voir la paire de *Balœniceps* posée sur une seule patte sur la sommité d'un vieux tronc ou sur une roche élevée, et y rester des 4 où 5 heures immobiles, attendant que les rayons du soleil aient fait sortir de la vase les tortues qui aiment également à venir s'y réchauffer. Dans cette pose, le cou est tout-a-fait rentré, et leur énorme tête repose sur les épaules. Mais dès que le moment de la péche est arrivé, ils se transportent d'un vol léger sur un tertre garni de roseaux,

qui peut servir à en déterminer le nombre si rien ne vient les en détourner.

"Espérons que les naturalistes voyageurs qui se trouveront assez fortunés pour parcourir ses countrées si riches encore en histoire naturelle, viendront remplir les lacunes qui existent encore, et fixer enfin l'opinion que nous émettons sur la place que nous venons de lui donner dans l' échelle des êtres. Heureux serons nous si elle se trouve justifiée !"

The late James Wilson, Esq. of Woodville.

Mr James Wilson was the youngest brother of the late Professor Wilson, and was born at Paisley in November 1795. At his father's death, which occurred when he was about two years old, the family removed to Edinburgh, and in due time he went through the customary school and college classes, which then formed the recognised curriculum of a liberal education. He became apprentice, about 1811, to Mr William M'Kenzie, Writer to the Signet, but, from delicacy of health, did not follow out the profession. The love of Natural History displayed itself in early boyhood ; and whilst yet very young, he had made a considerable collection of birds and insects. Literature, however, divided his pursuits with science. He was specially fond of imaginative works, and read largely both grave and humorous authors. The circle of which Professor Wilson was so great an ornament, gave his brother, who ardently admired the genius of the head of his family, an opportunity of meeting many of the most famous literary men of his time, and a peculiar vein of subtle wit and curiously grotesque humour, which characterized the subject of our sketch, made him a welcome addition to every social circle. The following description of Mr Wilson in early manhood, by the late J. G. Lockhart, Esq., is taken from his famous volume, "*Peter's Letters to his Kinsfolk.*" All who knew Mr Wilson as a young man, bear witness to the fidelity of the portrait.

"I dined with Professor Jameson yesterday, with a small party of his most distinguished pupils. Among these, there was one whom the Professor particularly introduced me to, a Mr James Wilson, brother to the poet. This young gentleman follows the profession of a Writer to the Signet (which, as I have told you, is the name for the highest class of attornies in Edinburgh), but forms, as Mr Jameson assured me, a brilliant exception to the neglect with which matters of science are commonly treated by the members of the profession. He is very young, many years junior to his more celebrated brother, and no casual observer would suspect them to be of the same family. I have already described to you the exterior of the poet. James is a thin, pale, slender, contemplative-looking person, with hair of rather a dark colour, and extremely short-sighted. In his manners, also, he is as different as possible from his brother; his voice is low, and his whole demeanour as still as can be imagined. In conversation, he attempts no kind of display, but seems to possess a very peculiar vein of dry humour, which renders him extremely diverting. Notwithstanding all these differences, however, I could easily trace a great similarity in the construction of the bones of the two faces; and, indeed, there is nothing more easy to imagine than that, with much of the same original powers and propensities, some casual enough circumstances may have been sufficient to decide that the one of the brothers should be a poet and the other a naturalist. The parts of the science of which Mr James Wilson is fondest, are ornithology and entomology—studies so delightful to every true lover of nature, that I suspect they are, in some measure, familiar to every poet who excels in depicting the manifestations, and in tracing the spirit of beauty in the external universe. Professor Jameson, indeed, informed me that his young friend is, in truth, no less a poet than a naturalist, and has already published several little pieces of exquisite beauty, although he has not ventured to give his name along with them."*

* "Peter's Letters to his Kinsfolk," vol. i., pp. 256-258.

In 1816 he made a tour on the Continent, visiting Holland, part of Germany, and Switzerland. Soon after he visited Paris, acquiring the friendship of several eminent scientific men there. On this occasion, according to information communicated to us, he was intrusted with the purchase of a collection of birds for the Edinburgh Museum, known as the Dufresne Collection. It was afterwards arranged by him, and now constitutes one of the most attractive series of objects in the Museum. In 1819 he made a tour in Sweden, and soon after his return symptoms of the pulmonary complaint which ultimately proved fatal first showed themselves. He went in consequence to Italy, where he resided during the winter of 1820–21, but for the next three years his health continued very delicate.

This period, we believe, formed a crisis in Mr Wilson's life. His natural character was a very fine one. Simplicity, modesty, truthfulness, earnestness, and gentle affection, had always been conspicuous in it. He had a clear, penetrating intellect, an excellent memory, a quick fancy, a poetical imagination, and a high moral aim. But his long illness led him to reflect deeply on the true ground of all high morality, and a deepened interest in religious subjects, and a more open confession of faith were manifest from this time, although his extreme unobtrusiveness and reserve upon sacred things prevented his giving a spoken testimony to the truths which influenced his heart and life, except to the members of his home-circle. In 1824 he married Isabella, daughter of the late William Keith, Esq., and settled down to a life of scientific and literary labour.

We cannot do more on this occasion than refer to him as a man of science. Only his great modesty kept his reputation from being much wider than it was. In spite, however, of his aversion to display, he could not avoid becoming known as a highly accomplished naturalist; and we know on the best authority that, after the death of the late Professor Edward Forbes, the chair of natural history was offered to Mr Wilson, but declined by him. He was an acknowledged authority on entomology, and scarcely less distinguished as an ornithologist

a boat with as much care and kindness as if she had been an aged duchess. And the feelings of servants, which many so-called ladies and gentlemen have no scruple in outraging, to him were as sacred as those of their most high-born mistresses.

Children came in for a large share of his affection, and, after they had been lavishly cared for, there was still a mighty surplus of kindness to expend upon the lower animals. The characteristic love of a naturalist for dumb animals showed itself in him like a human affection. In his early invalid days the walls of his sick-chamber were hung around with bird-cages containing his favourite songsters. We have heard him tell of a *pet* glow-worm which rather than desert he carried with him on a long tour through the Highlands; and all the wild singing birds to whom Woodville was a freehold knew him as their friend and benefactor. For the following more particular estimate of Mr Wilson's character we are indebted to one who had the fullest opportunity of studying it.

His knowledge of art and its literature was considerable; the latter he had carefully studied in the works both of English and Italian authors, and his love for this subject continued unabated. His admiration of Mr Ruskin's works may be mentioned as a proof of this, although that admiration was, no doubt, enhanced by his sympathy with that author's exquisite appreciation of nature, and his enjoyment of the beauty of his style. The last book he read was the fourth volume of "Modern Painters," and the last extracts made in his commonplace book are from that work.

He drew accurately and gracefully, his practice of the art being confined, however, to illustrations of natural history; but his great enjoyment of collections of paintings, both in this country and abroad, and the accuracy of his judgment on works of art, proved that his deep feeling of the subject, and his knowledge of its details, were greater than his powers as an artist.

His love of nature and natural scenery was intense. Many passages in his published works attest this; but his private letters, written during tours in the Highlands, and often in unfavourable circumstances for composition, show not only how deep this love was, but mark also with what ease and graphic power he could describe what thus awakened all the poetic and artistic feelings of his heart.

The power of concentrating his mind on any subject he was engaged in was remarkable. Many of his papers were written when some one was reading aloud in the room; and unless when engaged in any calculation, no interruption seemed to disturb him, or prevent his returning to his studies as if nothing had occurred. He had evidently pleasure in writing on his favourite subjects; and this, combined with great power of steady application, enabled him to persevere in any work he undertook, to a degree sometimes, it was feared, prejudicial to his health.

In a mind so gifted with imagination and fancy, it is not common to find such logical accuracy and love of methodical arrangement as were possessed by the subject of this sketch. These were shown both in his studies and his domestic arrangements, and it was often remarked that his judgment of the mental characteristics of others was much influenced by his quick perception of their habits of accuracy in observation or research. There are several names now eminent in science which he foretold would become so, when the owners were young; and it is recollected that this was foreseen, not so much from their evidencing an early taste for natural history, as from a combination of this with careful scientific accuracy. From his pleasant style of writing, he was certainly a "popular author" on scientific subjects, but he had rather a dislike to the title, connecting the term as he did with loose scientific ideas; and he never seemed to feel sure of any young person attaining the rank of a real naturalist, till he had shown some steadier pursuit of the science than is evinced by being what he used to call "a field naturalist."

His playful wit and humour are almost as well known as his literary powers; but, obvious as these are in his writings, and admired as they were in society, it was at home that he gave free scope to this faculty, and never was he so brilliant and overflowing with wit or fun as when alone with his family.

As is frequently the case, this cheerful humour was combined with deep pathos, and an almost feminine tenderness and delicacy of mind and heart. He seemed to have an instinctive power of understanding and sympathizing with the feelings of others; and this gift was employed by him not only in soothing and comforting those in sorrow, but in making peace where any misunderstanding had arisen among others. Contention of any kind was most distasteful to his spirit, and many may remember the way he had of parrying or turning aside, by a playful remark, aught that might wound or even jar upon the feelings of others. "No one," it has been truly said, "could quarrel with James Wilson;" sensitive as his nature was, he was so totally free from selfishness in any shape or disguise, that he never seemed to feel any difficulty in passing over or forgetting an accidental slight or neglect; and had a serious misunderstanding ever arisen between him and any one, his truly Christian spirit would have enabled him to forgive as he hoped to be forgiven.

In a private letter written two days before his death by one well qualified to judge of his character and abilities, it is said, "There are very few like James Wilson in the world, and he will be an irreparable loss to all who know him. So genial a disposition, so warm a heart, so strong and clear an intellect, and so pure a mind, with such fancy and power of eloquence, are rarely found in combination; and it must be deep consolation to you all to know that his religious character is no less remarkable than his natural."

His love of literature was as early shown as his taste for science. The writings of Wordsworth exercised a deep influence on his mind from his youth upwards, and Milton, Wordsworth, and Coleridge, remained to the last his favourite poets.

The contributions of Mr Wilson to the literature of science were greater than is generally known even to its most diligent students. To the seventh edition of the *Encyclopædia Britannica* alone, he furnished a whole volume of articles, amounting to 649 pages, viz.—

formed to play their own peculiar parts in the great economy of the world—and all showing forth the beneficence and almighty power of their Creator. Thus it was that he did not form any system of his own, or attempt to vary those of others, so as to suit his own views; but when a systematic arrangement had to be made use of, he preferred taking that of another, making it the artificial index to his work. Entomology was, I believe, his first study, and continued to be a favourite to the last. Next to that, ornithology; and it is probably in this latter branch that his pen has been more frequently used, either to illustrate some favourite subject of his own, or to assist friends by a notice of their works. We have said he took a broad view of nature; but his information did not show itself—did not come out as it were—until the subjcct was fairly entered upon. To know his information, it was necessary to know himself. A naturalist looking at some one branch, might find him at a loss in some of its parts; but when the general matter was taken up, the reverse would in all probability be the result. At the same time, his power of observation was good, and he never *despised* entering upon the minuter structures when opportunity served. There is a good example of this in an early paper in the *Trans. Wern. Society*, 'Concerning the early state of the Common Frog.' Facts regarding seasonal or sexual changes, habits, influence of climate, confinement or domestication—were thought equally worthy of attention; and the results are brought out in some early papers, such as 'Observations on the Genus Mergus,' the sexes of which were long kept as so many species, from the diversity of the colours of their plumage; or in a later series of essays 'On the origin of our Domestic Animals,' which join the acquirements of the scholar and historian to those of the physiologist and naturalist. In his more strictly scientific 'Illustrations of Zoology,' we have now and then his views of system and arrangement expressed. Some of the figures of this work were published just at the time when 'Natural Systems' of all kinds and Quinarian arrangements were in fashion; and speculations, which he characterized truly as 'more likely to be distinguished by ingenuity than accuracy,' were widely entered upon. These were gently reviewed; and throughout this work, pleasantly written, will be found a great deal to prove the accomplished scientific zoologist.

"I think that James Wilson possessed all the qualifications required for the study of natural history; but his various avocations, both domestic and public, did not allow the drier or more systematic parts to be so elaborately worked out. As a naturalist, his name will stand as taking the far more difficult part of applying scientific knowledge to what was practical and useful, and of improving thereby our commerce and manufactures. It was for this that he was so frequently consulted in all our great Fishery Questions; and this will be found to run through all the more important separate works and papers he has published."

Dr Fleming also, who had long known and esteemed Mr Wilson, has furnished the following clear and pleasing account of his position among Naturalists:—

"I need not surely make any reference to his social qualities, quiet humour, great discernment, sound judgment, unimpeached integrity, prudence, and Christian philanthropy. These prominent features in his character were well known to a wide circle of friends, whose confidence he fully enjoyed; and many of whom are ready, I have no doubt, to bear testimony, who have had more numerous opportunities of observation than fell to my lot. In reference to his position as a man of science, his claims to occupy a distinguished place among Scottish naturalists will be readily conceded. In the truly extensive field of natural science, he selected, as the more particular subject of his studies, the animal kingdom, and especially devoted himself to Ornithology and Entomology. The Museum of the University owes much, in these departments, to his sound judgment and zeal. Without aiming, as a zoologist, at the rigid discriminating precision of the Linnæan school, he carefully avoided the unsatisfactory diffuseness of that of Buffon. While his poetical temperament inclined him somewhat to the latter, his practical sagacity imposed suitable limits. His writings were therefore always readable and instructive, furnishing an excellent example of a popular style. In proof of this view, reference may be made to his 'Illustrations of Zoology,' or his paper on our Domesticated Animals in the 'Quarterly Journal of Agriculture.'

"His fondness for angling naturally led him to investigate the habits of the fish which furnished his sport, and to this branch of study he devoted a considerable share of attention. He had examined carefully the various questions which related to the salmon fisheries, whether in reference to the growth of the species or the legislative enactments regulating its capture. In like manner, he had devoted much time and thought in considering the breeding-grounds, the growth, and the capture of the herring. His labours in connection with the Fishery Board, of which he was appropriately a commissioner, and one qualified to give an opinion, were of an important kind. It is to be hoped that the inquiries in which he was engaged respecting the spawning-grounds and the distribution of the fry will still be prosecuted by some qualified member of the Board.

"Perhaps the most valuable tribute to his memory would be secured by the publication of his scattered papers in various periodicals. In themselves they are valuable, and, if collectedly published, would add greatly to the stability of his reputation."

Dr Fleming's thorough acquaintance with all questions affecting our Scottish fisheries gives special weight to his judgment on Mr Wilson's labours in connection with these. The amount, indeed, of purely gratuitous service which the latter rendered to his country in connection with the salmon, cod, and especially the herring fisheries, as sources of national wealth, and of honourable livelihood to thousands of persons, besides being nurseries of hardy, yet wonderfully civilized and gentle seamen, can be appreciated by very few, for these, like all his other good deeds, he was careful to conceal.

His latest scientific papers, one entitled "Scottish Fisheries," in *Blackwood's Magazine* for March 1856, and the other on "Fish-Ponds and Fishing-Boats," for May of the same year, were devoted to these subjects. The preparation of his articles on kindred topics in the *Encyclopædia Britannica* would of it-

they too sadly know, how wrathful and ruthless is the power of that great destroyer."—(*Blackwood's Magazine, March*, p. 328.)

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" 'The weary ploughman plods his homeward way,"

but seldom fails to find it. The

'Swinked hedger at his supper sits,'

and soft is the mossy bank beneath him, and sweet the air around, redolent with the balmy breath of flowers, and filled with the melody of birds singing their evening hymn. How rarely does the extinction of life from other than natural causes overtake these dwellers on the land, compared with the frequent fate of those who do business in the great waters! How astounded would be the natives of our inland vales, and the shepherds on a thousand hills, if ever and anon their hitherto steadfast and enduring boundaries were rent by earthquakes, and, literally "adding field to field," one fine piece of pasture was lifted up and laid upon another, entombing for ever alike the corn and its cultivators, the shepherds and their sheep. No very pleasant greetings in the market-place would ensue among the grain-merchants, wool-growers, and cattle-dealers, when the morning's news might chance to be—that the Lammermoors had subsided 1500 feet, and were entirely under water; that "Eildon's triple height" had been turned over, peaks downmost; that the debris of Penicuik was scattered over the vestiges of Peebles; and that the good town of Dalkeith was lying (its fine body of militiamen fast fossilizing) at the bottom of a coal-pit. Yet equally disastrous, though not quite similar, calamities not unfrequently befall those whose precarious lot it is to cultivate the sea."—(*Ibid.*, p. 329.)

And here is the concluding eminently characteristic passage of the paper in which the anonymous author of the article "Scottish Fisheries" in *Blackwood* deals with the anonymous author, *Alter et idem*, of the article "Fisheries" in the *Ency-*

clopædia Britannica, and with mirthful gravity admonishes and patronizes himself.

"The author of the treatise on 'Fisheries' in the current edition of the *Encyclopædia Britannica* has presented us with an ample and accurate exposition of his subject, with which he is no doubt well acquainted. He appears to us to be rather long-winded on the history and habits of the salmon and its smolts, whether one year old or two; but this is probably one of his hobbies, and as it may be also a favourite topic with a numerous class of curious and inquiring readers, and has recently assumed additional importance in connection with the artificial breeding of the finest of our fresh-water fishes, our ingenious author's time and labour have probably been by no means misbestowed in its elucidation."—(*Ibid.*, p. 349.)

The poems referred to by Mr Lockhart as published in early life by Mr Wilson, he also mentions appeared anonymously. They have long been lost sight of by his friends, and in his later years he always disavowed the title of poet, although acknowledging great love for poetry. His mind was, however, essentially a poetical one; and he strongly sympathized with that comparatively small class of scientific men who find food for the imagination as well as for the intellect in their studies, and employ both in prosecuting them. He was not more poetical than devout. Brought up in the Church of Scotland, and latterly an office-bearer in it, he cast in his lot with those who left it in 1843; and, as one of the elders of Free Greyfriars, under the pastoral charge of his relative, the Rev. John Sym, he took an active part in all the Christian schemes of the Free Church, of which he was an attached adherent.

The death in January 1855 of Mr Sym, to whom he bore the sincerest affection, greatly distressed him, and from a severe pulmonary attack which followed this bereavement he slowly recovered, never to regain his former health. In the succeeding September a sharp attack of rheumatic gout brought him down still farther, and his health continued very delicate throughout the winter, but no apprehensions of immediate danger were entertained till within a fortnight of his death. He was then seized with great difficulty of breathing, which rapidly increased, so as to render him unable to lie down, or to use the slightest exertion. His sufferings were great, but his patience was greater. Neither murmur nor complaint ever crossed his lips. When able to articulate, which was only occasionally, his expressions were of thankfulness for his mercies, and of thoughtful consideration for those around him. He knew that recovery was hopeless, and shortly before his death calmly arranged all his affairs, leaving messages for his friends, and mingling with them announcements of his faith in Christ crucified as the only ground of hope. Nearly the last words he uttered were—"Eye hath not seen, nor ear heard, neither hath it entered into the heart of man to conceive the things which God hath prepared for them that love him." And not long after this utterance, at early dawn on Sunday, May 18, 1856, he fell asleep in Jesus, so calmly that those around him knew not when he departed to be for ever with the Lord. So passed away one of the most gentle and excellent of men, to join the ever-increasing cloud of witnesses, and add another to the list of students of science who "count all things but loss compared with the excellency of the knowledge of Christ Jesus our Lord."

legs of a spirit-level; both were supplied from the same source. We believe, however, after all, that a similar connection does not exist between the two works before us. Whatever Dr Zeising may be, we know Mr Hay to be a good man and a true. His writings have been long familiar to us: the present is, in fact, his thirteenth publication on kindred subjects.

The question discussed by these two authors is not that of beauty in the abstract; it is not whether the fat lady of the Chinese ought to please the eye rather than the less adipose ladies of our own country, or whether it be really true, as asserted by Prince Pückler Muskau, that the sallow Asiatic is the pristine type of perfection, which in its varieties of degradation has been scorched by the burning sun of Africa, or bleached by the cutting winds of Europe. It is not whether the fresh green of spring, or the bright yellow of summer, or the orange brown of autumn, speaks to the eye in more heart-stirring tones—the question treated is a much narrower question—whether there be not in the elementary composition of the typical forms of nature, a law which finds an unconscious interpreter in every heart; a law which, when obeyed, strikes the beholder with pleasure, and when violated with a certain, perhaps slight, amount of pain. Before we open the works before us, we hope to be excused if we ask the question, "have we not reason to believe *a priori* in the existence of such a law?" We think we have. We find abundant traces of symmetry in all nature around us, and we think we are justified in expecting that the Creator of this symmetry shall have implanted in ourselves some principle of judgment by which this in itself is made a real though subtle source of pleasure to us. The piece of granite which we pick up in the cold north, where we now write, shows in every little star that twinkles on its surface a perfect regularity of angular facets. The *Veronica* which we gather by the road-side shows the four parts of its corolla set at equal intervals with the four lobes of its surrounding calyx, and guarded by them. The earlier forms of creation, less developed as they may be in many particulars, are perfect in this one, nay more, it is just here that their great perfection seems to be concentrated. If we descend to the minutest microscopic organism, we shall find a speck smaller than the finest dust, the *Campylodiscus horologium* or the *Arachnoidiscus Ehrenbergii*, divided and subdivided with a regularity as great as in the engine-turned watch, or the spider's web. The deeper we descend, the more conspicuous the symmetry. We have a portion of brick earth from Carmarthen, kindly furnished us by Mr Okeden. It is found at a distance of one hundred yards from the river Towy, by which it was probably deposited thousands and thousands of years ago. Here deeply buried below the surface men dig up the remains of once living forms. Under a high magnifying power let us examine one of them—the *Triceratium favus.* Had human eyes existed along with it, none of its beauty could have possibly reached them. And yet what exquisite symmetry! The whole organism is an equilateral triangle, and every part is divided into hexagons, such as it would delight the eye of a bee to look upon. We can hardly trace here, as we seem to do in the honeycomb, an economic arrangement of spaces; we appear to see symmetric beauty developed, not because it is useful, but because it is beautiful,—and that, too, thousand of years before human eyes were created to rest lovingly on it. Surely it must have pleased some other eye, and if it did, then symmetry cannot be an accidental law of beauty, but a fundamental fact in its manifestation. This then is the basis of both the systems before us; on this point they reason, and try to push the inquiry one step further back, and to ascertain, in a simple geometric form, what single law rules the various phenomena. Both argue, "there is certainly some relation traceable amongst the different points of a beautiful surface—some simple law which connects them all." But what is that relation? Dr Zeising thinks he finds it in the division of every line—Mr Hay, in the division of every angle. Dr Zeising's principle is this: "every line of a beautiful form is divided in extreme and mean ratio." Mr Hay's, "every right angle is divided by some simple divisor." Thus the one believes the eye to enjoy satisfaction from the harmony of the parts into which every line is divided;—the other believes it to obtain it from the directions in which the different lines lie with respect to one another.

Let us now examine each of these theories a little more in detail. We will begin with Zeising's. The principle on which it is based has the advantage of having had supporters in modern times, whilst the opposing theory, though it may have been presumed to have been acted on, cannot be shown to have been distinctly enunciated prior to the time of its publication by Mr Hay. Some of our readers may have seen a curious work by Albert Durer, in which the human figure is made subject to the measuring line. The cuts with which the book is adorned, whilst they prove the freedom of the artist's pencil, seem also to prove to our unsophisticated minds the still greater freedom of the models measured from any suspicion of being beautiful. But let that pass; there they are, old and young, ugly and ———, nay, nothing but ugly, frightfully ugly—all measuring something alike. But the results of measurement seem to defy all attempt at reduction to law. In other authors, before and after Albert Durer, Vitruvius, Leonardo da Vinci, Flaxman, you find something similar—many relations but no law. Now, Dr Zeising groping over the pages of Plato, finds a law in the *Timæus*, or believes he does,—the law which we have enunciated above—that every line is beautifully divided when its whole is to its greater part as the greater part to the less. If you ask why this should be, Dr Zeising replies, he cannot tell; let it suffice that it is so. But is it so? That is the question. Dr Zeising occupies a great part of a goodly octavo volume in answering this question.

We shall content ourselves with a very brief sketch of this work. The author, with considerable erudition, proves from the writings of philosophers, ancient and modern, that some law of symmetry has ever floated through the atmosphere of human thought; and that this law assumed a bodily shape, seems pretty well made out from the observations of Galen, the tradition of Varro relative to the canon of Polycletes, and a host of minor authorities. What the law was, is another matter. That it was identical with what the author finds in the 31st chapter of the *Timæus* is by no means demonstrated; but, considering the obscurity of the passage in Plato, we are disposed to allow that sufficiently broad features of coincidence have been discovered to warrant the argument which is based upon it. Let us then turn to the argument, which consists of an appeal to nature and art, and see whether it establishes the law in question. According to that law every line in a pleasing composition ought to be divided into parts which are to one another nearly in the proportion of 5 to 3 (more strictly $\frac{1}{18}$th less than 5, and $\frac{1}{18}$th greater than 3). And that because 5 times 5 is nearly equal to 8 times 3. This mode of dividing a line was certainly well known to the ancients. It is given by Euclid in the 10th proposition of his 4th Book; and is commonly called the *Golden Rule*, but wherefore and by whom the name was given, it is not easy to determine. With this rule in his hand the Doctor proceeds to examine the universe; nay, he even ventures to ascend to Deity itself. We will accompany him only a little way, and witness his success in matters within the scope of our humble faculties. We wish we could transfer to our pages some of the beautiful wood-cuts which adorn his book. As we cannot do this, we will not weary our readers with many examples. We meet first with the Apollo Belvidere—the golden line divides him happily. So it does the Venus de Medicis and Raphael's Eve.

But what is the meaning of that face terminating, not at the chin but at the centre of the throat? And the arm too! Well, we have a face and an arm of our own. Of the former we will not speak, but we think we may assert that the latter is a tolerably average one. We measured it carefully, and found it did not come out right at all. We were rather vexed at this discovery, and meditated the purchase of a poncho wrapper to hide our defects; but, on reflection, we thought it wiser to turn up the plates of some anatomical works. On doing so, we became re-

nature, but by those of art, whether in symmetrical or picturesque compositions of forms, or in harmonious arrangements of gay or sombre colouring.

Now in respect to the first of these modes of sensation, we know that from the time of Pythagoras the fact has been established, that in whatever manner nature or art may address the ear, the degree of obedience paid to the fundamental law of harmony will determine the presence and degree of that beauty with which a perfect organ can impress a well-constituted mind; and it is my object in this, as it has been in former attempts, to prove it consistent with scientific truth, that that beauty which is addressed to the mind by objects of nature and art through the eye is similarly governed (p. 9).

And again—Our physical and mental powers, æsthetically considered, may therefore be classed under three heads, in their relation to the fine arts, viz., the receptive, the perceptive, and the conceptive. The senses of hearing and seeing are respectively, in the degree of their physical power, receptive of impressions made upon them, and of these impressions the sensorium, in the degree of its mental power, is perceptive. This perception enables the mind to form a judgment whereby it appreciates the nature and quality of the impression originally made on the receptive organ. The mode of this operation is intuitive, and the quickness and accuracy with which the nature and quality of the impression is apprehended will be in the degree of the intellectual vigour of the mind by which it is perceived. Thus we are, by the cultivation of these intuitive faculties, enabled to decide with accuracy as to harmony or discord, proportion or deformity, and assign sound reasons for our judgment in matters of taste. But mental conception is the original power of constructing original ideas from these materials; for after the receptive power has acted, the perception operates in establishing facts, and then the judgment is formed upon these operations by the reasoning powers, which lead, in their turn, to the creations of the imagination (p. 19).

The physical part of Mr. Hay's theory is very simple, and we confess we like its promise. It consists, as we have already said, in the hypothesis that the eye estimates not by distance but by direction, not by complex proportion but by simple division. It assumes that all the angles of a composition are aliquot parts of some given angle, and consequently related to each other by the same direct relations which govern the notes in music. We think this theory has the threefold merit of originality, of simplicity, and of *vraisemblance.* But we do not intend to adopt it without strict examination. We trust our readers will not deem the discussion tedious.

Mr Hay then is perfectly right in assuming the *a priori* probability that a right angle is more pleasing to the eye than an angle a little greater or a little less than a right angle, and that were the right angle before the eye its half would be more pleasing than an angle a little greater or a little less than its half, and so on. Thus, for example, that the sixteenth part of four right angles should be a much more pleasing angle than the seventeenth part. There is no difficulty whatever in admitting this; but the theory before us requires something more, about which there may be reasonable scruples. If, for example, we look at a picture frame, the line which joins opposite corners does not appear at first sight to be a very ruling line, seeing that it is no way indicated to the eye, and we may doubt whether it can be true that the whole beauty of the form depends on its direction. Perhaps this difficulty may be removed by supposing that the eye involuntarily places itself at the centre of such a figure, and judges of the symmetry from that point by crossing respectively to the corners. However this may be, it is certain, 1. that one form of parallelogram is more pleasing to an eye, even the most uneducated, than another; and, 2. that the pleasing forms set at defiance all idea of a simple proportion between the sides. Let the reader measure carefully the length and breadth of the engravings which he possesses, executed by men who may be presumed to have a tolerably correct eye, and he will find it impossible to express their relation by any conceivable proportion, such as 2 to 3, 4 to 5, and the like. There is no relation which we can trace amongst the lines. This fact in itself upsets all linear theories, but we want another fact to come out, and we confess we are not sure what a careful examination might show in reference to it. We require, according to Mr Hay's theory, to find that in every pleasing form the diagonal should make with the longer side an angle which is an aliquot part of four right angles. We wish those who possess a good collection of engravings, would so far put it to the test of experiment by furnishing a table of the corresponding lengths and breadths of the plates.

We repeat, then, that the basis of Mr Hay's theory is the hypothesis that in every figure which for symmetry is perfectly satisfactory to the eye, the different diagonal lines make with the horizontal and vertical line angles which are complete parts, such as halves, thirds, quarters, &c., of four right angles. Of the application of this hypothesis the author gives numerous examples, of which we shall select only two. We begin with the Parthenon, a building which is pre-eminently symmetric in its beauty, and beautiful in its symmetry. We could not select a better example, for, in the first place, the outline is remarkably simple; secondly, its proportions have been measured by Mr Penrose, with scrupulous and almost microscopic accuracy;

and, thirdly, we possess a comparison of Mr Hay's theory with the measures of Mr Penrose, published by the latter, who had an interest in rejecting the theory as opposed to his own views, but who candidly gives his results to the world. Mr Hay divides the Parthenon into three distinct portions—firstly, a vertical portion, being a series of vertical columns; secondly, a horizontal portion, being a series of short rectangles placed over the vertical columns; and thirdly, an oblique portion, being an isosceles triangle placed over these rectangles. Mr Hay imagines that the eye would refer them all three to one single rectangle, which would be divided into three portions by horizontal lines. He finds, on this supposition, that the respective diagonals make with the common base the angles which are one-fifth, one-fourth, and one-third of a right angle. Moreover, the two upper rectangles are respectively rectangles of which the angles are one-sixteenth and one-seventh of a right angle. He finds the individual columns, the intercolumniation, &c., all governed by the same simple proportions. And what is the result of comparing this theoretical building with actual measurement? Any one who examines the figures as they stand in the *Builder*, or extracted in Mr Hay's *Harmonic Law of Nature*, p. 8, *note*, will be surprised, not at the discrepancies, but at the extreme closeness of coincidence between theory and fact. The Parthenon certainly comes out well.

Let us next take the human figure. Mr Hay states the mode of applying his theory to the figure in the following words.

The facts are—1st. That on a given line the human figure is developed, as to its principal points, entirely by lines drawn either from the extremities of this line or from some obvious or determined localities. 2d. That the angles which these lines make with the given line are all simple submultiples of some given fundamental angle, or bear to it a proportion expressible under the most simple relations, such as those which constitute the scale of music. 3d. That the contour is resolved into a series of ellipses of the same simple angles. And, 4th, that these ellipses, like the lines, are inclined to the first given line by angles which are simple submultiples of the given fundamental angle. From which four facts, and agreeably to the hypothesis I have adopted, it results as a natural consequence that the only effort which the mind exercises through the eye, in order to put itself in possession of the data for forming its judgment, is this, that it compares the angles about a point, and thereby appreciates the simplicity of their relations. In selecting the prominent features of a figure, the eye is not seeking to compare their relative distances; it is occupied solely with their relative positions. In tracing the contour, in like manner, it is not left in vague uncertainty as to what is the curve which is presented to it; unconsciously it feels the

We trust the reader has a tolerable conception of Mr Hay's theory It has the same merit with that of Mr Zeising—singleness of principle; but it has a merit of its own—simplicity of principle. It traces the existence of formal beauty to the exhibition of definite proportions amongst the different angles which the eye may be supposed to trace out, in passing successively from the centre to the different prominent points in the object. This would seem, perhaps, to make the operation of seeing to consist of motion rather than of rest. It certainly agrees rather with the supposition that the eye receives its impressions in succession, and judges by muscular exertion, or otherwise, of the angles which the different directions in which it is carried make with one another, or with some fixed line. Now we believe this is not an unreasonable supposition, though by no means essential to the theory. We remember the eloquence of the late Sir Charles Bell on the searching motion of the eye. We presume, too, we may assert that the researches of Sir David Brewster leave no doubt on this subject. Perhaps our readers will excuse us if we express a little more fully what we refer to, and try to make it plain. The eye then, in fact, resting steadily, sees distinctly only a small surface. Everything around is indistinct. But, in ordinary practice, it wanders from point to point, and by successive impressions corrects or makes up a whole. The mind puts the parts together, and the result is the same as if the whole was seen distinctly. That the eye itself unites successive impressions, may be inferred from the circumstance that an excitement on it endures about one-third of a second, so that a vast number of points, though not seen by one direct appulse as it were, yet all stand painted at the same time on the retina. In our younger days, the stage coach used to pass the quickset hedge which divided our playground from the road. 'Twas a grand thing to count the passengers, and catch a glimpse of their countenances through the crevices of the hedge as they were whisked by, and if the coachman pulled up, expectation was on tiptoe; but, alas! only to be disappointed. What was tolerably easy when the coach was dodging us, became impossible when it fell to our turn to dodge the coach. Little or nothing could we see until it drove off again. This was an early lesson on the retentive power of the eye, and we have not forgotten it. It is, however, true that the memory stores up impressions. After they have faded from the retina, they are viewed by the mind's eye, and we are quite unable to divine, without further aid, whether our sensations are immediate or ruminative. Nor is it important for our present purpose that we should do so. It is sufficient to show that Mr Hay's theory comes within the scope of physical propriety, when we have made out the fact that we do actually see by succession, by movement. And of this there can be little doubt.

But it may be argued: How can such movement aid us in judging of the space passed over? Even if it takes place, we are quite unconscious of it—we are aware of no muscular effort; or, were it otherwise, is there any reason to suppose that that effort would enable us to appreciate delicate deviations from exact proportionality? Now, we repeat that we do not deem it absolutely essential to a geometric theory that motion should be the measure of space, yet we think it exceedingly probable such is the case. But whether motion or not, we are aware, that great difficulty is experienced by many unprejudiced thinkers, in consenting to trace their grounds of judgment to any extent, or in any degree, to operations so active, so mechanical, we might say, as those which Mr Hay points to. They seem to think that the mind is a certain etherial dream-land in which spiritual existences float, hardly accessible to the laws which govern the grosser parts of man. Their dim perception of the workings of the mind drives them to divorce it, if possible, from body. We trust they will excuse us if we venture to differ from them. If you are one of them, reader, we invite you to accompany us back again from your lofty eminence to a walk amongst a few of the humbler paths of our common infantile education. We will start at the very beginning, and try to see how our mental and muscular framework have undergone a mutual training. Probably you can remember when the ordinary operation of playing with both hands on the piano appeared little short of an impossibility—perhaps even Plato himself had some foreknowing intelligence whispered in his ear, that his little grand-daughter of a hundred generations would have the power of throwing simultaneously her thoughts on the separate performances of her two hands—perhaps even he would have seen in such an announcement the theory of progressive development, and have clothed his little grand-daughter with an ideal form liker to the great prototype of man than to himself. But there are accomplishments equally important, the acquisition of which you probably do not remember. You do not perhaps remember the gradual acquisition of that muscular power by which you became enabled to support your body on your two tiny feet. You are probably not aware of how many of your faculties are constantly engaged, even now, in helping you to that very act. You are ignorant, it may be, of the part which the eye performs in that operation. True, yon can stand very well with your eyes shut. Be thankful for it, but know that it is not the lot of all; your muscles have an extreme delicacy of sensation, which in others is blunted by disease. There are men living and working around you, who, if they shut their eyes, would presently lose their balance and fall to the ground.

You see then that your senses have learnt their duty of mutually supporting each other, although you are not taken into their counsels. And you may expect to find other things going on within you, which your philosophy has never dreamt of. Let us try to enter briefly on an examination of the education of the senses. We shall not be long in discovering one fact,—that it is not possible for us to trace to their ultimate causes all the physical bases of our conceptions. Many of our modes of forming our judgment are acquired or improved silently, and we know not how. Our estimate of distance, for example, is the application of reason to facts of various kinds, which are weighed and commented on, and received as the basis of our judgment with confidence, although we cannot trace through the mind the passage of a single thought directed towards them. Our delicate judgment of the distance of the candle which we snuff, is affected by the muscular sensation of the relative directions of the axes of the eyes; but we have no connecting link in our minds between this judgment and this sensation: we are in fact quite unaware of the sensation, quite ignorant of the grounds of our judgment.

So, again, we form our estimate of the magnitude of objects by comparing their apparent size with their distance. The eye is constantly making measures, instituting comparisons rapidly and accurately, but we are at the same time ignorant both of the manner of its acting, and of the simple fact that it is acting at all. We are accordingly very much astonished when brought into a country to which we have been altogether unaccustomed, to find that our infallible judgment has deserted us. Bring a man, educated in the fens of Lincolnshire, into a hilly country, and he will make the most ridiculous mistakes. A party of Cambridge men took up their residence in the neighbourhood of Keswick. The day of their arrival, three of them having an hour to spare before dinner, started on a stroll to reach a sheet of water which they imagined to be a mile and a-half from them. They returned too late for dinner and much crest-fallen, having walked four miles without attaining their object. They had converted Bassenthwaite lake, upwards of six miles distant, and four miles long, into a small fish-pond. Similar mistakes in abundance occur to Arctic navigators; for example, Parry, in his first voyage (chap. v.) says, "We had frequent occasion, in our walks on shore, to remark the deception which takes place in estimating the magnitude and distance of objects, when viewed over an unvaried surface of snow. It was not uncommon for us to direct our steps towards what we took to be a large mass of stone at the distance of half a mile from us, but which we were able to take up in our hands after one minute's walk." We have ourselves, in a fog, converted a sheep into a corn-stack.

And then again, as to position, we do not require to be taught the

relative magnifying power for more distant objects. Professor Forbes, however, hit on the true explanation. The phenomenon was neither natural nor optical, it was entirely mental. Reasoning as usual, the mind expected to see, developed in the part which the telescope presented to it, the complete perspective which it knew to exist in the whole. Acting on this expectation, it did as it was wont to do, it lengthened the more remote lines in proportion to their fancied distance; and as they were, in the telescope, almost equal,—so nearly equal indeed, that the micrometer could detect no difference between the two ends,—the mind itself, by its own action, had made the further ones seem to be larger, and caused an inversion of perspective, more ridiculous than ever Hogarth ventured to imagine.

We have said enough to prove that, as to direction, form, distance, position, the mind acts rigorously on the education it has received. How it gets that education, by what power it acts, we are ignorant; it is not indicated to our senses; we are unconscious of the whole process. And what is true in regard to the eye is equally true of the other senses. Who has any knowledge of that delicate, but not uncommon operation by which the food is conveyed to the mouth? Who understands the arithmetic by which the ear counts the pulsations of each individual note, or the mechanical effort by which the voice produces them all in obedience to the ear's demands? All our senses have received a complete education, have experienced a severe drilling, but the fact that we have been under the rod, has never occurred to us,—the education has been the silent education of time.

We may go further than this. Not only are we ignorant of the existence of a power of acting which time has quietly developed within us, but even acquired power, which purposely-directed education has engendered, is a power of which, as regards its nature, the reason has no cognisance, and over which the judgment has little control. Could Turner say by what exercise of the visual organs he conjured up on canvas the wonderful story of the wreck of the Minotaur? Could Paganini tell you by what extraordinary muscular sensation he was enabled to travel at will with such rapidity and accuracy over the unmarked fingerboard of his instrument? Could the juggler tell you how he is enabled to calculate, with unerring precision, the direction and velocity which he must give to his ball, so that it shall fall at a certain spot? Ask them the question, and they will tell you simply that they can do it. They know no farther. Once more. Whilst we are ignorant of what education draws out, we are also ignorant of half that lies within capable of being developed. Men are like sheep in this respect. When one has leapt the fence a hundred are prepared to follow him, though they had grazed quietly for months, little dreaming that the barrier was not impassable. Had Paganini not been born, Ernst might have been an ordinary player. We have known a blind fiddler, with a tolerably correct ear and considerable appreciation of music, relying entirely on the lower notes of his instrument, never discovering, after half a century of experience, that he could easily acquire the faculty of wandering at will amongst the strings. Not only does many a mute inglorious Milton rest undeveloped, but painters, sculptors, musicians lie, like the statue in the rock, buried and unknown even to their possessors, because no Ithuriel's spear has caused them to start into a living form.

We think we have said enough to clear away that stubborn prejudice which stands as an obstacle to the reception of any mechanical theory of symmetric beauty—the prejudice which arises from our ignorance of the action of the eye and of the mind—the argument that, because we are not aware of applying any measure—because we are unconscious of exciting any of our powers of mental arithmetic—therefore it cannot be believed that we do so. We trust also that what we have said will suffice to remove another objection to a mechanical theory, viz., that proportions are not seen as they exist, but foreshortened and influenced by perspective. This objection, if admitted, would be fatal to every conception of symmetric beauty. But it has really no force whatever. The mind is not, like the focus of the telescope, a mere space on which external nature is painted, with all its obliquities and distortions. It is rather the interpreting, correcting, reasoning inner eye. To such an extent is this the case, that we may say without exaggeration that its great duty is to sit in judgment on the senses. In fulfilling this duty, it is true, it adopts fixed principles of action: and thus, like the most honest of judges, it may be cheated by a prepared case, in which the facts are perverted. In one of the palaces of Italy is a colonnade, made purposely converging, with a diminutive statue at the end. You are not let into the secret, but are requested to guess the height of the statue. Judging from the perspective that it is forty yards distant, you probably say six feet. You are rewarded by being laughed at when you find it to be only three, at half the distance. Such facts, instead of arguing for the incapacity of the mind, prove it to possess a really active power of weighing, discriminating, and concluding from the evidence presented to it. And what does Mr Hay's theory require of it? Simply that it shall exercise a geometric skill in reference to angular spaces exactly similar to the arithmetical skill which it is known to exercise in reference to sounds. How beautifully it judges of the exact number of vibrations which should constitute a given note. How carefully it counts them, and detects a deficiency in the exact tale. Most people are aware of the pleasure of hearing a person sing in tune. Most ears can detect the want of capacity in the precentor which some of our country parishes painfully present. What do such persons do? They quite unconsciously count, we mean estimate, the number of vibrations which his successive notes are made up of, and find them, alas! too few. We remember, in a town in the west of Scotland, some years ago, the precentor was accustomed to sing the first verse of the psalm with his nose, the second with his mouth, the third with his throat—the attempt to sing the fourth with his stomach was generally fatal, and we have known the verse to die suddenly. This gradual flattening was painful even to our ears, which have but little delicacy. What would it not have been to a more highly sensitive organ, or a carefully educated listener! We believe many persons pretend to have ears for music, whose tympanum is little better than our own; but we have heard of others whose delicacy of counting is so great that the minutest deviation from accuracy in a note sounded by itself could be immediately detected. We have ourselves experimented on a boy who could, blindfold, and in another corner of the room, name every note on the piano, and discriminate as many as three sounded together, whatever they may have been. Who has not heard of old Gardner the stocking weaver of Leicester, who worked Haydn's symphonies on a pair of hose for their illustrious composer—that, like a certain old lady, he "should have music wherever he goes?" Who has not read his curious volume "The Music of Nature?" Have you not? Then get it at once. It will amply repay you. The Music of Nature! There is charm in the very name. Read it, and you will learn what the ear is capable of; how, like the hand or the eye, it can be tutored to an extraordinary degree. You will learn, too, the science of singing birds, how the Kentish nightingales are more courtly, more Italianized in their song than their country cousins. You will learn that birds which sing but one song, sing it every one of them in the same key, so precisely that the fastidious author is disposed to recommend the throat of a living bird as an unerring pitch-pipe. Hear what he says: The song of the cuckoo I have invariably found in Leicestershire to be in the key of D. If the cuckoos in other countries should be found to accord with this curious fact, as nature is pretty much the same, we may take these notes as a standard of pitch. White of Selbourne observes,—"I have tried all the owls in this neighbourhood with a pitch-pipe, and found them to hoot in B flat, and the cuckoos to sing in the key of D." Is the cuckoo's ear then, like Gardner's own, so exquisitely sensible? We presume so. At any rate, every ear is a marvellous arithmetician, though the head to which it pertains knows nothing

realized. In our own island, especially, the most valuable contributions have been made; the Geological Map of England, published in the beginning of this century by the distinguished first president of the Geological Society, G. B. Greenough, Esq., afforded the first specimen of a sufficient geological map of any extensive district; but still these earlier essays may be characterized as topographical, rather than geological maps, as illustrating particular provinces rather than the general features of our globe, or even of its several quarters. We may fairly consider the map specified at the head of this article, as presenting the most promising and valuable specimen of the more advanced stage of geological chartography of which we have spoken. And we say this the more emphatically, because it has not attempted a more extended field than the actual state of information enabled its projectors distinctly and accurately to record; and because it has therefore so satisfactorily accomplished all that it professes to undertake. A bold and accomplished French savant, Boué, has not hesitated to present us with a geological map of the whole surface of our globe; but although we consider this as a useful, as well as bold approximation, it is and must be as yet too vague to convey very exact information, and too destitute of the guarantees of certainty to command general reliance; whereas in the map before us, the district embraced comprises the regions which have been most carefully explored by the hammers and surveyed by the eyes of well-known geologists; and the individuals concerned in its construction are exactly those whom their brethren in the same field of science would at once select as the best qualified to record and combine the results which have been accumulated by so many of the stone-breaking corps in which they themselves hold such high commissions. To justify this assumption, it will be quite sufficient to refer to the name first attached to this production, that of Sir Roderick Murchison, who has more largely perhaps than any other individual contributed to the general stock of our actual geological information. He first brought to a real consummation the investigation of the general series of our geological formations, and of the various successions of animated organizations whose remains are preserved in each. The structure of our own island had long been found to present peculiar facilities for such a task; but Sir Roderick's predecessors, while they had very fully illustrated all the other members of the series, from the sands and clays of the tertiary basins to the rocks composing our great coal fields, and the limestone of the Derbyshire and Pennine mountain-chains on which they repose, still had shrunk from the attempt to classify and arrange in similar groups the formations subjacent to these carbonifera, and left them confusedly huddled together under the vague designation of various transition sands and limestones; but Sir Roderick has now marshalled all these in as perfect discipline as any of their younger brethren, under a triple order of Silurians, with as full authority as if he were the earl-marshal of the great Arthur, the mythological prince of of that fabled district, or the usher of the black-rod to his ancient court.

Having thus completed the subjugation of Britain, our author undertook a more difficult and hitherto unattempted enterprize, the reduction of the mighty and inaccessible Russia itself. This heroic undertaking he most gallantly and triumphantly achieved, with the cordial assistance of the authorities themselves of the invaded territory, and has brought back with him, in testimony of their admiration, all the stars of all the orders of all the Russias. Since his return, with more exclusively patriotic devotion, his sagacity first indicated the possibility of discovering valuable gold-diggings in the valleys of the Australian chains—an example of geological foresight which has since been so richly realized.

On the death of the late De la Beche, he was most suitably and justly placed at the head of the departments which the former before occupied, as Superintendent of the Ordnance Geological Maps, as Principal of the Great Museum of Economical Geology, the only, but the most efficient, school of mineral science which our island (dependent as it is on the resources connected with that science) as yet possesses, and which it principally owes to the comprehensive information of its illustrious statesman, the late Sir Robert Peel.

The former researches of Sir R. I. Murchison in Russia had, years ago, enabled him, from his own independent investigations, to complete a map, embracing all the Russian European territory and the conterminous countries, and therefore including nearly two-thirds of our own quarter of the world. All interested in the advance of geological science, who had enjoyed the advantage of studying this beautiful and complete Russian map, became therefore most desirous that the smaller remaining portion of Europe should be incorporated by the same author, who from his own very general geological researches through the Continent, and from his intimate acquaintance with its first men of science, with whom he is associated as a corresponding member of the French Institute, was known to be so peculiarly competent to the task. This very desirable object is now accomplished by the present publication in the most satisfactory manner.

Such general maps form the most valuable companion and guide to the scientific tourist; they enable him to trace the extended course of the formation with which he is familiar in his own country through the most remote countries, and often under novel affections, induced by local diversities in the general causes which have acted in the deposition and arrangement of strata of uniform age and composition. We remember the astonishment—almost incredulity—of a geological friend, when he first observed in an old Swiss volume on the fossils of the Alps, accurate figures of the turrilated ammonites which he so well knew as denizens of the greensand beneath the chalk ranges of the Kentish and Sussex wolds, and the midland and parliamentary Chiltern Hundreds, but whose forms were here preserved on the summit of Mount Pilatre. With the same surprise we may see the humble English cretaceous downs elevated into the lofty chains of the exterior Alps and the Apennines, and constituting the classical summits of Greece so interesting to our schoolboy memories, Pindus, Parnassus, and Helicon; and the chains of Athens, Laconia, and Arcadia; but we must feel that formations of so high pedigree have a right to swell into a haughtier dignity as they approach the origin of their name, the cliffs of the Isle of Creta, and its proud summit of Ida. We shall also find our own friable material of English chalk converted into the most beautiful crystallized statuary marble in the Tuscan Carrara and Athenian Pentilicus. We are thus also led to form hypothetical yet not altogether unauthorized speculations as to the primitive islands which first heaved their granitic summits close to the general ocean plain, and to endeavour to trace the more limited outlines of the successive seas, and the conditions under which the Silurian deposits were first precipitated, to be succeeded by coral reefs crowned by the free forms of the carboniferous era; and below these again, new waves bore shreds of cephalopodous mollusca, exhibiting the snake-like coil of the ammonite and the acute cone of the belemnite, while monstrous forms of marine saurians, compared with which the crocodile of the Nile and the Ganges appear dwarfed and degenerated, products of a decayed and effete age, floated through the liasic sea, along the borders of Devon and Dorset and the opposite coasts of France. Or we may proceed to the far later period when bears and hyænas herded in the caves of Franconia and Yorkshire; or, as we advance to the close, regard with astonishment troops of elephants and rhinoceroses stalking over the plains of Kew, and look at the hippopotami wallowing in the marshes of what is now the vale of Thames. Or if our researches partake of the idiosyncracies of London aldermen, we may recal with deep sighs of regret the happy ages, now, alas! never to return, when Sheppy was a redundantly productive turtle island; and while its groves could yet have yielded rich desserts of tropical fruits. While in the basin now giving course to the Seine, but then like the Indian Run of Cutch, exposed to alternations which rendered it doubtful whether its correct description should be a marine estuary or a fresh-water lake,* herds of extinct species of tapirs haunted the banks, as their remoter congeners still frequent, in the west, the

* The mouth of the river Heyl, in North-west Cornwall, displays combinations of same nature in a very illustrative manner.

Sermons in Stones. By DOMINICK M'COUSLAND.

This work professes to reconcile the established facts of Geology with the Mosaic narrative of the creation; but however good the author's intentions, his Geology is very indifferent; and when we read in his Sermons of the "hasty and dogmatic assertions of the Savilian Professor at Oxford," the truth of an old proverb, respecting certain persons who reside in glass houses, and the danger of their throwing stones, forces itself vividly upon the mind. "Sermons in Stones" are full of "dogmatic assertions." Had the author been aware of Mr Salter's discoveries in the Cambrian rocks of Wales, publicly announced by Sir R. I. Murchison at the meeting of the British Association at Glasgow, and that organic remains have been detected in the lowest known sedimentary rocks, the Longmynds, he would hardly have founded his basement arguments on universal "Azoic rocks" and "boiling oceans." Again (p. 42), we are informed that "the Grampians and Welsh ranges, the Pyrenees, Hartz Mountains, Dofrafield, Uralian, Himalayan, Atlas ranges, Mountains of the Moon, the Andes and, Alleghanies, were all elevated "during the period of the OLD RED SANDSTONE." This is a grand discovery, and one for which we do not doubt Sir Roderick Murchison will be truly grateful, especially if the author would also inform us *how* the OOLITIC strata and their fossils mounted to the height of 16,000 feet on the flanks of the Himalaya, and how the CARBONIFEROUS deposits were pitched high and dry on the summits of the Alleghanies. As for the "angle which the Silurian rocks make with the Devonian in the Mountains of the Moon," we should like to be informed how, when, and where, our author took his sections.

We regret extremely to observe many instances of Geology warped to suit the author's arguments and "dogmatic assertions," contrary to geologic truth, such as, that "no sunbeams penetrated the clouds" "during the carboniferous epoch," and many other such gratuitous suppositions.

The contemporaneous classification of "The Trias and Oolitic system" is also an instance of "confounded confusion," seldom met with in works of Geology of the present day. The systems are as distinct as the oolite and the chalk, nevertheless we have the Labyrinthodon hopping in the days of the OOLITE (p. 68), when we might just as truly contemporize the Iguanodon and the Monkey.

The author's knowledge of Conchology is as indifferent as his Geology; for we read (p. 24) that "Lingulæ, Brachiopods, and Rhynchonella, sometimes called Terebratulæ, have been termed 'the scavengers of the ancient seas,'" from "their formidable apparatus for destruction." This is a sad libel on those unoffending Brachiopods. The author has evidently confused them with Sir R. I. Murchison's account of palæozoic Cephalopods and their habits; the Lingulæ and Rhynchonellidæ would be horrified at such a destructive classification.

Passing on from the Geology, we read the analogy between the Mosaic record and the Geologic record with greater pleasure, and recognise a devout spirit and many careful arguments; although we are rather mystified by the author's theory of the manner in which Moses was inspired, and how he beheld "IN A VISION" certain events of the creation; while of others, which "he could not see NATURALLY," it appears he was profoundly ignorant. We don't understand the author's theory of inspiration.

There is much eloquent language in this little book, and the author evidently understands the importance of Geology on the question on which he treats, when he writes thus:—

"Of the physical relations between the Creator and the created, there is more instruction to be gained from geological studies and research than from the whole of the transactions of the human era."—(P. 218).

A *second* edition of this little book will, we are satisfied, afford us the pleasure of hailing a very readable, useful, and truthful work.

Pictures of Nature. By EDWIN LEES, F.L.S.

This work is the production of a well-known Botanist and careful general observer of Nature's works; thus every page is a valuable addition to the local natural history of the West of England. The field excursions of the Malvern and Worcestershire Naturalists' Clubs have supplied Mr Lees with many a tale of interest to the general reader, as well as to his brother naturalists. Pictures of nature will be read by many who never have seen, and perhaps never will see, the Malverns and their glorious scenery.

One circumstance is mentioned, which the geologist will probably question. Mr Lees, speaking of palæozoic plants says: "I have myself met with two impressions of parts of the fronds of two species (of ferns) in LUDLOW rock from West Malvern!"

Perhaps Mr Lees would forward his "impressions" to the Geological Society of London for examination. *Ferns* are unknown in Silurian rocks, and our *impression* is that Mr Lees is mistaken!

An attempt to Classify the Flowering Plants and Ferns of Great Britain, according to their Geognostic Relations. By JOHN GILBERT BAKER.

In this essay the author attempts to arrange the plants of Britain according to the geological formations in which they grow.

He adopts, although without acknowledgment, the views and nomenclature of Thurmann, in his *Essai Phytostatique*, and divides the formations into *Dysgeogenous*, or those which are disintegrated with difficulty, and *Eugeogenous*, or those which abrade easily. He remarks: "Every species possesses essentially its characteristic special range of lithological adaptability, in the same way that each possesses its characteristic special range of climatic adaptability. Under equal climatic conditions, some species are restricted to more or less distinctly marked *dysgeogenous* situations, and others to more or less distinctly marked *eugeogenous* situations; but a greater number can adapt themselves, more or less decidedly, to stations of either class." He divides the surface of Britain into six zones, as follows:—

1. *Psammo-eugeogenous or Scandinavian zone.*—North Isles, North Highlands; nearly the whole of East Highlands and West Highlands.
2. *Mixed or Subscandinavian zone.*—The Lakes, North Wales, South Wales; the greater part of East Lowlands, West Lowlands, and the Peninsula; a small part of East Highlands, West Highlands, and Severn.
3. *Primary dysgeogenous or Jurassic zone.*—Nearly the whole of Tyne; part of Humber, Mersey, and Trent; a small part of East Lowlands and West Lowlands.
4. *Eugeogenous or Belgic zone.*—The greater part of Severn; part of Humber, Mersey, Trent, and the Peninsula; a small part of Tyne.
5. *Secondary dysgeogenous or Jurassic zone.*—The greater part of Ouse and Channel; part of Humber, Trent, and Thames; a small part of Severn.
6. *Subeugeogenous or Gallic zone.*—The greater part of Thames; part of Humber, Trent, Ouse, and Channel.

The author then gives lists of the British species, according as they are dysgeogenous, ubiquitous, (including by far the larger number,) eugeogenous, maritime and saline, Irish and Sarnian, anomalous or introduced. There can be no doubt that there is a marked connection between the soil and the vegetation which covers it; and the plants of one kind of soil differ often remarkably from those of another. The division into chalk plants, sand plants, maritime plants, &c., is familiar to every one. We do not think that Mr Baker has made any step in advance in this essay. Much remains to be done by the Geologist, Chemist, and Botanist, before any correct conclusion can be drawn in regard to the geognostic relation of plants; and we think that the present essay proceeds upon too slender data to be of much use in the elucidation of this confessedly difficult question. In conclusion, we cannot agree with the author in his statement that the difference between *Viola odorata* and *Viola hirta* are not specific, but that they are mere variations caused by geognostic influences.

The accurate system of contours which have been carried round the hill allows the calculation of the attraction of all its parts at the two stations N and S, to be performed with the utmost nicety, on the supposition of its being of homogeneous material. By including the effect of all the inequalities of the ground within a radius of 6000 feet (or rather more than a mile) around each of the stations, and denoting by x the unknown ratio of the density of the hill to that of the entire globe, these equations are obtained:

Deflection at South station,	. .	$=4{\cdot}197\ x$ North.
,, Arthur's Seat,	. .	$=0{\cdot}607\ x$ South.
,, North station,	. .	$=3{\cdot}710\ x$ South.

by the solution of which the ratio of the density of the hill to that of the whole earth is as ·5245 to 1.*

By extending the radius of sensible attraction considerably beyond 6000 feet, and calculating the effect of the surrounding country in the same manner on the plumb-line at the three stations, this value of the relative density of the globe is somewhat modified. The ratio is then 5348 to 1.

From direct experiments on the specific gravity of the rocks of Arthur's Seat, Colonel James infers the mean density of the hill to be 2·75 times that of water; whence the earth's density comes out

5·14,

with a probable error of 0·07.

3. *On the Possibility of combining two or more independent Probabilities of the same Event, so as to form one definite Probability.* By Bishop Terrot.

Monday, 7th April 1856. Dr Christison, Vice-President, in the Chair.

The following Communications were read:—

1. *On Atmospheric Manoscopy, or on the direct Determination of the Weight of a given bulk of Air with reference to Meteorological Phenomena in general, and to the Etiology of Epidemic Diseases.* By Dr Seller.

2. *Researches on Chinoline and its Homologues.* By C. Greville Williams. Communicated by Dr T. Anderson.

In this inquiry, which is an extension of an investigation published in the Transactions for last year, the author examines the connection which has been said to exist between chinoline and quinine, and shows that they bear no simple relation to each other. He states, also, that the supposed analogy between the action of heat on quinine and the hydrated oxide of tetramethyl-ammonium does not exist, and that the assertions which have been made regarding the possibility of the formation of quinine from the leukol of coal-tar are founded on error. He then, after showing that chinoline from cinchonine had not previously been obtained in a state of purity, gives the history and composition of the platinum, gold, and palladium salts; also the nitrate, bichromate, and binoxalate.

He describes two new classes of salts formed by the chlorides of cadmium and uranyl with organic bases, and gives the analysis of their com-

* The outstanding abnormal deflection of the plumb-line (assumed to be equal at the three stations) amounts to $4''{\cdot}72$.

pounds mith chinoline. Then follows a determination of the vapour density of chinoline, and an examination of the action of the iodides of the radicals on the base, and some of the products of the decomposition of the hydriodates of the ammonium bases so formed.

He also examines the chinoline series as it is obtained from coal-tar, and proves the presence, in addition to chinoline, of lepidine, and a new base "cryptidine."

In the course of the investigation, the following compounds were analysed:—

Platinum salt, chinoline,	$C_{18} H_7 N, HCl, + Pt Cl_2$
Gold,	$C_{18} H_7 N, HCl, + Au Cl_3$
Palladium,	$C_{18} H_7 N, HCl, + Pd Cl$
Cadmium,	$C_{18} H_7 N, HCl, + 2 Cd Cl$
Uranium,	$C_{18} H_7 N, HCl + (U_2 O_2) Cl$
Nitrate of chinoline,	$C_{18} H_7 N, + NO_5 HO$
Bichromate,	$C_{18} H_7 N, + 2 (Cr O_3) HO$
Binoxalate,	$C_{18} H_7 N, + 2 (C_2 O_3 HO)$
Platinum salt, methyl-chinoline,	$C_{20} H_9 N, HCl + Pt Cl_2$
Hydriodate ethyl-chinoline,	$C_{22} H_{11} N, + HI$
Platinum salt, ethyl-chinoline,	$C_{22} H_{11} N, HCl + Pt Cl_2$
Hydriodate amyl-chinoline,	$C_{28} H_{17} N, HI$
Platinum salt, amyl-chinoline,	$C_{28} H_{17} N, HCl + Pt Cl_2$
Platinum salt, lepidine, from coal-tar,	$C_{20} H_9 N, HCl + Pt Cl_2$
Hydriodate ethyl-lepidine,	$C_{24} H_{13} N, HI$
Platinum salt, ethyl-lepidine,	$C_{24} H_{13} N, HCl + Pt Cl_2$
Platinum salt, cryptidine,	$C_{22} H_{11} N, HCl + Pt Cl_2$

3. *On Fermat's Theorem.* By H. Fox Talbot, Esq., F.R.S.

4. *On the Transmission of the Actinic Rays of Light through the Eye, and their relation to the Yellow Spot of the Retina.* By George Wilson, M.D.

In 1849 the learned Swiss philosopher Wartmann stated, in his "Deuxième Mémoire sur le Daltonisme," p. 40, that "the eye arrests the chemical radiations which accompany the more refrangible rays." He founded this conclusion on experiments made with guaiac resin; but as this substance is by no means very sensitive to actinic influence, it seemed desirable to test the question whether the eye can transmit the chemical rays of light, by an appeal to those highly impressible *actinolytes* (as they may be called) which the recent progress of photography has revealed to us. The necessary trials were kindly made for me by Messrs Dick and Spiller of London, and their results, which are opposed to those of Wartmann, were published last autumn in the Appendix (p. 166) to my Researches on Colour-Blindness.

I now lay upon the Society's table photographs of small objects, on glass and paper, produced by rays which, before reaching the sensitive surfaces, had traversed the transparent humours of an ox's eye. These photographs were obtained by the gentlemen I have named in the following way:—

"An ox-eye was prepared by cutting away the sclerotic until the choroid came into view; a circular aperture of one-eighth of an inch in diameter was then made through this membrane and the retina, which laid bare the vitreous humour at a point opposite to that where the light enters. The eye was then supported in the brass mounting of a photographic lens (*i. e.* a brass tube adapted to the front of a camera), resting at the posterior end on a ring of cork which fitted tightly into the tube, and retained in front by a diaphragm, so as to permit the cornea to protrude.

From the arrangement of the fittings, we are quite satisfied that no light excepting that which passed through the eye could enter the camera.

" Within the dark box, a slip of black paper, with a diamond-shaped or rhombic aperture occupying the greater part of its breadth, was extended across in front of the prepared collodion glass plate, so as to throw its image on the latter, in the event of any chemical rays finding their way to it. The camera was then pointed to the sky (the morning being bright and the sky shining), and the plate exposed for fifteen seconds. On developing with solution of sulphate of iron, a very decided picture appeared. The glass plate which accompanies this paper was the result of twenty seconds' exposure.

" The conclusion derived from this experiment, although perfectly satisfactory to those who arranged the apparatus, is open to the objection, on the part of others, that the picture does not present any *prima facie* evidence of its being the result of rays which passed through the eye. We therefore endeavoured to copy photographically the actual image which is depicted on the retina. To do so, another bullock's eye was carefully dissected, so as to open a circular space of about three-eighths of an inch in diameter at the back of the eye, the retina was removed, and a very thin film of glass, in shape like a watch-glass, substituted for it; this supported the vitreous humour in its original position, and served also to prevent its contact with the photograph paper placed behind to receive the impression, In another trial, the retina was left untouched, without altering the ultimate result.

" Iodide of silver paper was then made sensitive to light by a wash of gallo-nitrate of silver, and used as in the Talbotype process, small squares of the wet paper being successively applied to the back of the thin glass film, and exposed for varying periods (one minute on an average) to the different objects to which the bullock's eye was presented. On developing the latent images with strong gallo-nitrate of silver, very distinct pictures were obtained *of a key* and of a *spotted window curtain.* These negative pictures are inclosed. It is thus beyond a doubt that the chemical rays penetrate the humours of the eye, and impinge upon the retina."

It thus appears that the actinic or chemical rays are not arrested in their passage across the chamber of the eye ; and it becomes an important question how they will affect the general surface of the retina on which they impinge, and what share they have in producing vision. Into this problem, as a whole, however, I do not purpose to enter ; the question I alone consider is the change which the actinic rays will undergo when they fall upon that peculiarly organized portion of the human retina which anatomists distinguish as the " yellow spot." This " spot," almost peculiar to man, presents a diameter of $\frac{1}{12}$th inch, and occupies the bottom of the eye, in the exact axis of its transparent humours. It is more transparent than the rest of the retina, and has long been recognised as the seat of most perfect vision in the eye of man. I have elsewhere drawn attention to the effect which it must have as a coloured medium on the light which reaches it,* and on the actinic rays which traverse it. I wish now to carry these views a step further, in connection with the reflection of light from the choroid through the retina, which was discussed before the Society last session, in a paper "*On the Eye as a Camera Obscura,*" and which, before and since, has been largely made the subject of independent inquiry by foreign and British observers. In particular, Professor Goodsir has shown, in a lecture delivered in the University of Edinburgh last June, and since published,† that it is not merely

* Researches on ColourBlindness, p. 83.

† Edinburgh Medical Journal, October 1855.

pared. Thus, lines are easily seen in the spectrum of the flame of alcohol, which are invisible in that of the flame of oil of turpentine.

These discrepancies are shown, in the present paper, to arise from the predominance of the light of incandescent solid carbon in some flames, and its comparative absence in others; and it is also proved, that, in order to obtain uniform results from the flames of the various compounds of carbon and hydrogen, it is sufficient, in cases where the body contains much carbon, to convert the carbon into carbonic acid, without its previous separation in a solid form, by means of an artificial supply of air. This is conveniently effected for coal-gas by means of the Bunsen gas-lamp, which burns a mixture of gas and air; and, for other bodies, by directing a stream of air from a table blow-pipe through the flame.

When thus treated, all the compounds of carbon and hydrogen which have been submitted to experiment, were found to produce identical spectra, that of the Bunsen lamp serving as a standard of comparison.

In these spectra, five principal bright lines were observed, accompanied by several smaller ones, and separated by dark intervals. One of the lines, the well known R of Fraunhofer, has been long known to coincide with the line D of the solar spectrum. Two other extremely close coincidences were discovered. One between a brilliant green line of the lamp spectrum, and the remarkable triple line *b* of Fraunhofer; and another, between a bright purple line and the conspicuous line G of the solar spectrum.

It follows, from these experiments, that all bodies whose composition is expressed by the general formulæ

$$C_p\, H_r, \text{ or } C_p\, H_r\, O_s,$$

produce, in burning, perfectly identical spectra; the nature of the light being always the same, notwithstanding variations in the relative proportions of carbon and hydrogen, and the occasional presence of oxygen in the body.

2. *On the Laws of Structure of the more Disturbed Zones of the Earth's Crust.* By Professor H. D. Rogers of the United States.

After adverting to previous publications on the subject by himself and Professor W. B. Rogers, the author of the paper began the enunciation of the laws of structure of disturbed tracts of strata, by stating the general proposition, that in all districts where the strata have been displaced from the original positions or levels in which they were deposited, they invariably have the form of one or many waves, even where, from a flatness of the undulations, they seemed to retain their original horizontality. In large areas of undulating strata, where the dips are gentle, the main or primary crust waves are very broad; but where the dips are steep, the crests of the adjacent undulations are more closely approximated, and, generally, the amplitude of the waves is in proportion to their flatness.

It is another prevailing feature of districts of displaced strata, that the undulations into which they have been lifted are approximately parallel, and exhibit a remarkable resemblance to those great continuous billows, which are called waves of translation. This wave-like structure was first distinctly recognised by the author and his brother in the Appalachian chain of the United States, and has been subsequently shown by them to characterize other mountain systems, such as the Jura, the Alps, and the mountainous districts of Wales and Belgium, and other countries.

Parallelism.

1. Expressing, in systematic form, the general relations of the flexures

of the earth's crust to each other, the first law is that of the mutual parallelism of the waves. This prevails not only between adjacent individual flexures, but between these and the chief igneous axes of the disturbed zones, including them. The parallelism extends to the different groups of waves into which the breadth of the undulated district is divided, and subsists as well between those which are curved in their crest lines as between those which are straight. The persistency of this law of parallelism throughout the Appalachian chain was fully exemplified in the paper. The geological maps of the United States and of Pennsylvania, soon to be published, make it obvious upon mere inspection.

2. The flexures, when the undulated belt is broad, exist in groups of waves, and the parallelism is generally more perfect between the members of a given group than between one group and another.

3. Usually where the zone of undulated strata is extensive, there are several orders of waves, as regards their dimensions, the secondary or lesser classes constituting as it were ripples on the slopes and summits of the primary or larger. These minor flexures, or subordinate rolls, are themselves parallel, but not always necessarily parallel with the principal waves upon which they lie.

Form and Gradation of the Waves.

Three essential varieties of form prevail among the great flexures of the earth's crust. 1. The most simple is that of a symmetrical wave, or one where the convex (*anticlinal*) or concave (*synclinal*) curve is of equal flexure upon both slopes. This form belongs chiefly to the flatter and broader waves, and when met with among those of steeply-inclined sides, is apt to be accompanied by an angular bending, or even partial dislocation at the anticlinal or synclinal axis. 2. A second prevailing form is where one side of the wave is visibly steeper than the other. This is the normal type of flexure in the Appalachian chain, in the Jura mountains of Switzerland, and in the undulated zone of Belgium and the Rhenish Provinces. 3. The third class of flexures embraces those which exhibit an inversion or folding under of the most bent slopes of the several waves. This doubling under frequently amounts to an almost perfect parallelism of the two sides of the flexures. In such cases where the alternate convex and concave bendings are numerous, and the whole belt is closely plicated, a transverse section presents the puzzling phenomenon of strata of different ages dipping in one direction, in parallel, seemingly conformable superposition, the newer rocks underlying the older ones as frequently as they overlie them.

Conceiving a series of imaginary geometric planes to bisect the successive anticlinal and synclinal bends in a belt of undulated strata, these axis planes, as they may be called, are, in the case of the symmetrical class of waves, necessarily perpendicular; but, in the other two classes, they are inclined to the horizon, and their dip or inclination is flatter as the waves approach the form of most extreme folding with inversion. In many districts, as along the south-eastern side of the Appalachians, and on both flanks of the Alps, these axis planes, or, what is the same thing, the foldings of the rocks, incline at a very low angle, implying an excessive amount of horizontal movement at the time the strata were thus plicated and packed together.

This parallel reduplication of strata is usually attended by more or less metamorphism, amounting to that change of internal structure which is denominated cleavage; and the cleavage planes, frequently more conspicuous than the original planes of sedimentation, serve still further to conceal the flexures, and disguise the true order of superposition of the rocks.

Waves of the Crust, both Straight and Curvilinear.

In the much corrugated belts, the crust waves are both straight and curvilinear. In the Appalachians, there are groups of both these classes, retaining their special features throughout their entire length, which, in some instances, exceeds 100 miles. Some of the crescent-shaped waves present their convex curvature towards the region of maximum dislocation and metamorphism, while other groups are concave toward the same quarter. These different systems of waves seem to have been generated some of them from straight, others from curvilinear fractures in the earth's crust.

The Appalachian chain, regarded in the light of a long zone, or chain of groups of parallel, straight, and curving waves, consists of eleven sections, six of which are straight, and five curvilinear, three of the latter form being convex towards the N.W., and two convex towards the S.E., the whole zone having a length of 1500, and a maximum breadth of 150 miles. Certain of the straight divisions have their anticlinal axes, or the crest lines of the undulations trending N. 15° E.; other divisions, theirs trending N. 70° E., while some of the curving sections of the chain show a deflection in the direction of their individual axes of as much as 40°. Indeed, in particular instances, the change of trend amounts to as much as 60°. So remarkable a bending without disruption, of groups of parallel anticlinals, seems incompatible with the inferences of some eminent geologists, who conceive that there prevails a general relation throughout the globe between the directions of the lines and the epochs of crust elevation; for we here find that the selfsame axis, generated throughout its whole length, not merely in one geological period, but in one brief interval of time, alters its direction to coincide successively with sundry of the different assumed systems of crust elevation.

GRADATIONS IN FLEXURES.

Every broad belt of undulated strata exhibits certain gradations in the form of its flexures starting from the side of maximum igneous action, as this is displayed in plutonic eruptions, or in dislocations and metamorphism. Crossing the zone, the flexures first met with are invariably of the closely plicated class, their axis planes dipping often at a low angle towards the igneous border. To these succeed more and more open waves, until, from being perpendicular, the steep far sides of the undulations become flatter and flatter in their dips, till at last they assume a slope equal and symmetrical with those of the gentler flanks. Parallel with this gradation is a progressive widening of the waves themselves, and a corresponding sinking or flattening down of the summits, until they finally disappear in imperceptible undulations. All these phenomena of gradation may be clearly discerned in every section across the Appalachian chain, traced from the S.E. towards the N.W., and a perfectly identical structure will be found to exist in the great plicated belt ranging through the Rhenish Provinces and Belgium. In truth, there is no great corrugated zone that does not display a similar law of gradation in its flexures, when these are properly traced and generalized.

FRACTURES IN UNDULATED ZONES.

Two classes of dislocations abound in all the belts of the crust,

the north, and not from the igneous axis of the Alps, or probably from both quarters, at the period of the production of the flexures.

The Alps themselves show the same general structural phenomena as the other plicated zones described, but under more complex conditions. This much convulsed mountain system contains but few waves of the open or normal type, consisting, except in its outer flanks, of many very close plications of the strata. When these foldings are carefully studied and structurally connected with each other, the whole chain appears to be composed of two or more central parallel igneous crests, and each flank of these mountain ranges of a belt of closely compressed waves. Each of these plicated zones or Alpine slopes displays the axis planes of its flexures dipping in towards the centre of its own chain, the flexures nearest the igneous axis plunging at a lower or flatter inclination than those more remote. High in the slopes of the chain, where denudation has removed the largest part of the originally present upper formations, only the synclinal folds of these remain preserved. These are the so-called V's of the tertiary and jurassic beds, pinched in between the closely folded anticlinals of the gneissic, and other older rocks. The inward dip of nearly all the beds of both slopes of the Alps, thus occasioned by the completeness of the folding and the outward thrusting of the anticlinal parts of the flexures, is the obvious cause of that fan-like feature of dip of the entire chain, which has recently excited so much discussion among geologists. Cleavage of the rocks, and a superinduced crystallization parallel to the cleavage planes, contribute not a little, the author conceives, to the illusive appearance of a general inward dip of all the strata, even the newest, under the older formations of the high igneous crests of the chain; for both the cleavage planes and the crystalline foliation observe a very constant parallelism in the direction of their dip to the dip of the axis planes of the flexures.

Slaty Cleavage.

It is now a good many years since Professor Sedgwick and other geologists announced the important general fact, that the structure called *slaty cleavage* pervades the altered strata affected by it in directions independent of their bedding or laminæ of deposition; that these planes of cleavage are approximately parallel to each other over large spaces of country, however contorted the dip of the rocks; and that where the cleavage is well developed in a thick mass of slate rock, the strike of this cleavage is nearly coincident with the strike of the beds. Professor Phillips, in 1843, added to this rule a still more comprehensive and exact expression—that the cleavage planes of the slate rocks of North Wales were always parallel to the main direction of the great anticlinal axes. Since 1837, these phenomena of the close parallelism of the cleavage planes with each other, and with the main axes of elevation, have been observed and recorded by Professor W. B. Rogers and the author of this communication; and in 1849 the author submitted to the American Association for the Advancement of Science a communication on the analogy of the ribbon structure of glaciers to the slaty cleavage of rocks, in which he stated what he deems the true law of cleavage of a district of undulated and plicated strata,—namely, that the cleavage dip is parallel to the average dip of the anticlinal and synclinal axis planes, or those planes which bisect the flexures. The generality of this rule was shown by sections exhibiting the flexures and cleavage in the Appalachians, in the Alps, and in the Rhenish Provinces. Subsequent observations in other localities have confirmed the universality of this law; and the recent description of the Devonian strata in the south-west of Ireland by

Professors Harkness and Blyth still farther tend to illustrate and establish it. In their paper in the *Edinburgh New Philosophical Journal*, (October 1855), they not only recognise an agreement between the strike of the cleavage planes and that of the several rolls (or anticlinals) which affect the island of Valentia, but they show, that while the cleavage dip is northerly, the anticlinal "curves have been pushed over in a more or less southerly direction," inverting the carboniferous limestones and coal measures. Their general statement is, that the cleavage structure of rocks does not result from the simple rolling of the strata, but from this cause combined with a considerable amount of pressure, and this latter force acting from the south, has pushed over the strata in a series of oblique curves to the north, and given to the inclined cleavage more or less of its southern dip. They further support the deductions of Mr Sharpe, "that there has been a compression in the mass in a direction everywhere perpendicular to the planes of cleavage, and an expansion of the mass along these planes in the direction of a line at right angles to the line of incidence of the planes of bedding and cleavage." But from this view of the mechanical nature and the direction of the force engendering cleavage the author of this communication begs leave to dissent.

A second general law is, that where the cleavage is fully developed, and the anticlinal and synclinal flexures are also conspicuous and very sharp, the cleavage planes immediately adjoining these bendings are not parallel to the axis planes, but radiate partially from them, in a fan-like arrangement, upward in the anticlinals, and downward in the synclinals. This aberration from the normal direction is, furthermore, not symmetrical upon the opposite sides of the geometric axis planes, but is usually greatest upon the inverted or steep sides of the waves.

A third prevailing relation of the cleavage planes is—their tendency to deviate from the normal direction of parallelism to the axis planes, in order to conform partially to the direction or dip of the strata; and as in every belt of uniform flexures closely plicated with inversions, the uninverted, or normal dips, greatly exceed the inverted ones in breadth, there prevails a lower inclination in the planes of cleavage than belongs to the planes bisecting the flexures.

There is yet another law modifying cleavage, dependent upon the mechanical texture, and possibly the chemical composition, of the strata. In formations composed of alternations of the coarser mechanical rocks, such as siliceous grits and conglomerates, with the finer-grained argillaceous beds, such as slates, shales, or marls, the coarser beds are unaffected by cleavage, while the finer-grained ones are often pervaded by it. Indeed, there appears a strict proportion between the degree of intimate fissuring of the rocks by cleavage and the degree of comminution of the particles. Connected probably with this interruption in the propagation of the cleavage, the author has observed another modification of the cleavage planes, —namely, that they tend to curve a little from the normal direction, in the finer-grained argillaceous beds, approximating to parallelism with the surfaces of bedding of the adjoining coarser mechanical deposits, as they approach them, showing in a transverse section, a kind of gentle sigmoid flexure. This fact is well illustrated in the cleavage-traversed rocks at the base of the anthracite coal-formation of Pennsylvania, where the red shales alternate with the lower beds of the coal-sustaining conglomerates and coarse sandstones. These remarkable facts seem sufficient of themselves to refute the hypothesis, somewhat in favour at present, of the purely mechanical origin of the cleavage-producing force; for we cannot conceive how a mechanical force either of compression, or of tension, transmitted, as necessarily it must have been, very equally, through parallel layers of coarse and fine material, should have exerted no fissuring action the moment it reached the surface of the coarser beds, and yet have been able to cleave into thin parallel slaty laminæ the whole body of the finer-grained argillaceous strata. One would more naturally suppose that the less finely-aggregated softer mud rocks or shales would have been even less easily fissured into sharp-cleavage joints than the more massive and better cemented grits.

Foliation.

The relations of the foliation or crystalline lamination of metamorphic strata to the cleavage planes and the planes of stratification, are next dwelt on. Two facts may be stated of foliation, which possess perhaps the constancy of general laws. One of them is, that this structure, as it is seen in gneiss and mica schist, observes, when the strata are not traversed by cleavage, an approximate parallelism with the original bedding. The author of this paper has beheld apparent exceptions to this rule in several localities near Philadelphia and elsewhere in the United States; and others have been noticed in Europe by Mr D. Sharpe and other good observers, but all of them can be reconciled to the general fact, and reduced, it is conceived, to the one comprehensive law,—that the planes of foliation, or the laminæ formed by the crystalline constituents of the foliated rocks, are parallel to the planes or waves of heat which have been transmitted through the strata. Whenever large tracts of the gneissic rocks retain a nearly horizontal undisturbed position, the foliation is almost invariably coincident with the stratification; and in this case the wave of heat producing the crystalline structure can only have flowed upwards through the crust, invading stratum after stratum in parallel horizontal planes. Again, when injections of granite have lifted the gneissic strata, the crystalline lamination is generally seen to be parallel to the plane of outflowing temperature.

The other general rule is, that the foliation is parallel, or approximately so, to the cleavage, wherever these two structures occur in the same mass of rocks. This fact, recorded by Darwin, of the gneissic rocks and clay slates of South America, has been noticed likewise by Mr D. Sharpe, Mr David Forbes, Mr Sorby, and other geologists in Great Britain, and by the author in many localities in southern Pennsylvania. An interesting instance of such parallelism of the foliation to the cleavage, in the last-named region, tending to show convincingly that both phenomena are the consequences of one species of force, or but different degrees of development of the same molecular or crystallizing agency, is presented in the great synclinal trough of the lower Appalachian limestone, north of Philadelphia. On the north side of this trough, the primal and auroral rocks, Cambrian or Lower Silurian, dip S., over a wide outcrop, at a very regular angle of about 45°. On the south side, they have been lifted into, and even a little beyond, the perpendicular position, so that the synclinal axis plane of the belt dips at an angle of 65° or 70° to the south. Neither formation shows cleavage structure on the northern side of the valley, the limestone being there of an earthy texture, and in thick massive beds; but on the south, or upturned side, this limestone is altered into a mottled blue and white crystalline marble, and is pervaded with cleavage planes, dipping at angles of 70° and 80° southward. Many parts of the rock are like a foliated calcareous gneiss, thin laminæ of mica and talc dividing the slate-like plates of the marble. What is especially worthy of notice is, that the foliation of the mica and talc, composing some of the thin

present day;—earthquakes being, as they have demonstrated, a true pulsation of the flexible crust of the globe, propagated in parallel low waves of great length and amplitude, with prodigious velocity, from lines of fracture, either conspicuous volcanic axes, or half-concealed deep-seated fissures in the outer envelope of the planet.

Theory of the Origin of Cleavage Structure.

Concerning the cause of slaty cleavage, the author has adopted the explanation originally proposed by Professor Sedgwick, that it is due "to crystalline or polar forces acting simultaneously and somewhat uniformly, in given directions, on large masses having a homogeneous composition." And following up the further suggestion of this idea, ingeniously proposed by Sir John Herschel, that this molecular force was of the nature of an incipient crystallization, and has been developed in the particles, by their being heated to a point at which they could begin to move among themselves, or upon their own axes, he has endeavoured to show that, whether the cleavage-cut strata have been much disturbed or not, the cleavage planes invariably approximate to parallelism with those great planes in the crust which give indications of having been the planes of maximum temperature. It has been already stated, in the present paper, that the cleavage dip is parallel to the average dip of the anticlinal and synclinal axis planes bisecting the flexures. Now it is easy to prove that these axis planes, and the inverted parts of the flexures, are just those portions where the greatest crushing, fissuring, and displacement of the strata must have occurred, and where the highly heated pent-up volcanic steam, gases, and liquid mineral matter would find their chief channels obliquely upward towards the surface. Not to attempt the application of this view in detail, it will suffice at present to state, that every plicated belt of strata may be regarded as having, at the time of its folding and metamorphism, contained from this cause a series of alternate hotter and colder planes or belts, arranged in parallel oblique dip. These planes of temperature are supposed to have acted to polarize the particles of the strata in corresponding parallel planes, by transmitting through the half-softened mass parallel waves of heat, stimulating the molecular crystalline forces ever resident in mineral matter in planes parallel to the generating surfaces.

3. *On a Property of Numbers.* By Balfour Stewart, Esq. Communicated by Professor Kelland.

4. *Analysis of Craigleith Sandstone.* By Thomas Bloxam, Esq., Assistant-Chemist, Industrial Museum; with a Preliminary Note by Professor George Wilson.

One object of the Laboratory of the Industrial Museum is the prosecution of investigations likely to throw light on the economic value of materials employed in the useful arts. It has been impossible this winter to do more than make a small beginning by instituting an examination into the properties of certain of our building stones; and as the results obtained in the case of the sandstone of Craigleith Quarry have an interest for geologists as well as for architects and builders, they are laid before the Society, as all similar results of any scientific value will be in future. The entire investigation will be published in the course of the summer.

It is necessary to remark here that the following experiments were made solely upon the coarser variety of the stone, known as Common or Bed Rock; the finer portions, not yet submitted to chemical investigation, being called Liver Rock, most probably from the closeness of its grain.

The objects which I had chiefly in view in the course of the following inquiry were, the exact chemical composition of the stone; the extent to which it contains other insoluble substances than silica; the amount of substances soluble in pure water, in water saturated with carbonic acid, and in water containing the mineral acids. The extent to which the stone absorbs and retains water, was also object of investigation, and the coaly matter which occurs at intervals in it was analysed.

The whole of the analyses were made by Mr Thomas Bloxam, the assistant-chemist in the Laboratory of the Industrial Museum, who spent much pains on the inquiry. From what follows it will be seen that the Craigleith sandstone, as taken in cubes for building, is nearly all silica, but that it contains in addition small portions of alumina, lime, magnesia, iron, and, occasionally, a hitherto unsuspected ingredient, oxide of cobalt, which Mr Bloxam has distinctly indicated. In addition to those substances, black particles occur disseminated even through the whitest and most solid portions of the stone, which in the majority of cases appear to be coaly matter, but are sometimes in greater part carbonate of the protoxide of iron, coloured by an admixture of coal.

The condition in which those bodies occur in the stone is as important as their relative amount; but it is not so easily ascertained. Much of the silica is present in more or less perfect grains of quartz; a small portion occurs as the chief ingredient of scales of mica, and also probably as felspar; and according to Mr J. Napier of Partick, Glasgow, a certain amount of the silica is in combination with alumina as clay. Mr Napier experimented by reducing the stone to fine powder, and washing it on a flannel filter, which retained the silica, and allowed the clay to pass through. Proceeding in this manner, and receiving on a weighed filter paper the muddy water which passed through the flannel, Mr Bloxam found that 9·33 per cent. of substance remained on the paper after drying at 212°. This may provisionally be called clay, of which it consists in small part; but till it is analysed, it would be premature to discuss its nature. Mr Napier's observation, however, that sandstones contain clay, is an important one, especially in reference to their power to retain moisture, and continue long damp in the walls of buildings.

The iron which occurs so generally in sandstones, and is so important an ingredient, from its tendency to stain the stone after it is quarried and exposed to the air, is certainly present in different chemical conditions. It has been generally assumed, I think, to occur in carboniferous sandstones as bisulphuret; but it appears to be chiefly present in the Craigleith rock as carbonate of the protoxide, the form in which it has always been recognised as prevailing in the shales accompanying such sandstone. As already mentioned, the protocarbonate of iron occurs in detached portions, coating and dividing certain strata of the stone from each other; but it is not on this circumstance that I found the conclusion stated above, but on the following results:—1000 grains of the stone, finely powdered, were suspended in cold distilled water, and a stream of washed carbonic acid gas sent through the liquid for an hour. The water passed through a filter quite transparent; but upon boiling became troubled, and deposited carbonates of lime and magnesia, peroxide of iron, and a little silica. Of these substances the peroxide of iron was the most abundant, and it had plainly been dissolved as protocarbonate. The probability, accordingly, is that the metal existed as carbonate in the sandstone; but it may have been present as metal or as black oxide, though scarcely as bisulphuret, and certainly not as peroxide. The point of most practical interest, however, is, that rain-water, containing, as it always does, carbonic acid, is able to dissolve iron as well as lime and magnesia from exposed sandstones, so that we may always expect to find them colour more or less from the solution and subsequent peroxidation of the iron which they contain.

It was not found possible to remove the whole of the iron from the powdered sandstone by the action of carbonic acid water, for after it had exerted its full effect, hydrochloric acid, if boiled on the powder, extracted iron as peroxide, unaccompanied by protoxide.

The action of other solvents on the stone is as follows:—Distilled water boiled upon it in fine powder acquired a notable quantity of lime, a small quantity of sulphuric acid, and a trace of iron. Minute quantities of the alkalies, of magnesia, and of silica, were doubtless also present, but were not sought for. Hydrochloric acid boiled upon the powdered stone yielded a solution in which protoxide and peroxide of iron, alumina, lime, and magnesia, were found in marked quantity; and traces of manganese and cobalt, along with potassa, soda, and silica, in small quantities.

From those results it will be seen that the purest water can dissolve a certain amount of substance from Craigleith sandstone; that if charged with carbonic acid it will disintegrate it further; and that if containing free mineral acids, as the rain-water of towns occasionally does, it will decompose it still further.

In connection with those results, it is important to notice the extent to which the stone absorbs and retains water, points on which Mr Napier has already made valuable observations. The specimens selected for the following trials had an average sp. gr. of 2·443.

A piece weighing 3506·1 grains, which had been received from the quarry in the month of November 1855, and remained for about a month in a room without a fire, was kept at 212°, till it ceased to lose weight; the loss was equivalent to 5·7 fluid ounces per cubic foot.

A similar piece, weighing 4597·95 grains, was immersed in distilled water at 58°, till it ceased to gain weight. The surface-moisture was then allowed to evaporate, and the stone weighed. The gain was equivalent to 3·8 imperial pints per cubic foot.

According to Mr Napier, a sandstone acquires much more moisture if allowed to absorb it by capillary attraction from one part of its surface, than if entirely immersed in water; but upon making the experiment in the way he describes, the difference by capillary attraction was comparatively small, the whole gain being 4·2 imperial pints on the cubic foot. On the other hand, when the stone was immersed in water under the belly jar of the air-pump plate, and the air withdrawn, the ultimate gain in weight amounted to 6·2 imperial pints per cubic foot. The error of those who hope to render buildings dry by constructing their walls of solid sandstone, will be sufficiently apparent from these facts. The numerical results obtained by Mr Bloxam are added in full.

Royal Physical Society.

Thursday, 28th February 1855.

Robert K. Greville, LL.D., in the Chair.

The following Communications were read:—

1. *On Uigite, a new mineral (?)* By M. Forster Heddle, M.D.

In a quarry near Uig, in Skye, I obtained indifferent specimens of Faroelite, a single crystal of Analcime, and a few pieces of a substance which, being unknown to me, I analyzed, and which may be considered new. Should this be admitted, I would propose for it the name Uigite. It occurs in small nests in the amygdaloid, which is here very vesicular, is not distinctly crystallized, being in radiated sheafy plates, somewhat resembling the structure of a plumose mica, but in general appearance intermediate between Faroelite and gryolite; colour white, slightly yellowish; lustre tremulous and pearly: hardness, 5·5, brittle; specific gravity, 2·284; before the blow-pipe fuses readily and quietly, with strong re-action of soda, to a white opaque enamel, which is not frothy. On analysis, it afforded 45·98 per cent. of silica, 21·93 of alumina, 16·15 of lime, 4·7 of soda, and 11·25 water. These proportions give equivalents,—silica, 7; alumina, 3; lime, 4; soda, 1; water, 9. The mineral, therefore, consists of 1 equivalent of a silicate of lime and soda (where the lime is to the soda as 4 to 1), 1 equivalent of a sesquisilicate of alumina, and 9 of water. The calculated percentage proportions of which compound are,—silica, 46·09; alumina, 21·93; lime, 15·97; soda, 4·46; water, 11·55; which agree closely with the analytical results. No mineral has the above formula, which differs, however, from that of Faroelite (Mesole), merely in the insertion of the compound 2 (Ca O, Si O) + H O.

2. *Remarks on the Scientific bearings of recent discoveries in Helminthology.* By James Wardrop, Esq.

3. *Notice of a curious Metamorphosis in a Zoophyte-like Animal.* By Charles W. Peach, Esq., Wick.

In March last year, I obtained from a fisherman's line an old and much corroded valve of *Psanombia ferroensis*, which had been hooked up from deep water; on it I noticed jelly-like spots, and placed it in a shallow glass of sea water; the next day I fancied that I could make out, with my pocket lens, zoophyte-like animals. At once I transferred the shell in a watch glass, filled with sea water, to my microscope, and was delighted to find my suspicion correct, for after a little management, so as to catch the light, I could see the forms as figured (Fig. 1) attached to the shell by a short foot-stalk, a little inflated near the upper part, tipped with a slightly raised and rounded centre, from which extended four long and four short leaf-like arms, each granulated down the centre; one or two had, in addition, springing from these, delicate tentacle-like arms, probably in a farther stage of development. They were easily disturbed, but soon again displayed themselves; their transparency, added to this shyness, rendered it difficult to catch their forms. At first I thought they were the early stage of a *Hydractina*, and probably, *H. brevicornis* of Müller, mentioned in Johnston's second edition of "The British Zoophytes," page 35. My next examination was on the 2d of April. After giving them a supply of sea water, they were still fixed; I could, however, perceive a difference, the centre of the head more raised and cone-shaped, and the arms shorter. I continued my examinations daily; and on the 6th, instead of moored creatures, I had a fleet of probably one hundred minute, free, naked-eyed, medusoid-like beauties (Fig 2), jerking about in all directions, with the exception of size all alike, perfectly transparent; the umbrella

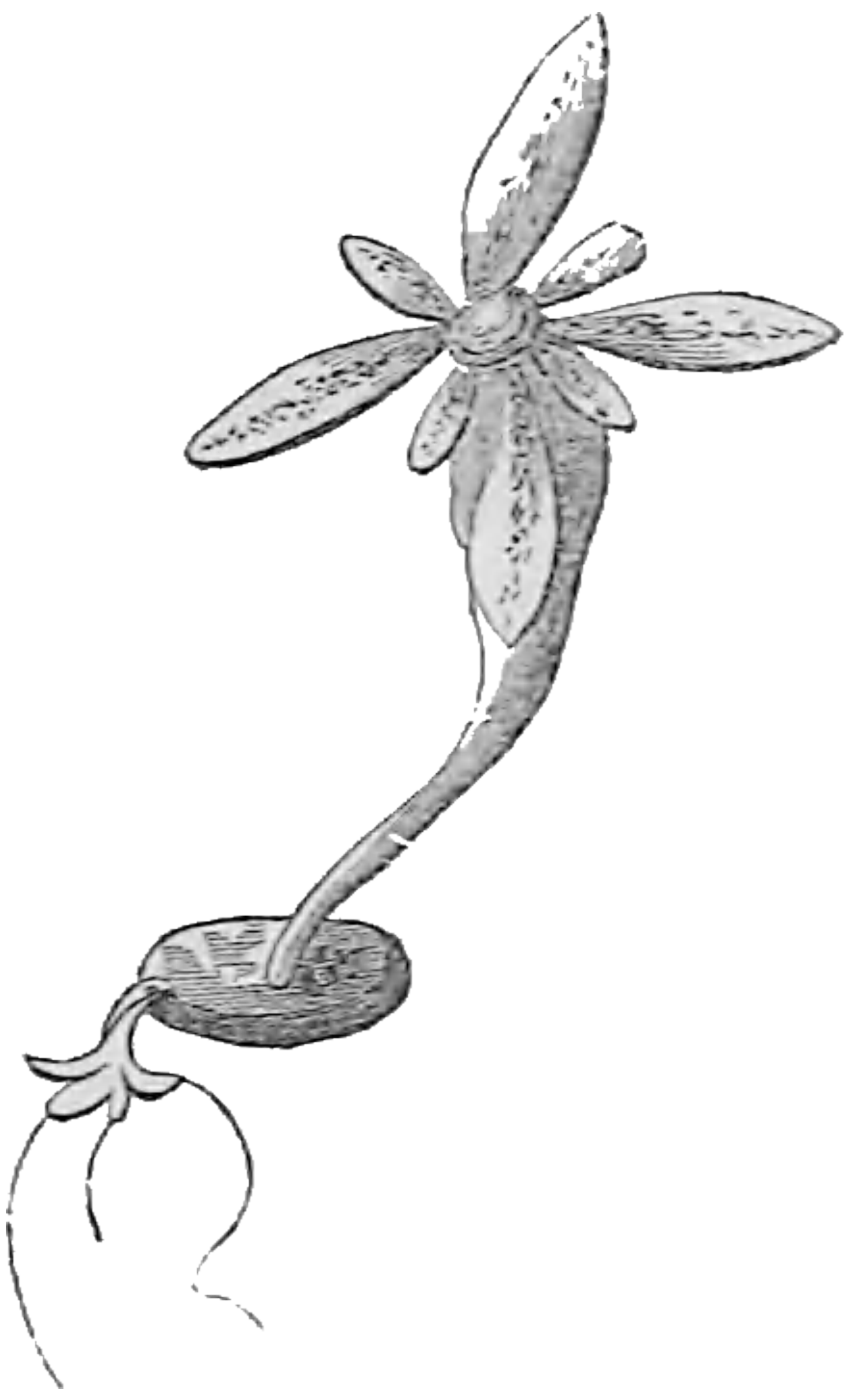


Fig. 1.

Fig. 2.

well rounded and pilose; the sub-umbrella large; each had four large ocelli-like bulbs on the edge of the mantle, furnished with a stiffly turned-up tentacle, tipped with a disk having a dark centre; this surrounded by a light ring, and outside a darker edge, dark but short bars arranged in a quincunx manner on these tentacula. The ocelli were composed of minute, dark granules. As well as these long tentacula, there were four smaller and shorter ones, also turned up, but no ocelli where the edge of the mantle is shown. On the lower part of the mantle runs a canal communicating with the bulbs of the large tentacula; in the canal I observed a granular circulation passing along, and, as if revolving in the bulbs and a short way down each large tentacle; into these bulbs smaller granules descended from the sub-umbrella, by the gastro-vascular canals; these canals extended to the upper part of the stomach, the stomach being attached to them, and is rounded on the upper part, and divided into four lobes; it then narrows and runs out bell-shaped to the quadrate mouth, which has four long lips fimbriated at the tips. They were very active up to the 10th, when some little change took place. I supplied small quantities of water, and used every precaution, from being anxious to see all I could of them. On the 11th they became sickly, and the upper part of the umbrella in eight festoons, the tentacula slightly drooping. On the 13th, nearly inactive, hyaline, and *turned inside out.* I began to hope that, as the mouth *had become elongated* into a peduncle-like form, they were about to become fixed again; they, however, dwindled away, and although I kept the water for months, I could trace nothing more. I have not yet seen Steenstrup's work on "The Alternation of Genera," therefore am unable to say whether it may be one of the interesting facts noticed by him. They differed in the *fixed state* from any of the zoophytes figured and described by Johnston; and when *free* from all the naked-eye medusæ figured in the monograph of Forbes, it may be one of the latter in its earlier stages, and probably is, *from being pilose,* this being the case with many of the young of the medusoid tribe which have fallen under my notice, and I have seen many. This is the most interesting of all. The most like the free state, is *Lizzia octopunctata* of Forbes, Pl. xii., fig. 3; it agrees thus far in the form of the umbrella, in having 8 tentacular bulbs, 4 gastro-vascular canals, the shape of the stomach, quadrate mouth, and long fimbriate-tipped lips. It differs in being pilose, and having only 8 tentacula, instead of 20, viz., 3 at each large ocelli bulb, and 2 at each of the smaller ones ; even this difference in the number of tentacula, &c., ought not to put it out of court, for I have seen, and have a long list of notes and numerous drawings of the strange changes from the young to the adult state of these lovely gems. At present I cannot spare the time to make the drawings and extend the notes. I present this fact, so that others may be aware that such transformations are to be met with on our own coasts, and that by watching for shells from deep water thus begemmed, a series of observatious may be made, and more facts collected, so that the true nature and phases of these Proteus-like objects may be made out.

4. *A Letter was read from the* Rev. H. M. Waddell, *Old Calabar, to* Andrew Murray, Esq., *containing additional information regarding the new Electric Fish* (Malapterurus Beninensis, Mur.)

Mr Waddell writes as follows :—" As you attach some importance to an observation I had formerly made concerning the power of the small electric fish of this river to benumb other fish with which they come into contact, I should have verified my observation by renewed experiments. An opportunity soon offered of accomplishing this object, and I now communicate the result, which you will probably deem to be of a very satisfactory description. I have four electric fish in a large basin, the largest about six inches long, and as thick as the neck of a quart bottle ; the smallest about three inches long, and the thickness of your finger. They have been there in a healthy state for some months. I procured eight small fishes, varying from two to three and a half inches in length, which I put in with the others. The electric fish continued, as usual, side by side, quiescent at the bottom, while their visitors swam and darted about in a lively manner, and even ventured down among their dangerous neighbours, rousing them to activity, passing through their ranks, and disturbing them not a little, without seeming to be either afraid of them or molested by them. They frequently rubbed sides without any effect similar to what I had before observed being produced, and I began to fear that my former observation would not be confirmed. Having watched their movements in vain, I retired for a while, but returned in half an hour to see how they were getting on. I then found the new-comers, all but one, the largest of them, lying at the bottom among the electric fish. Having taken out the seven which were evidently struck, I found four of the smallest quite dead and stiff, their backs twisted or curved, and their mouths gaping open. Three of them, though much benumbed, revived when transferred to another basin of water, and, after an hour or two, recovered perfectly, and were as lively as before. The one which escaped at first was left with his dangerous companions, but was not so lively as at the first. It would swim about a little, then sink, again rise and make a few darts, and then sink again. Tired of watching him, I went on with my book, but after a little returned, and found him quite dead, his back curved downwards very considerably, and his mouth gaping half an inch open. Taking him by the tail, I lifted him out as stiff as if frozen, and further, observed his colour quite gone ; a very dark brown before, he was now as pale as ashes. I had noticed something of this change of colour in the first four affected, but not of so marked a kind as in this last one. The three which recovered from the first attack remained to be tried again, and were put in with the electric fish a second time, when quite strong and lively. They swam and frisked about as playfully and safely

Actinia mesembryanthemum, *troglodytes*, and *bellis*, were exceedingly prolific, Sir John Dalyell and Dr Cobbold having seen twenty or thirty produced at a single litter from the first species, and yet the number of very young Actinias found in situations where old specimens abounded was very small, and certainly bore no proportion to the number generated. The cave at Arran was very difficult of access, on account of its shallowness and the floor being covered by a pool of water; and the Actinias were only to be reached by assuming a posture which could not be maintained for more than a few minutes. A number were, however, obtained, which, being attached to sponges, were easily stripped from the rock, and with them were associated a great number of very small specimens. Not long afterwards the author noticed a number of young surrounding a large white *dianthus* in the Vivarium of a friend at Leith, and was told that the Actinia, while moving round the tank, had left behind it small white bodies, which separated themselves from the foot or sucker and became young Actinias. Sir John Dalyell had described a similar mode of multiplication in *Actinia lacerata*, and Hollard in *Actinia rosea* (?) The former writer had observed that *Actinia lacerata* protruded from all parts of its foot, stolons or suckers, which became detached, and presently put forth tentacles, and were developed into minute Actinias. After reading Sir John Dalyell's account of *Actinia lacerata*, Dr Wright was anxious to ascertain whether there might not be included in the prolongations separated from the foot, either true ova or germs, or some tissue specialized for the production of young. In the hydroid zoophytes, such as *Hydra*, *Coryne*, &c., the walls of the body consisted of three elements or layers,—a dermal or integumental, an areolar or muscular, and a mucous or intestinal layer; and when gemmation took place in these animals, it occurred by the protrusion of a simple diverticulum or sac from the canal of the body, formed of all the three elements. This diverticulum was developed into a polype body, with mouth and tentacles like those of the polype, from which it pullulated; the two bodies having the digestive canal and all the tissues continuous with each other. In *Hydra tuba*, multiplication took place by stolons, which extended to some distance from the body before the new polype bodies sprouted from them, but in that case also a prolongation of the intestinal element passed through the stolon from the old into the new body. These new polypes were not young; their production was a simple increase of the individual, becoming afterwards a multiplication, either by accident, in some cases, or in others by a natural process of absorption. The structure of the helianthoid zoophytes or Actinias was more complicated in its development than that of the hydroid polypi, but it consists of the same three elements. The dermal coat was succeeded by the muscular element, which constituted the chief part of the external wall of the body and tentacles, and then passed inward to the stomach, in the form of septa or partitions, which suspended that viscus in the centre of the body, and divided the intervening spaces into numerous chambers. The mucous or intestinal element existed as a flattened sac or stomach, which appeared, when viewed edgeways, as a mere line extending down about half the centre of the body. The stomach communicated freely with the general cavity of the body. This cavity, which corresponded to the water-vascular system of the Acalephæ, was single below, but as it passed upward it formed a number of chambers divided from each other by the septa before mentioned, and finally communicated with the tentacles, each chamber terminating in the cavity of a single tentacle.

The whole of the general cavity and its chambers was lined with cilia, by which a constant circulation of the fluid was sustained, and the functions of nutrition, respiration, and excretion were all carried on simultaneously. From the lining membrane of the general cavity, the male and female reproductive organs were also developed, and there, in some species, the ova were hatched, and the young (at first mere shapeless, ciliated germs, swimming rapidly in the fluids of the cavity, chambers, and tentacles) became fully formed, passed into the stomach of the parent, and were ejected from the mouth as perfect Actinias, with mouth, tentacles, and suctorial foot. The author had thought it possible that the prolongations from the foot of *Actinia lacerata* might contain one of these hatched germs in its imperfect state, and that it might be thus deposited on the surface occupied by the parent, and its safety insured. Having some specimens of dianthus in his possession, he had waited for some time in vain for their multiplication by fissure; he therefore determined to try an *experimentum crucis*, and for that purpose having placed the specimen in a jar of sea-water, and fed it until it had become fully distended, he examined the edge of the foot, which was perfectly transparent, with a powerful lens, and convinced himself that no ovum or germ existed in that situation. He then separated a piece about a line in length, by half a line in breadth, from the edge of the foot. The parts immediately receded from each other, and the next day he found that the separated portion had crept to a considerable distance along the glass. In two or three days it had raised its divided edge from the surface to which it was attached, and had become a curved column; in a fortnight tentacles had appeared; and in three weeks it had become a perfect Antinia, with a single row of beautiful long tentacles. From the foot of this small Actinia he cut two other exceedingly minute slips, which also became Actinias; and from the foot of the original Actinia he also separated, at various times, fourteen other slips, all of which became developed as the first. The author stated that this case of gemmiparous increase was an instance of the development of a perfect and very complicated organism, from a minute fragment of one similar to itself, all that was essential to the process being apparently the existence of a portion of each of the three elemental tissues of the original, the dermal, the muscular, and the mucous tissue,—the last being represented by the lining membrane of the general cavity. And it appeared to be analogous to the instance of gemmation from the water-vascular system observed by the late Professor Edward Forbes in *Sarsia prolifera*, in which animal the young medusæ pullulated forth from the hollow bulbs which supported the tentacles.

4. *Memorandum of Shells and a Deer's Horn found in a cutting of the Forth and Clyde Junction Railway, Dumbartonshire.* By JAMES M'FARLANE of Balwill, Esq., W.S. (Specimens exhibited.)

Wednesday, 23d April 1856. W. H. LOWE, M.D., Pres. in the Chair.

1. *Account of an Undescribed Marine Animal.* By T. STRETHILL WRIGHT, M.D. (This paper will appear in the next number of the Journal.)

2. *Note on Indications of the Existence of Bilateral Symmetry, and of a Longitudinal Axis in* Actinia, *as shown in Living Specimens.* By T. STRETHILL WRIGHT, M.D.

The author stated, that he had lately received from the south of England several specimens of *Actinia bellis*, which illustrated in a striking manner the existence of bilateral symmetry and of a longitudinal axis, maintained by Agassiz as occurring in this and other classes of the Radiata. The members of the Society would at once perceive that the disks of the animals placed on the table were not circular, but oval; and that the slit of the mouth intersected the long diameter of the oval. Agassiz had noticed that the fœcal discharge in Actinia always took place from one extremity of the mouth, which was indicated by a tentacle of peculiar colour or form. This observation had been confirmed by Dr M'Bain of Leith. In some of the specimens exhibited, the fœcal extremity of the mouth was marked by a brilliant yellow tentacle, while all the other tentacles were of the usual mottled-brown colour. Others of these specimens, again, exhibited still more remarkable markings. At first sight, their disks appeared to be accurately divided into four quarters, three of which were striped with broad lines of white, whilst the fourth was of an unmixed brown colour. A closer inspection showed that this fourth was intersected by the line of the mouth and the long diameter of the oval, so that in these specimens the bilateral symmetry was perfect, and the existence of an antero-posterior diameter very apparent.

3. *Specimens of living Madrepores* (Caryophyllia Smithii), *from Ilfracombe, Devonshire, were exhibited.* By T. STRETHILL WRIGHT, M.D.

4. *A Collection of Scales of the* Holoptichius maximus *was exhibited; found on Rule Water, Roxburghshire.* By JOHN ALEX. SMITH, M.D.

Botanical Society.

Thursday, 10th April 1856. Professor BALFOUR, V. P., in the Chair.

Professor Balfour read a letter from Professor Allen Thomson, Glasgow, in which he remarks:—

" I got the other day a curious specimen of a piece of plane tree, with a portion of the metatarsal bone of a large ruminating animal imbedded in it. The bone was about three or four inches in diameter, and so completely imbedded that the turner had worked for some time upon it, and was about to finish the wood for a printing roller when his tool grated on the bone, and he broke up the wood. I have, from the rings of wood, made out its place to have been not far from the centre of a tree of not less than 16 or 18 inches in diameter.

The following Papers were then read:—

1. *Remarks on the State of the Forests in Pegu, and other parts of India.* Communicated by Professor BALFOUR.

The statements in this communication were taken from Dr M'Clelland's Report as given in a Madras paper transmitted by Dr Cleghorn. It was stated that that report, taken in connection with Dr Falconer's report on the forests of the Tenasserim provinces and Dr Cleghorn's on the forests of Madura and Malabar, prove—

1. That the forests of Southern India and Pegu are approaching rapidly to exhaustion. 2. That the first step necessary to check this process is a more effective organisation of the forest department of the government of India. Instances are recorded in the Tenasserim provinces of the indiscriminate felling of teak trees of all ages. Trees with a straight bole of 100 feet, and trees with the wood not yet hard, were all hewn down alike. In some forests the axe never ceased for twenty years. In others, every teak tree was removed. In Malabar the destruction had not been so extensive, and steps had been taken to prevent the further deterioration of the forests.

In Pegu, it appears that the Burmese Government and the squatters

DICOTYLEDONES.

Thalamifloræ	59
Calycifloræ, Polypetalæ	78
———— Gamopetalæ	55
Corollifloræ	72
Monochlamydeæ	50

MONOCOTYLEDONES.

Petaloideæ	32
Glumiferæ	74
Total, ...	420

Among the more interesting of these may be enumerated the following —Brassica monensis, on the sandy shores; Sagina subulata, Malva moschata, Hypericum Androsæmum, Geranium sanguineum, Radiola Millegrana, Rubus discolor, Lythrum Salicaria, Cotyledon Umbilicus, Sedum Telephium, Carum verticillatum, Conium maculatum, Eryngium maritimum, northern shores of the Great Cumbrae; Haloscias scoticum, Helosciadium inundatum, nodiflorum; Œnanthe Lachenalii, Dipsacus sylvestris, naturalized; Hieracium gothicum, vulgatum; Jasione montana, Calluna vulgaris, var. tomentosa, Pyrola media, Erythræa littoralis, Convolvulus Soldanella, sandy northern shores of the Great Cumbrae; Mertensia maritima, western shore of the Great Cumbrae; Solanum Dulcamara, Hyoscyamus niger, Linaria vulgaris, Lamium intermedium, Lycopus europæus, Scutellaria galericulata, Stachys ambigua, Pinguicula lusitanica, Utricularia minor, vulgaris; Anagallis tenella, Samolus Valerandi, Littorella lacustris, Atriplex Babingtonii, erecta; Salicornia herbacea, Suæda maritima, Polygonum Raii, Rumex viridis, Habenaria viridis, Listera cordata, ovata; Juncus maritimus, Alisma ranunculoides, Zostera marina, var. angustifolia, Carex extensa, paniculata, vulpina; Eleocharis uniglumis, Schœnus nigricans, Scirpus maritimus, Catabrosa aquatica, var. minor, Festuca arundinacea, Pseudo-Myurus; Melica uniflora, Phalaris arundinacea, var. picta, Schlerochloa maritima, Triticum laxum.

Of Ferns and their allies collected on the island the following is the number:—

Equisetaceæ	4
Filices	20
Lycopodiaceæ	3
Total	27

The proportion of Ferns, as compared wlth Phanerogamous plants, is large. Among the more interesting of these may be noticed—Asplenium marinum, Botrychium Lunaria, Hymenophyllum Wilsoni, Lastræa fœnisecii, Ophioglossum vulgatum, Osmunda regalis, Polypodium Phegopteris, Polystichum angulare, Scolopendrium vulgare.

Among other plants gathered may be mentioned Chara flexilis, Palmella cruenta, which formed a covering of the sandstone in many of the streams, and Batrachospermum moniliforme.

The following is a list of the Cumbrae Mosses, partly determined by Mr Nichol, and partly from a list given by Mr Levack:—Sphagnum cymbifolium, acutifolium, cuspidatum, squarrosum; Pleuridium subulatum, Gymnostomum tenue, Weissia controversa, Dicranum heteromallum, varium, cerviculatum, Scoparium, palustre; Campylopus flexuosus, Fissidens bryoides, adiantoides, taxifolius; Pottia Heimii, truncata; Tortula muralis, subulata, unguiculata; Didymodon rubellus, Ceratodon pur-

pureus, Trichostomum homomallum, Orthotrichum affine, Grimmia pulvinata, maritima ; Racomitrium lanuginosum, canescens, aciculare ; Ptychomitrium polyphyllum, Physcomitrium ericetorum, Entosthodon Templetoni, Splachnum ampullaceum, Bartramia fontana, pomiformis ; Bryum capillare, carneum ; Mnium punctatum, undulatum, hornum, rostratum ; Atrichum undulatum, Pogonatum nanum, alpinum ; Polytrichum commune, Fontinalis antipyretica, Neckera complanata, Pterygophyllum lucens, Pylaisea polyantha, Homalothecium sericeum, Thamnium alopecurum, Thuidium tamariscinum, Hylocomnium splendens, triquetrum, loreum, squarrosum ; Plagiothecium undulatum, Eurhynchium longirostre, Stokesii ; Brachythecium rutabulum, velutinum, populeum, plumosum ; Hypnum commutatum, revolvens, cuspidatum, scorpioides, Schreberi, fluitans, purum, cupressiforme ; Jungermannia asplenioides, tamarisci, furcata.

The following list of Lichens collected on the Cumbraes, has been prepared by Mr Macmillan :—Nephroma resupinata, in fruit ; Parmelia caperata (barren), pulverulenta, parietina, stellaris ; Sticta scrobiculata, barren ; Borrera tenella, Placodium plumbeum, Sphærophoron coralloides (in fruit), compressum ; Parmelia glomulifera (barren), omphalodes (in fruit), perlata, barren ; Cladonia rangiferina, uncialis ; Roccella tinctoria, Parmelia conspersa, in fruit ; Peltidea canina, horizontalis ; Scyphophorus alcicornis, Ramalina fraxinea, fastigiata ; Parmelia saxatilis, Lecanora tartarea, Parmelia Aquila, in fruit ; Evernia prunastri, Usnea florida, Squamaria murorum, Ramalina scopulorum, Lecidea geographica, sulphurea ; Lecanora atra, Sticta pulmonaria, barren ; Parmelia olivacea, Variolaria velata, Lecanora parella, Collema lacerum, Sticta fuliginosa, barren ; Squamaria affinis, Parmelia perforata, barren ; Stereocaulon paschale, in fruit.

Mr Macmillan remarked, "In the above list of the more conspicuous Lichens of these islands, it will be observed that several species occur which are usually found only in the depths of shady woods in situations far inland. The Parmelia glomulifera, Sticta scrobiculata, Placodium plumbeum, Nephroma resupinata, and Sticta fuliginosa, are almost peculiar to the extensive forests of mountainous regions where there is a great deal of moisture and shade; and hence their occurrence not merely as stray or isolated individuals, for the Lichens are sometimes very erratic in their choice of habitats, but in considerable quantities on islands almost entirely destitute of wood and very much exposed, is a somewhat singular circumstance. It is also curious to notice in the list no less than eight species, which we should scarcely expect beforehand to find, inasmuch as they belong to a somewhat Alpine zone, which usually commences at a greater elevation than that of the highest ground on the islands. The region in which the Cladonia rangiferina, Lecanora tartarea, Lecidea geographica, Sphærophoron coralloides, Parmelia omphalodes, &c., prevail in the greatest quantity, and attain to their greatest luxuriance and beauty, commences about 500 feet, and terminates at a height of 1000 feet or a little more. Of course extensive patches of these Lichens may sometimes be found at much lower elevations; indeed, I have repeatedly gathered considerable quantities of each of them, but very diminutive and ill-developed, all along the west coast of Scotland in immediate proximity to the sea—but it is only within the above limits that uniformly large and perfect specimens furnished with fructification can be obtained. There are two Lichens occurring on these islands which are found on almost all our sea coasts, and are never found far inland, the Parmelia Aquila and Ramalina scopulorum. The former has never been found, I believe, at a greater distance from the sea than some 20 or 30 miles, and always grows on rocks fully exposed to the sea breeze; it is found in considerable abundance on rocks so situated on Arthur's Seat. The latter Lichen is peculiarly plentiful upon rocks along the west coast of Scotland, and attains a greater length and thickness in proportion as we advance northward, the Orcadian rocks being sometimes covered with individuals from six to eight inches long, and nearly one broad. The specimens obtained in the Cumbraes are among the longest and shrubbiest I have ever seen, and present a remarkable contrast to those gathered on the east coast, and especially along the Firth of Forth, where it is rare to find an individual above an inch high, and with lateral branches. The fructification is rather uncommon, and occurs, I believe, more frequently on small and well-grown individuals, than on those which attain the greatest length; the thallus, in the case of the latter, commonly developing new elongated branches at the points of the margin where apothecia ought to have been produced. The specimens found in the Western Islands differ considerably from those collected on the Irish coasts, in being much narrower, of a paler colour, and destitute of the oblong pale pitted buds, which give a rough appearance to the aged Irish plant, and also in the disk of the apothecia being of a much lighter colour, and nearly similar to the thallus. It is a very variable species, however, if species it can be truly called, presenting slight difference as regards size, colour, shape, and mode of branching, on almost every coast. I have observed in Menzies' Herbarium at the Botanic Garden, a specimen marked *R. scopulorum ?* collected on the coast of the Mexican State of California, which appears to me to differ very little from certain states of our native specimens, except perhaps in the thallus being a little thinner, softer, and somewhat lacunose; and I possess specimens collected in New Zealand and the antarctic regions, which, making the usual allowances for the widely different circumstances in which they were developed, may safely be referred to one or other of the numerous states of our own *R. scopulorum.*

"By far the most interesting rarity found in these islands, however, is the Roccella tinctoria. This well-known and valuable Lichen is now for the first time ascertained to be a native of Scotland; the most northern localities previously known for it being the maritime rocks along the south coast of England, and the Guernsey, Portland, and Scilly Islands. The specimens found on the Cumbraes, where I believe it occurs in pretty considerable abundance, are somewhat slender and diminutive, but remarkably characteristic. They are very shrubby and usually elegantly formed, and are covered with a profusion of powdery warts. The west coast of Scotland, and especially the smaller islands, have been very little visited and explored by the botanist; and hence it is that we have remained so long ignorant of the existence of this very interesting addition to the Flora Scotica. I have no hesitation in saying that, were a sufficiently careful and diligent search once instituted along the other smaller and less known islands on the same coast, we should be able to record more than one locality in Scotland for the Roccella tinctoria. I may add, in conclusion, that the nomenclature of these Lichens is that of Hooker's English Flora. I have adopted it in preference to that of other authors, whose works are now slowly finding their way among us—not because it is the best, but because it is more simple and familiar—generally better understood, and can be easier consulted."

The following list of Marine Algæ found on the coast of the Cumbraes, was prepared by Mr R. Hennedy :—Halidrys siliquosa, Fucus vesiculosus and var. balticus, ceranoides, serratus, nodosus, canaliculatus; Himanthalia lorea, Desmarestia aculeata, viridis; Alaria esculenta, Laminaria digitata, bulbosa, saccharina, phyllitis, fascia: Chorda Filum, lomentaria; Zonaria parvula, Dictyota dichotoma and var. intricata; Stilophora rhizodes, Lyngbyii; Dictyosiphon fœniculaceus, Striaria attenuata, fragi-

ticula tenuis, sinuata; Tabellaria fenestrata, flocculosa; Diatoma elongatum, Melosira varians, distans; Mastogloia elliptica, Colletonema neglectum.

In the above list, is added to the names of such species as have been recently added to the British Flora the name of the observer.

It will be seen that the number and variety of species is considerable, yet, as we have found in all other localities in summer or autumn 1855, smaller than usual. The species are for the most part, indeed with very few exceptions, such as belong to fresh water; for the only forms that belong to brackish or sea water, are Navicula elegans, Pinnularia peregrina, and perhaps Synedra acicularis.

There are two or more forms, which, although I have described them as occurring in the Glenshira sand, are yet more frequent in some of these gatherings than I have seen them elsewhere. Such are Cocconeis transversalis, which I have also found in other fresh-water gatherings; and Tryblionella apiculata, figured in the paper I lately read to the Royal Society. The rest of the forms, with the exception of those marked with my name, and one or two others of Ehrenberg's, are such as have long been known, and are very frequent.

Besides the 94 species I have named, there are four or five doubtful forms, which I have not yet had time to determine with precision. One of these resembles a Tryblionella, another a Stauroneis, a third a Pinnularia, a fourth a Cymbella, and a fifth a Navicula. But there is nothing specially interesting about these, and they will most likely prove to be varieties or immature forms.

Some of the gatherings yield very pretty slides, containing good specimens of many forms. Stauroneis acuta, a rare form, occurs but sparingly in one gathering.

Mr M'Nab laid on the table the following record of the flowering of spring plants at Annat Cottage, in 1856 and 1855, kept by the late Mr David Gorrie:—

	1856.	1855.
Eranthis hyemalis . .	January 24	January 11
Garrya elliptica . .	February 6	Blasted by frost
Galanthus nivalis . .	... 8	February 20
Leucojum vernum .	... 15	March 3
Hepatica triloba . .	... 21	... 29
Sisyrinchium grandiflorum	... 25	Blasted by frost
Helleborus viridis . .	... 28	April 6
Salix purpurea . .	March 3	... 6

	Degs.			Degs.
January 1856, mean temp.,	1st week, 40·05	...	Jan. 1855,	1st week, 45·30
... ...	2d week, 32·50	...	...	2d week, 37·87
... ..	3d week, 35·50	...	...	3d week, 34·81
... ..	4th week, 35·25	...	...	4th week, 32·12
February 1856, ...	1st week, 38·21	...	Feb. 1855,	1st week, 34·78
... ...	2d week, 41·78	...	...	2d week, 30·64
	3d week, 38·93	...	...	3d week, 29·85
... ...	4th week, 44·94	...	...	4th week, 34·07

Sweet-scented Coltsfoot flowering in remarkable abundance in the open ground in the latter part of February, and also sweet scented Violet; Garrya elliptica more rich in blossom than usual, having brought none to perfection last year. Bees busy gathering honey and pollen before the end of February.

5. *Register of the Flowering of Spring Plants in the Royal Botanic Garden, as compared with the four previous years.* By Mr M'Nab.

	1856.	1855.	1854.	1853.	1852.
Scilla bifolia alba	Mar. 15	April 5	Mar. 13	Mar. 27	Mar. 21
Narcissus pumilus	„ 16	„ 2	„ 10	„ 21	„ 11
Rhododendron Nobleanum ...	„ 16	„ 13	„ 2	„ 22	
Scilla bifolia rubra	„ 16	„ 6	„ 14	„ 30	„ 28
Asarum europæum	„ 18	„ 18	„ 16	„ 28	„ 29
Primula nivalis	„ 18	„ 10	„ 4	„ 15	Feb. 20
Tussilago nivea	„ 18	„ 14	„ 18	April 1	„ 27
Gagea lutea	„ 19	„ 14	„ 23	„ 12	April 6
Knappia agrostidea	„ 20	Mar. 2	Feb. 28	Feb. 1	Jan. 31
Scilla bifolia cœrulea ...	„ 20	April 10	Mar. 15	Mar. 27	Mar. 20
Draba aizoides	„ 20	„ 11	„ 20	April 1	„ 26
Corydalis solida	„ 24	„ 16	„ 14	„ 8	„ 28
Doronicum caucasicum ...	„ 24	„ 11	„ 11	Mar. 26	
Erythronium Dens-canis ...	„ 24	„ 11	„ 10	„ 19	„ 12
Potentilla alba	„ 24	„ 16	„ 16	April 12	
Puskenia scilloides	„ 25	„ 16	„ 27	„ 2	„ 28
Vinca minor	„ 25	„ 16	„ 7	„ 4	
Ranunculus Ficaria	„ 26	„ 24	„ 29	„ 7	„ 15
Hyoscyamus Scopolia ...	„ 26	„ 15	„ 14	„ 4	„ 25
Ribus sanguineum, first flower seen open on standard plants	„ 26	„ 19	„ 14	„ 4	„ 21
Hyoscyamus physaloides ...	„ 27	„ 14	„ 15	„ 12	April 2
Muscari botryoides	„ 30	„ 14	„ 24	Mar. 22	Mar. 20
Corydalis cava	April 1	„ 14	„ 14	April 5	
Anchusa sempervirens ...	„ 1	„ 13	„ 25	„ 12	Feb. 21
Holosteum umbellatum ...	„ 2	„ 15	„ 20	Mar. 30	
Doronicum Pardalianches ...	„ 2	„ 20	„ 26	April 12	
Narcissus Pseudo-Narcissus	„ 2	„ 20	„ 25	„ 6	Mar. 28
Carex montana	„ 2	„ 20	„ 30	Mar. 22	
Adonis vernalis	„ 2	„ 19	„ 28	April 6	„ 6
Tussilago hybrida	„ 3	„ 15	„ 14	„ 4	
Cochlearia officinalis ...	„ 4	„ 20	„ 28	„ 9	
Orobus vernus	„ 4	„ 16	„ 16	„ 8	„ 31
Dalabarda geoides	„ 6	„ 19	„ 25	„ 12	April 2
Narcissus moschatus ...	„ 6	„ 13	„ 28	„ 8	„ 1
Scilla sibirica	„ 7	„ 21	„ 30	„ 10	„ 1
Orobus Fischeri	„ 7	„ 19	„ 18	„ 1	„ 3
Anemone apennina	„ 8	„ 30	April 3	„ 12	„ 7
Alyssum saxatile	„ 8	May 1	„ 11	„ 7	Mar. 28
Saxifraga crassifolia ...	„ 8	April 21	Mar. 20	Mar. 27	„ 27
Orobus cyaneus	„ 9	„ 29	„ 17	„ 28	
Fritillaria imperialis ...	„ 9	„ 14	„ 26	April 12	April 3

Thursday, 8th May 1856. Colonel Madden, President, in the Chair.

The following Papers were read, viz. :—

1. *On the Sexuality of the Algæ.* By Dr Ferdinand Cohn, of Breslau. Communicated by Professor Balfour.

2. *On the Preparation of Sugar and Arrack from Palms in Ceylon.* By Alexander Smith, M.D., Staff Surgeon 2d Class. Communicated by Professor Christison.

Three Palms yield sugar in Ceylon: the Coco-nut Palm (Cocos nucifera), the Palmyra Palm (Borassus flabelliformis), and the Kittul or Jaggery Palm (Caryota urens). From each of these Palms the juice of the flowering stalk is collected under the name of Toddy, and from it sugar, known in the east as Jaggery, is regularly prepared; but it is from the Palmyra Palm that almost all the Palm Sugar is obtained. It is from the sugar of the Coco-nut Palm that arrack is made in Ceylon. This Palm becomes productive in about six or seven years. In collecting toddy, the spathe is stripped off from the spadix before it has fully expanded; the spadices are afterwards beaten between pieces of hardwood, and slices are cut with a sharp knife so as to allow the juice to flow out. Each spadix continues to yield juice for about forty days, at nearly the average rate of half-a-gallon in 24 hours.

When it is intended to prepare jaggery from the toddy, great care is taken by burning pieces of wood in the small earthen vessels attached to the flowers, and rubbing their interior with charcoal, to remove any impurities likely to promote fermentation; and, as an additional precaution, chips of the bark of Vateria indica are placed in each, so as to retard fermentation.

The jaggery of the central provinces of Ceylon, is entirely made from the Kittul juice, which yields a much larger quantity of sugar than does that of the other two Palms, and of a quality much more highly prized by the natives.

When toddy is collected for the purpose of making arrack, no care is taken to prevent fermentation, and as it is brought from the trees it is poured into wooden vats in which that process rapidly advances. If attention is not paid to the fermentation, acetic acid is formed, and this often causes the arrack to take up lead from any portion of that metal with which it may be brought into contact.

Dr Smith then entered into details as to the presence of lead in arrack, which was traced to the modes of preparation.

3. *On the occurrence of Scalariform Tissue in the Devonian Strata of the South of Ireland.* By Robert Harkness, F.G.S., Professor of Geology, Queen's College, Cork. (This paper appears in the present number of this Journal.)

4. *Notice of some additions to the Cryptogamic Flora of Edinburgh.* By Mr W. Nichol.

The Cryptogamic Flora of Edinburgh has been examined by several observers, but especially by Dr Greville, who, in his Flora Edinensis, has given a catalogue of the whole. Since that was published, however, there have been great changes, especially among the Mosses. The more constant employment of the microscope has not only hastened the abandonment of the old artificial classification and the substitution of a more natural one in its place, but has also led to the discrimination of species formerly grouped together as one. Among the species which appear to be new to the district, are the following:—

Sphagnum compactum, Pentlands, near the source of Bevelaw Burn. Anœctangium compactum very abundant, but barren, on the rocks at Habbies How, Pentlands. Blindia acuta, found in fruit at Habbie's How; in this state the stems are short, slender, and of a blackish colour. A curious variety also occurs on dry rocks at the same place, forming rounded cushions adhering only by their base. Here the stems attain the length of about two inches, and the leaves are more rigid, and their laminæ proportionally shorter and more rigid than in the ordinary state. Dicranum Schreberi, banks of the Breich Burn, West Calder, Edinburghshire. The male plants differ from the figure given by Bruch and Schimper, attaining a length of an inch. Campylopus flexuosus, source of the Medwyn, Pentlands; bog near Harburn, West Calder.

fishes, and crustaceans, present in their hemical properties, and in their point of coagulation, differences which permit us to suppose that these bodies are made up of different proximate principles.

9. An egg changes its nature; its liquids alter considerably at different epochs of its formation, when detaching themselves from the ovary, and resting in the oviduct before being hatched.

10. After having established in the eggs of different animals the presence of several new proximate principles, ichthin, ichthulin, icthidin, emydin, and comparing these results with those which MM. Dumas and Cahours obtained in the analysis of hens' eggs, we do not hesitate to propose to science to admit the existence in eggs of a new class of organic bodies, comprising some proximate principles which we will hereafter designate under the name of Vitelline substances or Vitelline bodies.—(*Silliman's Journal*, 1855.)

Birds forming Guano.—M. A. Raimonde, professor of Natural History at Lima, was sent in 1853 by the Peruvian government to the Chincha Islands, in order to ascertain the quantity of guano existing in these islands. During a sojourn of more than six weeks he made observations on the origin of the guano deposit, and on the birds to which it owes its existence. In some places the guano deposit is 30 metres in depth. From the bodies of animals, as well as from various manufactured articles found in it, he concludes that the deposit belongs to the present epoch of the earth's history. The birds observed during his visit were *Pelecanus majus*, Molin.; *Carbo Gaimardii*, Lesson; *C. albigula*, Brandt; *Sula variegata*, Tschudi; *Spheniscus Humboldtii*, Meyen; *Plotus anhing*, Lin.; *Rhyncops nigra*, Lin.; *Larus modestus*, Tschudi; *Puffinaria Garnotii*, Lesson; *Sterna inca*, Lesson. These species do not all live constantly on the islands; some of them only appear at the breeding season. The pelicans do not appear to produce much guano, as they almost always inhabit the cliffs, and their excrement falls into the ocean. The same may be said of the species of Carbo. The species of Sula contribute more to the deposit, their number being greater, and their habitations being more in the interior of the islands. The species of Plotus and Rhyncops are very rare; those of Larus are more numerous. The Sternas only visit the islands to lay their eggs, but their numbers are so very great that they must contribute in a great measure to the formation of guano. The Spheniscus abounds in the southern island, which is inhabited. These birds not being able to fly, hollow out habitations for themselves in the guano. The birds which produce the largest quantity of guano are the Puffinarias; their number is incalculable.—(*L'Institut*, May 1856.)

Edible Nests of Swallows.—M. Huten, chief physician of the Invalides at Paris, states that these nests, collected in Java, are considered by the inhabitants as formed from fish spawn. The viscid filaments often seen hanging from the bills of the birds are said to be derived from the spawn.—(*L'Institut*, May 1856.)

Scyllarus arctus.—In Pennant's British Zoology the only locality given for this species is "Found by Dr Borlasse on Careykillas in Mounts Bay." A specimen of this rare crustacean was taken this spring near the same locality. It was caught in one of the pilchard nets in Pemberth cove, about seven miles from Penzance, and was noticed by the fishermen as a species not known and not previously seen by them. It was procured from them by my active correspondent, Mr H. J. Shearer, factor for Lord Falmouth, and sent down to be identified.—*Edit.*

GEOLOGY.

Examination of some Deep Soundings from the Atlantic Ocean. By Professor G. W. Bailey. (Extracted from the American Journal of Science, vol. xvii.)

In an account of a microscopical examination of soundings made by the U. S. Coast Survey, near the Atlantic coast of the United States, I made known that the soundings along the coast, from the depth of 51 fathoms S.E. of Montak Point to 90 fathoms S.E. of Cape Henlopen, were chiefly made up of vast amounts of Foraminiferous shells, rivalling in abundance the deposits of analogous fossil species which I had found to compose immense beds under the city of Charleston, S.C.

The facts were also mentioned that none of the species found in the soundings belonged to the littoral genera of the group Agathistegues of D'Orbigny, and that they also differed from those found in the tertiary deposits of Maryland and Virginia. These facts were confirmed and extended by the observations of F. de Pourtales in his report to Professor A. D. Bache, on the distribution of Foraminifera on the coast of N. Jersey, as shown by the off-shore soundings of the U. S. Coast Survey. In this paper, M. Pourtales states that "the greatest depth from which specimens had been examined is 267 fathoms, and these *Globigerina*, are still living in immense numbers." He adds that the region of Globigerina extends to a depth not known.

I am indebted to that zealous contributor of science Lieut. Maury, of the National Observatory, for an opportunity to examine the deep-sea soundings, made by means of Brook's lead, on board the U. S. Dolphin, by Mr Berryman. The soundings prove to be of great interest, and furnished results which have an important bearing upon Geology and Physical Geography.

The soundings examined were as follows:—

Fathoms.	Lat. N.	Long. W.	Date.
1080	42°04′	29°00′	July 25, 1853
1360	44°41′	24°35′	„ 18 „
1580	49°56′	13°14′	Aug. 22 „
1800	47°38′	09°08′	No date.
2000	54°17′	22°33′	Do.

As these soundings are believed to be the deepest ever submitted to microscopic examination, and were obtained at localities far remote from those previously noticed, they were studied very carefully, and the following are the facts ascertained.

1. None of these soundings contain gravel, sand, or other recognisable inorganised mineral matter.

2. They all agree in being almost entirely made up of the calcareous shells of minute or microscopic Foraminiferæ (*Polythalamia*, Ehr.), among which the species of *Globigerina* greatly predominate in all the specimens, while *Orbulina universa* (D'Orbigny) is in immense numbers in some of the soundings, and particularly abundant in that from 1800 fathoms.

3. They all contain a few specimens of non-parasitic or pelagic Diatoms, among which *Coscinodiscus lineatus*, *C. excentricus*, and *C. radiatus* of Ehr., are much the most abundant.

4. They all contain a few siliceous skeletons of *Polycistinæ*, among which are several specimens of *Haliomma*, *Lithocampe*, &c.

5. They all contain spicules of sponges, and a few specimens of *Dictyocha fibula*, Ehr.

6. The above-mentioned organic bodies constitute almost the entire

mass of the soundings, being mingled only with a fine calcareous sand derived from the disintegration of the shells.

7. These soundings contain no species of Foraminifera belonging to the group of *Agathistegues* (Plicatilia of Ehr.), a group which appears to be confined to shallow waters, and which in the fossil state first appears in the tertiary, where it abounds.

8. These soundings agree with the deep soundings off the coast of the United States, in the presence and predominance of species of the genus *Globigerina,* and in the presence of the cosmopolite species *Orbulina universa* (D'Orb.), but they contain no traces of the *Marginulina Bacheii,* B., *Testularia Atlantica,* B., and other species characteristic of the soundings of the Western Atlantic.

9. Examined by chromatic polarized light, the foraminiferous shells in these soundings showed beautiful coloured crosses in their cells, and the sand accompanying them also became coloured, showing that it is not an amorphous chemical precipitate. It in fact can be traced, through fragments of various sizes, to the perfect shell of the Foraminiferæ.

10. In the vast amount of pelagic Foraminiferæ, and in the entire absence of sand, these soundings strikingly resemble the chalk of England, as well as the calcareous marls of the Upper Missouri, and this would seem to indicate that these also were deep-sea deposits. The cretaceous deposits of New Jersey present no resemblance to the soundings, and are doubtless littoral, as stated by Professor H. D. Rogers—*Proceedings Boston Society, Natural History*, 1853, p. 297.

11. The examination of a sounding 175 fathoms in depth, made in lat. 42° 53′ 30″ W., long. 50° 05′ 45″ W., near bank of Newfoundland, by Lieutenant Berryman, gave results singularly different from those above stated. It proved to be made up of quartzose sand, with a few particles of hornblende, and not a trace of any organized form could be detected in it. This exceptional result is important, as it proves that the distribution of the organic forms depends on something besides the depth of the water.

12. Connecting the results above mentioned with those furnished by the soundings made in the western portions of the Atlantic, it appears that, with the one exception above mentioned, the bottom of the North Atlantic Ocean, as far as examined, from the depth of about 60 fathoms to that of more than two miles (2000 fathoms), is literally nothing but a mass of microscopic shells.

13. The examination of a large number of specimens of ocean water, taken at different depths by Lieutenant Berryman, at situations in close proximity to the places where the soundings were made, shows that even in the summer months, when animal life is most abundant, neither the surface water nor that of any depth collected, contained a trace of any *hard*-shelled animalcules. The animals found, some of which are now alive in the bottles, are all of a soft perishable nature, leaving on their decay only a slight flocculent matter, while the Foraminiferæ and Diatoms would have left their hard shells if any had been present.

As the species whose shells now compose the bottom of the Atlantic Ocean have not been found living in the surface waters, nor in shallow water along the shores, the question arises, do they live on the bottom at the immense depths where they are found, or are they borne by submarine currents from their real habitat? Has the Gulf Stream any connection, by means of its temperature or its currents, with their distribution? The determination of these and other important questions connected with this subject, requires many additional observations to be made. It is hoped that the results already obtained will induce scientific commanders and travellers to spare no pains in collecting deep-sea sound-

have been a large one, some thousand miles or more in extent, and we have nothing analogous to this at the present day; but there is almost the same difficulty if we assume them to be deposited in an estuary; and the vast number of reptiles and land plants, as well as the ripple-marked character of the sandstones, tell against their being a deep-sea deposit. But view them as we will, it is difficult to account for the enormous thickness and extent of these rocks, which have scarcely a parallel in the known geological world.

It is in these rocks, but at a higher geological level than the Smithfield beds, that the Burgherdorp coal occurs, and at first sight I was inclined to regard them as true coal-measures; but the absence of true coal-plants, and the fact that they rest unconformably upon beds that have an equal right to be regarded as coal-measures, would bring them in as the representative most probably of the Trias, or upper New Red Sandstone; Permian or Oolitic they can hardly be, for these are essentially marine formations. The determination of their precise geological age will be a matter requiring careful and detailed observation, but this is not necessary for our purpose at present. It is enough to know that these rocks are *not older* than the coal-measures; this we may assume for certain; and the fact tells as powerfully against their auriferous character, as if we could arrive at their precise age. Gold has never been found in any quantity in rocks so modern as these, nor indeed has any other metal. Almost all the more noted gold workings are in rocks of Silurian age. Such is the case in California, in Australia, in the Altai and Ural Mountains in Russia, and in the smaller gold districts in Britain, namely, in Cumberland, in the south of Scotland, in Merionethshire, Wicklow, and some other places. The slates of Cornwall, in which a good deal of gold has been found, are set down by a good authority as of Devonian age, but this I have often doubted. There is thus a strong *prima facie* evidence against gold found in quantity in the Smithfield beds, which are undoubtedly of much more modern age.

On the other hand, the numerous greenstone dykes that cut through the sandstones and shales are somewhat promising, though I know of no single instance of gold accompanying these except where they cut through the older slates; and it is quite possible that if we could follow these dykes downwards to the place where they have burst through these older beds, some thousands of feet beneath the surface, we should find gold to accompany them in abundance. These dykes are perhaps a little more common in the Smithfield district than in the adjoining parts of the Cape Colony, though they occur in great numbers near Burghersdorp, in the Stormberg, Winterberg, and other places. They cut through the stratified rocks usually vertically, but frequently force their way in laterally between the beds. When we see them at the surface they look like walls running across the country, or more frequently form a narrow stony ridge, like a wall that has been thrown down. The rock of which they are composed is known by the local name of ironstone, from its great hardness and toughness, and from its great weight. Wherever they come in contact with sedimentary rocks they have altered them more or less. Such rocks have often been fused by coming in contact with them. In the Smithfield district the sandstone in contact with them has been greatly altered; the grains, originally rounded, have assumed the crystalline form, glancing like sugar in the sun; the beds have been stratified more in certain directions than others, so that they weather very unevenly, showing irregular ridges with large holes between. They are studded over with curious concentric nodules, caused by the segregation of small nests of iron pyrites, of a globular form, from the rock when in a half fused state. These are usually decomposed into a red rusty powder, leaving the nodule quite hollow inside. These curious appearances have all been produced by the dyke of greenstone alongside, and they are a sure indication of its presence.

The dykes in the Smithfield district are formed chiefly of two minerals, felspar and hornblende, in nearly equal amounts; the hornblende appears in some cases to be replaced by augite, but these are very nearly alike in composition. Besides these, there is an accidental ingredient in the form of micaceous specular iron, which is usually found lining the joints. When the rock is worn away, it is washed out, into the clay or sand, in the form of black shining spangles, where it is found on washing for gold, though, being light, it is easily washed away. It is common in the sandy clays all through the country, and is sometimes mistaken for something valuable. When burnt it forms the red pigment used by some of the native tribes.

These dykes are all nearly vertical—usually only a few yards in thickness—seen running along the flats or adhering to the side of a hill, a large portion having been removed by denudation. They usually run N.E. and S.W. The large one in the poort runs nearly at right angles to this, that is, N.W. One, it will be seen, divides into two branches, the mean direction being nearly N. and S. The one on which the gold was first found divides and meets again, enclosing a portion of sandstone. In many of these dykes small veins of quartz were found, usually filling up or lining a joint of the rocks. The quartz was of translucent and semi-crystalline character, and in that respect differed from the white opaque quartz in which the Australian gold is usually found. In the jackal's hole dyke the vein of quartz was horizontal, and in this several pieces of gold were said to be found. It was represented to me as being 2 feet thick, but, on raising the adjoining stones, I found it had dwindled away to a quarter of an inch, so that there must have been a large swelling or expansion of the vein, which may render the fact of the gold occurring here not so doubtful, though there was none to be seen in the thinner portion, to which alone I had access. This dyke in one place is seen to include a mass of trap of a lighter colour, and much more compact texture, and in this a grain of gold was said to be met with.

About a mile and a half to the eastward of the jackal's hole, on the rising ground beyond the river, is the branching dyke above alluded to: a vein of quartz runs nearly through the middle of one of the branches. Unlike the one at the jackal's hole, this vein is vertical, and thus it is parallel to the sides of the dyke. Three or four holes have been sunk on it, each about 3 yards in width and depth. It is thus traceable for some hundreds of yards, varying in thickness from a quarter of an inch up to 2 inches or more; its average thickness would be about 1 inch.

In this several grains of gold were said to be found, though the vein had, in some of the holes, been quarried away for a space of 80 square feet without finding any. As these quartz veins had been worked away as far as they could be reached, I could only get hold of a few fragments, and as I had neither time nor means to break new ground, I did not succeed in finding any gold, though I have no doubt that such exists; but that the quantity is small indeed was sufficiently indicated by the fact that parties had been working for two or three weeks in these veins without finding a grain of gold. The veins were themselves so utterly insignificant as almost to be unworthy of notice. If they had been 30 feet thick in place of 1 inch, it is very questionable whether they would have proved remunerative.

These were the only places where I could hear of gold being found, either in the quartz or in the ochry coating between it and the greenstone rock. Trials had been made on quartz veins in some of the other dykes without success. A few hundred yards north of the jackal's hole is a vein of calcareous spar, or crystallized carbonate of lime, which had been mistaken for quartz, and operated on accordingly. A small vein in another dyke, about a mile nearer Smithfield, containing quartz and prehnite, had been tried with the like unsuccessful result.

Such being the unpromising nature of the quartz veins, I turned my whole attention to the clay pits, eight or nine of which had been sunk on the lower ground near the river. In several of these holes the underlying rock, a soft purple or reddish shale, had been reached, at a depth of 12 or 15 feet, and this had been sunk into for 5 or 6 feet, apparently under the impression of its being only clay. In none of these was any gold found.

One small hole had been sunk in a yellowish-grey sandstone near the jackal's hole, the sandstone being reached at 1 foot from the surface. No gold.

Five or six pits had been sunk close together near the river, but most of these had been abandoned from the large quantity of water infiltrating through the loose sand at the bottom, being probably about the same level as the river. In one of these, sunk by the original finder of the gold to a depth of 16 feet, twelve grains of gold were said to be found.

The gold was reported as occurring beneath a layer of gravel, and resting on a "pot clay," at a depth of 16 feet.

The "Caledon River Gold Exploring Company" had recently sunk a pit alongside the above, at a distance of 5 yards only, and had reached a depth of about 15 feet, when they were driven out by the water, which now filled this and all the other pits to within 6 or 7 feet of the surface. To this pit I now devoted all my attention.

The first thing to be done was to get rid of the water. A pump had been tried, but it would not throw the water out as fast as it came in; so it was decided to erect a windlass with a couple of buckets.

On returning to Smithfield in the evening we found that a windlass could not be made for some time: but having got hold of an old windlass barrel, we had proper supports cut out, and arranged that it should be on the ground early on Monday morning.

With the assistance of Mr Staunton and two English labourers we erected the windlass, bent on ropes, buckets, &c., and set to work, and succeeded in getting out the water, sinking the pit to the depth of 18 feet or more, at which distance the rock, a yellowish-gray sandstone, was reached. The material raised was carefully set aside for washing next day. I was very much surprised to find that it was all loose fine sand, a deposit very unlikely to contain gold. Not a trace of gravel or of tough clay, such as we had heard of in the adjoining pits. On looking over the stuff thrown out of the latter I did not see any of this gravel or clay, but saw that this pit also had been terminated by a yellow sandstone. So far as I could judge the two pits had passed through the very same material, and the only difference was that the one we had been engaged on might have been a foot or two deeper.

When the sand came to be washed, not a particle of gold could be found, either by Mr Staunton or myself, though we persevered for several hours. Only one small fragment of quartz was seen. Some grains of specular iron, and a very slight amount of magnetic iron, were found in the sand, but this was what, in the neighbourhood of greenstone dykes, might be expected.

During the previous night the pit had been filled up with water nearly to its former level, but, setting our Kafirs to work, we emptied it in about four hours. We carefully scraped up the sand from the surface of the rock and washed it, but with no better success than formerly.

same locality and position, radiata are found which have heretofore been thought to be only inhabitants of deep water.*

On the Grooving and Polishing of Hard Rocks and Minerals by Dry Sand. By W. P. Blake. (Condensed from the American Journal of Science.)

"This phenomenon was observed in the Pass of San Bernardino, a great break through the south prolongation of the Sierra Nevada, by which the low interior plain of the Colorado Desert is connected with the Pacific slope. The summit level of the pass is 280 feet above the ocean, and the width of the gap is there about 2 miles, the ground sloping gently each way. On the eastern declivity of the pass are sharp ridges of granite and other crystalline rocks, jagged and devoid of soil and vegetation; the grooving occurs on those projecting spurs of the San Gorgonio Mountain. The entire surface of the granite throughout broad patches is traversed with long perfectly parallel grooves and little furrows, and is beautifully smooth, and though uneven is very finely polished. The appearance of the surface was so entirely different from that of rocks which had been acted upon by glaciers and drift, that Mr Blake could not regard those agents as the cause. This he detected to be the wind. At the time of his observation this was blowing very hard, and carried with it numerous grains of sand. These grains were pouring over the rocks under the influence of the powerful current of air, which seems to sweep constantly through this pass from the ocean to the interior. Everywhere on the horizontal tables of rock, and on its vertical faces turned to the wind, the sand grains had engraved their track on every stone, quartz was cut away and polished, and even garnets and tourmaline were cut and left with polished surfaces. Masses of limestone looked as if they had been partly dissolved, and were like pieces of rock salt that had been allowed to deliquesce in moist air. The degree of abrasion was in proportion to the hardness of the mineral matter. Garnets and lumps of quartz imbedded in compact felspar stood out from the felspar which was cut away around the harder minerals. On the lee-side of the garnets the felspar was seen standing up near to the full level, thus furnishing, in miniature, instances of crag-and-tail. Where the eroded surface stood perpendicular and was charged with garnets, these were seen standing forth in prominent relief on long pedicles of felspar, like jewelled heads of slender needles, jutting horizontally from the body of the rock, and pointing like fingers in the direction of the prevailing winds. All these little fingers of stone point westward in the direction of the pass. The wind through this pass blows with great force and persistency, not in gusts and eddies, but with a steady motion, pouring in from the cool sea to supply the vacuum caused by the ascent of the heated air of the surface of the parched desert. Mr Blake says that this pass is the only break of magnitude in the chain for a long distance, and, as an air-channel, holds the same relation to the Colorado district which the Golden Gate at San Francisco bears to the broad interior valley of the Sacramento and San Joaquim. He adds:

* By a recent letter from a correspondent in the United States, we learn that Professor Bailey, in a late communication to the Natural History Society of Boston, on the origin of greensand, confirms the discovery by Ehrenberg, that the greensand consists of internal moulds or casts of Polythalamia, &c., the greensand of New Jersey and other American localities, exhibiting the same origin. In addition, Professor Bailey found that the Polythalamia brought up by the deep dredging of the Coast Survey, exhibit the total or partial conversion of the interior matter into greensand, showing that this matter is now in process of formation. Here an interesting inquiry arises as to what are the chemical or vital conditions which accumulate, from the sea water, so much protoxide of iron and potassa in these organisms. H. D. R.

"The effects of driving sand extend to all parts of the desert where there are sand, rocks, or minerals to be acted on. On the upper plain north of the sand hills, where steady high winds prevail, and the surface is paved with variously coloured pebbles, these are all polished to such a degree that they glisten in the sun's rays. The polish is not like that of the lapidary, but more like that of lacquered ware, as if the pebbles had been oiled and varnished. On the lower parts of the desert, wherever silicified wood occurs, the sand has registered its action. When no obstacle has been encountered by the sand, the grains acting on each other have been almost perfect spheres."

Extent of the Gold Fields of California, &c.

According to Wm. P. Blake (see *Silliman's Journal*, xx., 72), the gold field of the Pacific slope extends from near the Tejon Pass, opposite the head of Tulare Valley, in lat. 35° continuously to the Umpqua River, in lat. 43° 45′, and even beyond this, to the parallel of 49°, in the northern limit of the United States. Beyond the Umpqua there is little known, except that gold does occur at intervals; but south of it, the mining operations are at such frequent intervals as to show that this part of the gold field at least is nearly continuous.

The eastern boundary is not yet well defined, the higher parts of the Sierra Nevada not having been well explored.

The western range, along the Sacramento and San Joaquim, is better known, but it is irregular.

The greatest breadth of the field is from the Shasta to the coast at Gold Bluffs, south of Klamath River, lat. 41° 30′, where it is 110 miles wide.

From the Yerba River southward, the breadth is about 50 miles, and this is about the *average expansion* of the *whole* field. It contracts going southward, and near the end of the Sierra Nevada it is only about 10 miles broad, where it finally terminates.

From the Umpqua River, on the north, to its southern end, it includes 9° of latitude, or a length of 700 miles; this, with the average breadth of 50 miles, gives an area of 35,000 square miles.

Taking the extreme northern limit, the length of the gold field covers 14° of latitude, or nearly 1000 miles.

Gold is found in the sand of the coast, at various points between Gold Bluffs, 30 miles south of Crescent city to the Umpqua River. The most important localities are near Port Orford, between Gold River and Coose Bay, distant 80 miles from each other.

The gold dust occurs in the beach sand from the surface to a depth of more than six feet. This sand is a black sand, containing very thin small scales of gold, mixed with platinum and other metals, which are separated with difficulty. This black sand is in enormous quantities—is irregularly stratified or sorted by the tides. The storms stir these sands to a considerable depth, renewing the gold on the beach after it has been exhausted by superficial mining.

Other detached gold placers occur south of the Sierra Nevada, in the south side of the San Bernardino chain, near San Fernando and San Francesquito, in talcose slates.

Gold exists in the Great Basin, 170 miles from Los Angelos, in place; it is in filaments, in quartz.

Gold has also been found in Colorado Desert, near the Fort Yuma, at the mouth of the Gila.

Dr Trask, in his report on the Geology of California (1855), classifies the gold mining districts of California into three ranges or belts, denominated the Upper or Eastern Range—the Middle Placers—and the Valley mines.

Eastern Range.—Extends from near summit of mountains to within about 25 miles of edge of plains.

Maintains uniform breadth of about 20 miles, and has a known length of 130 miles.

Covers an area of about 3000 square miles—a large proportion of this being available for mining.

The greater part of the so-called *dry diggings* occurs in this belt.

Considers the productive Placer deposits as at least one-third of this area, or equivalent to a mining ground of 1000 square miles.

Of this large area, only a surface of about 20 square miles, or two per cent., is yet opened, "or in any manner improved."

The amount of ground in 14 mining counties now under improvement does not exceed 300 sq. miles. This is the region of the deep diggings.

Middle Placers.—These occupy a range of country bordered on the east by a line 20 miles from the higher foot hills, and on the west by a line of about 4 miles up from the eastern edge of the plains.

This belt also is about 20 miles broad, but its length is 300 miles, and its area 6000 square miles.

In this belt occur the surface workings, though in some deposits the gold lies nearly as deep as in the higher mountain belt.

The ordinary depth of the Placer, or gold-bearing drift, in this district, is between 12 and 40 feet. This stratum is more heterogeneous in composition than the drift of the higher range.

The floor of the auriferous drift, or "bed-rock," consists in this district mostly of highly-inclined slates, occasionally of granite.

This middle range contains at present the chief mining operations of California.

Valley Mines.—The third, or western belt, extends in breadth from the lower foot hills of the mountains westward into the eastern edge of the plains of the San Joaquim and Sacramento, a distance of from 3 to 5 miles, ranging in length from Chico Creek, in Butte Co., to the Mercea River a distance of 250 miles.

The gold-bearing gravel of this zone is very ferruginous ; the richer deposits vary in depth from 3 to 8 feet, and rest on sandstone and slate, or on clay beds, above these rocks ; though the shallowest, these deposits are the most easily worked.

The western limit of the auriferous drift is generally well-defined. It is marked by a sudden change from the soil of the plains to a surface thickly strewed with small angular pebbles of quartz, covering a belt from 2 to 4 miles wide.

On the eastern verge of the plains there is an equally sudden transition from angular pebbles to rounded pebbles, mixed with alluvium, succeeded by outcrops of the slates.

Water.—The natural supply of water, indispensable to gold mining, is restricted to about four months in the year in California.

Water is now carried to great distances by canals from the mountain ravines and valleys, where streams exist, to gold-bearing deposits not naturally supplied with it.

There are about twenty-three canals dispensing water to the mines on the surface of the valley, and there are 109 companies engaged in seven of the principal mining counties in conveying water for mining purposes. Indeed, some very colossal enterprises are on foot for an erection of canals and aqueducts for the irrigation of the mines, especially on the upper diggings.

Methods of mining.—In the deeper deposits, the mining does not consist, as in the shallower, of open digging, but is genuine subterranean mining. Some of the adits are 1000 and 1200 feet long, and few shorter

Remarkable Formation—California.

The geological formation of that portion of Spanish Hill which has contributed most to its celebrity, as one of the richest gold deposits ever found in California, is one of the most singular and interesting we have ever seen. It consists of a very deep basin, the rim rock protruding out of the ground on nearly every side, so that although one may stand on the bed rock at the top of the hill, not six feet distant a shaft might be and has been sunk over one hundred feet. In the bottom of this basin are three crevices, the middle one of which, running longitudinally, through the Golden Gate claim, is most singularly formed, presenting the appearance of a quartz lead, of uniform width—about fifteen feet—and dipping towards the east. But, instead of being filled with quartz rock, it is filled with gravel, and massive, round, hard and smooth quartz boulders. The earth taken from this crevice, from the top of the ledge as far down as the shaft was sunk (about ninety feet), paid on an average a little over sixty ounces to every four hundred barrowsful, and the crevice at the east side of, and running parallel to this, being partly on the Golden Gate and partly on the Hook and Ladder claim, paid on an average a trifle over one hundred ounces to the same quantity of earth. The highest taken out of one day's washing, was one hundred ounces. But the most curious piece of work ever done in this, or perhaps in any other country, is now in preparation in the Hook and Ladder claim. The proprietors have been engaged for about four months, day and night, in cutting a tunnel through the bed rock, from a very low point, so as to strike the bottom of the basin. By a recent survey, they have ascertained that they have but a few more feet to run. As soon as they break through the rock and reach dirt, the skilful and enterprising proprietors intend to bring the water immediately over the mouth of their tunnel at a perpendicular height of two hundred feet, where it will be received by a strong hose running up through the tunnel—in which their sluices, and a car to carry off the rock, will be placed. It is intended to literally tear out the very bowels of the hill, so that nothing but a shell will remain, and, doubtless, some day the hill will fall in with a tremendous crash. Spanish Hill is supplied with water by the South Fork canal.

Reptilian Remains found in the Old Red Sandstone of Morayshire.

About fourteen years ago, Mr Patrick Duff discovered in the red sandstone of Lossiemouth, near Elgin, a slab with peculiar markings, which, on being submitted to M. Agassiz, were pronounced by that celebrated palæontologist to be the impressions of the scales of a fish which he named *Stagonolepis*. Last May, in a quarry to the east of Quarrywood, a little north of the town of Elgin, another slab was discovered bearing exactly similar impressions to the former one, but associated with these markings were several large bones and some distinct vertebræ, which exhibit the reptilian characters. This last fossil becomes highly interesting as connected with the discovery, some years ago, in an adjacent quarry of Spynie, of the complete skeleton of a smaller reptile. There are in this district three beds of the Devonian sandstone. 1. The lowest bed containing the Pterichthys and other fishes. 2. The middle or gray, characterized by the remains of the Holoptychius. 3. The upper yellow beds, containing the reptilian remains. Above these is a bed of unfossiliferous limestone or cornstone that separates the Devonian strata from the more superficial Oolitic formations which are partially scattered over part of the district. These three beds of the Devonian formation are placed conformably on each other, and the cornstone can be traced superimposed over a considerable portion of the district, so that there is a distinct separation between the older Devonian and the newer superficial outliers of the Oolitic. We hope to be able to give a more particular account of the reptile bones in a subsequent number.

CHEMISTRY.

On the Equivalent of Antimony. By R. Schneider.

The equivalent of antimony is taken from Berzelius' experiments at 129 (H=1), but, according to Schneider, it ought to be reduced to 120·25. This number is arrived at by the analysis of a native sulphuret of antimony of remarkable purity. The reduction of this sulphuret by means of a current of hydrogen was employed as the basis of the determination of the atomic weight. The author found that this reduction could be effected almost completely at a temperature at which scarcely an appreciable trace of the sulphuret is volatilized, provided the current of hydrogen be not too rapid. Taking into account a small quantity of sulphuret which sublimes (from 0·0005 to 0·00125 grammes) and of sulphur which adheres with obstinacy to the antimony, from (0·001 to 0·007 gr.) where from 3 to 10 grammes were employed for the experiment, he obtained in six experiments—

	Extremes.		Mean.
Antimony, . .	71·427	71·519	71·469
Sulphur, . .	28·573	28·481	28·531

giving 120·25 for the equivalent of antimony. The author promises the details of his experiments in a future paper.—(*Poggendorff's Annalen*, vol. xcvii., p. 483.)

On Silicon. By F. Wöhler.

In experimenting on the preparation of aluminium by Rose's method from cryolite, Wöhler employed Hessian instead of iron crucibles, and found that he frequently obtained in addition to the malleable buttons of aluminium, brittle globules, containing a crystalline substance. By digesting them with hydrochloric acid, the aluminium dissolved, leaving dark iron black crystalline scales, having a metallic lustre, and which proved to be silicon in the crystalline form recently discovered by Deville. In considering the mode in which the silicon was here produced, it was obvious that silico-fluoride of sodium had been formed by acting on the mass of the crucible, and that it had been reduced by the aluminium. Acting upon this view Wöhler has found it possible to obtain at will the silicon in this state. For this purpose aluminium is fused for about a quarter of an hour with 20 or 30 times its weight of silico-fluoride of sodium. On breaking the crucible a well-used dark iron-gray regulus is obtained, which consists of a compound of aluminium with silicon, containing a large quantity of the latter substance in a crystalline form. The mass is broken, digested first with hydrochloric acid, and then with moderately strong hydrofluoric acid. In this way there are obtained for every 100 parts of aluminium 70 or 80 of a regulus, containing from 65 to 75 per cent. of crystallized silicon. It is in the form of shining scales resembling natural graphite, but with a more metallic lustre. By the use of a large quantity of aluminium, crystals of considerable size may easily be obtained. It is harder than glass—sp. gr. 2·490. It does not burn in the air, and even when heated in the spirit lamp flame, alimented with a current of oxygen, does not lose its metallic lustre. At a low red heat it burns in chlorine. It is insoluble in all acids, but dissolves in solutions of the alkalies.—(*Poggendorff's Annalen*, vol. xcvii., p. 484.)

On the Detection of Strychnine.

"Edinburgh College, June 1856.

"My dear Sir,—The detection of strychnine has of late so much engaged public attention, that perhaps some of the readers of your Journal may find interest in the results of a few of many experiments which I have made upon this subject.

"1. The best method of eliminating this powerful poison from the contents of the stomach, is certainly by digesting those matters with alcohol, filtering, and concentrating the filtered liquid by a gentle heat. To separate any animal matter taken up with the strychnine, boiling this liquid with a little acetic acid, and again filtering, will afford a clear solution of the strychnine, and this concentrated will afford the poison in a fit state for administering it to small animals, or for the application of chemical tests.

"2. After many trials of various tests, that which seems one of the best is a neutral solution of chloride of gold, especially if a slight excess of acetic acid exist in the liquid, or be added to the chloride.

"This addition throws down from solutions of strychnine a gamboge-yellow precipitate, which, if the quantity of the strychnine be considerable, shows a tendency to form minute crystals, while the chloride of platinum affords a less copious precipitate of an *orange-yellow* colour; but the chloride of gold is most to be depended on.

"3. I have made comparative experiments with chloride of gold on all the vegetable alkaloids in the subjoined list, not one of which gives any precipitate at all with this test, which, therefore, will serve to discriminate strychnine from those other alkaloids, a point of considerable importance in the investigation of poisons. 1. Salicine. 2. Quinine. 3. Cinchonine. 4. Codeine. 5. Inuline. 6. Lupuline. 7. Veratrine. 8. Picrotoxine. 9. Solanine. 10. Atropine. 11. Delphine.

"4. With regard to the delicacy of this test, I may state that six drops of a saturated solution of strychnine in alcohol, in which, however, it is not very soluble even at a boiling heat, added to twenty minims of liquid, showed a slight yellow precipitate upon standing for some time.

"5. Another good test for strychnine is obtained, as is well known, by adding a few drops of sulphuric acid to bichromate of potass. When this is added to a solution of strychnine, it produces no precipitate, but forms a pale blue liquid that seems very characteristic of strychnine. Believe me very truly yours, "THOS. STEWART TRAILL."

"Professor J. H. Balfour."

BOTANY.

Vegetable Ivory Plant.

Vegetable ivory is now imported chiefly from the river Magdalena into Europe and the United States of America; in some years no less than 150 tons of it were imported into England. The "nuts" may be purchased in the toyshops of the British metropolis for a few pence each, but when bought in large quantities, they are obtained at a much cheaper rate. In August 1854, 1000 "nuts" were sold in London for seven shillings and sixpence.

The ivory plant is confined to the continent of South America, where it grows between the 9th degree of north and the 8th degree of south latitude, and the 70th and 79th 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 3000 feet above the sea, as in Ocaña. Amongst the Spaniards and their descendants it is known by the name of "Palme 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 banks of the Magdalena, term the plant "Tagua," those on the coast of Darien "Anta," and those of Peru "Pullipunta" and "Homero." It is generally found in separate groves, seldom intermixed with other trees or shrubs, and where herbs are rarely

tea, or balm, or other herb tea. The word *cimarron* is applied to wild men also, and in Drake's Voyages he speaks of the Symerons, or fugitive negroes; in the West Indies they call them Maroons. It is probably a corruption from ancient Moorish times, originally Cis-Marrucco, or next to Morocco, as the French now call Spain "Africa beyond the Pyrenees." In some cases where *yerva* exists not, you are asked to take an *aqua caliente*, literally, a warm water, in which a bit orange or lemon peel is steeped. But these are beggarly appliances, and the true thing is a *maté de yerva*—"the herb," which is held to be a universal luxury, whether prepared in a simple calabash, or the silver cup, made in imitation thereof, for the wealthy. *Tomar un maté* is to have a good strong cup of the *yerva* infusion. Whether made in the mansion, the cottage, or the wilderness, the process is as follows:—The water is boiled in a copper pot, big-bellied below, and with a long neck and a small opening above; a pot such as I verily believe Ishmael first taught the Arabs to make, from traditions of Tubal Cain. The *maté* is then filled with *yerva*, after the *bombilla* has been placed in position. The *bombilla* is literally "a little pump," that is, a sucking tube, ending in a perforated bulb, which performs the office of the perforated diaphragm in our teapot spouts. Some use sugar with the infusion, epicures burnt sugar, and others add a piece of lemon peel, just as we folk at home put a black currant leaf amongst the tea. The boiling water being poured on, the preparation is complete, and the imbiber, holding the *maté* in both hands in cold weather, sucks it dry, with care not to burn his tongue. A second water is poured on, and a second person sucks it, and so on till all the strength is gone, when it is emptied and filled again, till all the company is supplied. It is customary for a *maté* to be sent to the bedside in early morning; and in travelling the first thing the guide does after lighting his morning fire is to prepare a *maté* for his patron. The *yerva* is generally carried in a kidskin bag, the sugar in a second bag, and all goes with the *maté* and the coffee-pot into the *alforjas*, or saddle-bags. Poor people use a reed instead of a silver *bombilla*. The infusion is highly refreshing taken in the ordinary way, but it is occasionally taken with milk, *maté con leché*. For my own part, whenever milk was to be had, and time served, I invariably used the *yerva* as we do our tea, with the difference of a bullock's horn, or some such contrivance, supplying the place of a tea-pot. It had all the effect of tea, and I believe it contains the principle of *theine*, as well as does the cocoa-leaf of Upper Peru. The notion of intoxicating qualities in *yerva* is fanciful. It will affect people with weak nerves as strong tea does, but not otherwise. Nor is there any reason why it should deteriorate by keeping. Chinese tea is carefully packed in leaf-tin; that of Paraguay is packed in bags of dry hide, in large quantities, and when the bags are open a large quantity is left exposed to the air for a long time. It is brought to Buenos Ayres, by land or river, 1200 miles, and sells there at about 4 dollars the arroba of 25 lbs. *Matés de yerva* are one among the four cardinal vices of certain parts of South America. On a villainous spur of the Andes, called, if I recollect, the Cuesta de Acay, it was hard sleeping, while running water was freezing, in the open air, night after night, and harder waking, in in the dark, with the Three Maries (Orion's belt) just rising on the horizon. On such occasions, my guide was wont to lace the *maté* with a little aniseed brandy. One morning, feeling very sleepy, stumbling along in the dark over the refuse of an extinct volcano, it occurred to me to ask old Sancho, "How much water did you put in the *maté*?" "*Ninguana*!" (none) was the reply. So it appeared that in the dark, frosty morning, between sleeping and waking, I had sucked through the *bombilla*—ere sherry cobblers were known—about half a pint of boiled brandy, flavoured with *yerva*—green-tea punch with a vengeance. There was no question of the intoxicating quality of the *yerva* under these conditions. To conclude. Some years back, Mr Hervé, an artist, returning from Buenos Ayres, brought with him some cuts of *yerva*, which was sold retail on Ludgate Hill for about 4s. per lb., and it was much liked by many people. It is probable that, with favourable circumstances, it could be imported here at about 6d. to 9d. per lb., and it would be a very useful addition to our stock of infusion-making materials.—(*Bridges Adams, in Report of Soc. of Arts, abridged in Gardeners' Chronicle.*)

Textile Plants.—Mr Nathaniel Wilson, the superintendent of the Jamaica Botanic Garden, exhibited at Paris fifty-one species of fibres procured from the following plants :—

Botanical Names.	*English or Vernacular Names.*
Yucca aloefolia	Adam's Needle, or Dagger Plant.
gloriosa	Ditto, the strongest fibre we have.
Bromelia Pinguin	Common Pinguin.
Karatas	Silk Grass.
Ananassa sativa	Pine Apple.
Musa sapientum	Banana.
sapientum var.	Martinique Plantain.
paradisiaca	Plantain.
Cavendishii	Chinese Plantain.
violacea	Violet ditto.
coccinea	Scarlet ditto.
Heliconia Bihai	Wild Plantain.
braziliensis	Ditto of Brazil.
psittacorum	Parrot-beaked ditto.
Tillandsia serrata	Wild Pine (our Epiphyte).
usneoides	Ditto, Old Man's Beard.
Pandanus spiralis	Screw Pine, *cultivated.*
Agave americana	American Aloe, or Curatoe.
Canna indica	Indian Shot.
Triumfetta semitriloba	Bur Bark, a common weed.
Malvaviscus arboreus	Bastard or Wild Maho.
Abroma augusta	Cultivated in gardens.
Kydia calycina	Tree 25 feet, rare.
Helicteris jamaicensis	Screw-tree.
Guazuma ulmifolia	Bastard Cedar.
Kleinhofia hospita	Tree 25–30 feet.
Sida sp.	Shrub 6–8 feet.
Ochroma lagopus	Down tree, common.
Cecropia peltata	Trumpet Tree.
Cordia Sebestena	Scarlet Cordia.
Gerascanthus	Spanish Elm.
collococa	Clammy Cherry.
macrophylla	Broad-leaved Cherry, or Man Jack.
Brosimum spurium	Milk Wood (common).
Ficus elastica	Indian Rubber Tree.
religiosa	Peepul tree of the East Indies, worshipped.
virens	Wild Fig Tree.
americana sp.	Ditto.
Hibiscus rosa-sinensis	Chinese Rose, or Shoe Black.
liliiflorus	Lily-flowered ditto.
esculentus	Ochro, *cultivated.*
elatus	Mahoe.
latifolia	E. I. ditto.
tiliaceus	Sea-side Mahoe.

Botanical Names.	*English or Vernacular Names.*
Lagetta lintearia	Lace Bark.
Daphne tinifolia	Burn-nose Bark.
Coco nucifera	Coco Nut.
Artocarpus incisa	Bread Fruit.
integrifolia	Jack Fruit.
Pterocarpus santalinus	———
Crotalaria juncea	Rattle Wort.

—(*Report of Jamaica Society of Arts, forwarded by Dr Bowerbank.*)

Fungus imbedded in Fens of Cambridgeshire.—Fungi are so rare in a fossil state, if indeed any undoubted cases occur before the post pliocene period, that no apology need be made for recording so trifling a matter as the present. Moulds are occasionally well preserved in amber, and a diligent search would probably detect species of other groups among the vegetable relics of the London clay. In the museum at Kew, there is a specimen of *Polyporus fomentarius*, Fr., communicated from the fens of Cambridgeshire by the Rev. Mr Hoilstone, where it occurred with bog oak, and must have been buried for many centuries. The specimen is so perfect, that it shows the particular substance of the pileus in admirable condition, both as regards colour and texture. It may be remarked that the specimen, which is attached by the centre, and ungulate, is far more strongly lanate than any British individuals which have passed through my hands, and in fact accords perfectly with one which was gathered in Sikkim by Dr Hooker, and which may be seen in the same compartment of the museum. It must have been dependent from some large branch, a situation in which the species seldom if ever occurs in Great Britain, and was probably surrounded by a moister atmosphere, in consequence of the prevalence of extensive forests that exist at present in the same or neighbouring districts.—(*Berkeley, Journ. Prov. Linn. Soc.*, June 1856.)

New Method of Disintegrating Masses of Fossil Diatomaceæ. By Prof. J. W. Bailey.

Put small lumps of the mass to be examined into a test-tube, with enough of a solution of caustic potassa or soda to cover them; then boil over a spirit-lamp for a few seconds, or a few minutes, as the case may require. If the solution is sufficiently strong, the masses will rapidly crumble to mud, which must be poured at once into a large quantity of water, which, after subsidence, is removed by decantation. If the mass resists the action of the alkaline liquor, a still stronger solution should be tried; as while some specimens break up instantly in a weak solution of alkali, others require that it should be of the consistence of a dense syrup. The mud, also, should be poured off as fast as it forms, so as to remain as short a time as possible in the caustic ley.—(*Silliman's Journal* for May 1856.)

MINERALOGY.

Voigtite, a new Mineral from the Ehrenberg, near Ilmenau. By E. E. Schmid.

In the granite of the Ehrenberg mica is wanting, and is replaced by another mineral in long thin plates, distributed irregularly through the rock. It sticks to both sides of fresh fractures, and though soft can be removed from the surface in plates of any size. It is brown, opaque, and possesses a somewhat fatty lustre; melts before the blowpipe to a black glass, and gives the reaction of iron. The mineral is ge-

Excluding the common salt, chloride of calcium, &c., this salt may be represented by the formula $K\ Cl + 2\ Mg\ Cl + 12\ HO$. It is therefore the same salt which Marcet obtained by the careful evaporation of the last mother liquor of sea water, and which Liebig found in the mother liquor of the Salzhausen brine.—(*Poggendorff's Annalen*, vol xcviii., p. 161.)

Composition of some Varieties of Arsenical Pyrites and Arsenical Iron. By Dr. G. A. Behncke.

In his inaugural dissertation, Dr Behncke has given analyses of arsenical pyrites from—I. Sala, in Sweden; II. Altenberg, in Silesia; III. Freiberg; IV. Rothzechau, in Silesia.

	I.	II.	III.	IV.
Sulphur, . .	18·52	20·25	20·38	19·77
Arsenic, . .	42·05	43·78	44·83	44·02
Antimony, . .	1·10	1·05	—	0·92
Iron, . . .	37·65	34·35	34·32	34·83
	99·32	99·43	99·53	99·54

The average specific gravity of the last three specimens was 6·058; but the first, which differs appreciably in composition from the others, had a specific gravity of only 5·820. The last three agree completely with the ordinary formula of arsenical pyrites, but for the first the author proposes the formula, $3\ Fe\ S_2 + 2\ Fe_2\ As_3$, although it seems very questionable whether it can be considered a different compound.

Arsenical Iron.—Compact masses, containing here and there crystals of the same form as arsenical pyrites—I. from Geyer—II. from Breitenbrunn, both in Saxony.

	I.	II.
Sulphur, ...	6·07	1·10
Arsenic, ...	58·94	69·85
Antimony, ...	1·37	1·05
Iron, ...	32·92	27·41
	99·30	99·41

The specific gravity of the first specimen was 6·283; of the second 7·270. Assuming the sulphur to exist in these specimens, and deducting it along with the corresponding quantities of iron and arsenic, the first specimen agrees with the formula $Fe_2\ As_3$; the second with $Fe\ As_2$.—(*Poggendorff's Annalen*, vol. xcviii., p. 184.)

Notice regarding the Mineral called Tyrite. By A. Kenngott.

The mineral described under this name by Mr David Forbes, in a previous number of the Edinburgh Philosophical Journal, has been examined by Kenngott, who considers it identical with Fergusonite. A crystal measured by him, approached in all respects the measurements of Fergusonite by Haidinger, and its hardness and other characters come so near those of that mineral as to leave little doubt of their identity. Forbes' analysis of Tyrite differs considerably from Hartwalls' of Fergusonite, but great allowance must be made for the time at which the latter analysis was made, and for our imperfect knowledge of the methods of separating the rare substances they contain. New analyses of both minerals are required. —(*Poggendorff's Annalen*, vol. xcvii., p. 622.)

Compact Boracite of Stassfurt. By G. Rose.

The compact boracite, obtained in 1847 from a bore at Stassfurt, was examined by Karsten, and found to have the composition of crystallized boracite, with which he considered it completely identical. He described it as amorphous, but, according to G. Rose, when examined under the microscope, it is found to be made up of minute *prismatic* crystals. It is almost instantaneously soluble in warm hydrochloric acid, while the crystallized boracite is quite insoluble even after long boiling, and is much more fusible before the blow-pipe than the true boracite. The author considers these facts entitle us to consider this as a different mineral from boracite, and he proposes for it the name of Stassfurtite. Should it, on further examination, prove to have the same composition as boracite, then it must be considered a heteromorphous form of that mineral, and the crystals of boracite with a fibrous structure, described as pseudomorphous by Volger, may be formed of Stassfurtite.—(*Poggendorff's Annalen*, vol. xcvii., p. 632.)

METEOROLOGY.

On the State and Prospects of the Scottish Meteorological Association.

The varying conditions of our climate exercise an influence, so obvious and powerful, on our health, food, and commerce, as to render the examination of their origin and limits deserving of every encouragement. Hitherto, in this country, the efforts of observers have in a great measure been fruitless, in consequence of employing imperfect instruments, conjoined with a deficiency of systematic combination. A remedy, however, is likely soon to be provided by the institution of the "Scottish Meteorological Association." Sir John Stuart Forbes, Bart., and Mr Milne Home, succeeded in procuring a meeting of gentlemen favourable to the scheme, on 11th July 1855. To the patriotic feeling and enlightened views of these two individuals, the thanks of the public are deservedly due, and we earnestly wish their Association all manner of success.

The meeting to which we have referred enjoyed the presence of the Marquis of Tweeddale, who presided in a very able manner; and it was addressed in the first instance by two gentlemen who had taken the initiatory proceeding in the matter, by Professor Rogers of Boston, Mr Stewart of Hillside, and others favourable to the undertaking. Office-bearers and a provisional council were appointed, a subscription list opened, and communications to Government, soliciting support, have since been forwarded. The scheme, indeed, seems now in some measure matured, and likely soon to come into active co-operation. With such convictions, we deem it expedient to call the attention of those willing to co-operate, to a few of the more prominent objects which should be kept in view, and the more obvious errors which experience has succeeded in exposing.

We happen not to be particularly pleased with the term *Meteorology*, as referring to our ordinary atmospherical phenomena constituting climate. We have great difficulty in considering the temperature, the pressure, or even the moisture of the atmosphere as *meteors* in the ordinary sense of the term, although entitled to be regarded as the most directly interesting of our atmospherical changes. *Climatology*, as peculiarly indicating practical purposes, would have furnished materials for a better title than the one now adopted. But let us pass on to more important matters.

The TEMPERATURE of the air usually and deservedly occupies the first place in the researches of the meteorologist. The observers have been numerous, while the results have been unsatisfactory, arising from several causes, among which the following may be noticed:—The instruments have too seldom been compared with a recognised standard one—those of a wandering Italian or a regular instrument maker have, usually, been regarded as of co-ordinate value. Differences of three or four degrees not unfrequently exist between neighbouring instruments, so that striking anomalies of temperature are indicated by the thermometers which have no existence. Besides, the instruments are usually placed on the sides of windows; and if not exposed to the direct or reflected rays of the sun in the morning or evening, are too frequently acted upon by reflection or radiation from surrounding objects, as the walls or roofs of houses. It has become an inveterate practice to *suspend* all thermometers vertically, by which considerable difficulty and even sources of error are introduced, while by other arrangements these might be easily avoided. Let us cherish the hope that all the thermometers recognised by the Association shall have been compared with *standard* instruments, and that some *normal position* shall be fixed upon as indispensable, in order that, by trustworthy instruments and suitable positions assigned to them, *comparable observations* may be procured from many and distant parts of the island.

The temperature of the air is derived either directly or indirectly from the *soil*. The solar rays, in passing through the atmosphere, do not heat it to any sensible degree, but they heat the earth against which they impinge, whether the surface be clothed with plants, covered with barren sand, or consist of naked rocks,—the power of absorbing and of being heated varying greatly in these different circumstances. The surface, thus acted upon, imparts its heat to the contiguous air, and hence the atmospheric temperature next the earth is that of the *soil*, and must vary with its different thermic conditions. With this truth in view, ought we not to direct attention to the temperature of the soil in the first instance, rather than to the effect which it produces on the air in contact? One conclusion may be drawn with tolerable safety, that the *normal position*, to which we have already referred, ought to be fixed by the Association, certainly not on the wall of a house, but simply *two or three feet above the ground*, in a free, open spot. Were a frame at this height, supported by four posts, and having resting on it a box made of copper, zinc, or tinplate, perforated with holes in the bottom and sides, but covered with a lid having a hinge, and overlapping the margin by an inch, of sufficient size in length and breadth to hold an ordinary and two register thermometers—the direct temperature of the air at this limited height above the ground, with the maximum and minimum of the intervals of observation, would be readily secured. A wooden dome, to prevent solar radiation, &c., but *open below*, would complete a simple *thermometer observatory*, very different from the highly objectionable *meat-safe*-looking concerns which have sometimes been recommended.

But the temperature of any locality is seldom, for any length of time, dependent on the heat communicated by its soil. Currents bring the heated or cooled air of other districts, the production of other and it may be distant soils, and thereby influence directly the temperature, not only of the atmosphere, but of the soil at the same time, in the particular locality. The direction of the WIND becomes, in such circumstances, an important element in the investigation of influencing or disturbing causes. Every one must be aware that in winter, when all our high ground is covered with snow, we may have a day or two of considerable warmth with the temperature above 50° F. This heat was not imparted to the air by the soil or the seas of the British Isles; but if we could trace the *direction* of such a current of warm air, we might approximate to a knowledge of its origin and progress. The *weathercock*, or anemometer, thus becomes indispensable, simply as marking the *direction* of the stream. If a simple instrument could be devised, capable of measuring its *velocity*,

in their position, and the accuracy of the indications doubtful. The Professor stated as the result of experiment, in accordance with theoretical considerations, that rain-gauges need not exceed three inches in diameter, that the trouble attending them may be limited to emptying them once a month, and that the index-rod, if divided into tenths of an inch, is sufficient for all practicable purposes. The eye, with a very little practice, can easily read off to one-fourth of a tenth, a difference often greater than the amount of rain falling at the same time within short distances. The Professor further stated, that gauges of the description which he recommended were being established in different parts of the country. At twelve of the parish schools of Annandale, rain-gauges, furnished by Mr Bryson for his Grace the Duke of Buccleuch, had been placed, and the results, according to Mr Stewart, Hillside, Lockerby, have been satisfactory. In conclusion, Professor Fleming observed, that trustworthy observations would not be secured for generalizations respecting the distribution of rain, until some simple, easily constructed, and inexpensive but accurate form of gauge be adopted, such as he believed the instrument on the table to be, and the instrument sunk in a grass plot, as free from the influence of trees, buildings, or local currents of wind as practicable, the grass around the funnel being occasionally trimmed."

The distribution over the country of rain-gauges fitted to yield comparable results, is a subject to which the attention of the Association will, we have no doubt, be carefully directed. In the meantime, those who feel an interest in the subject may witness an example of science run mad in the rain-gauges on the observatories of our Calton Hill. The *temperature* of the rain as it falls in different months must necessarily influence directly the heat of the air through which the drops pass, and the soil which receives them. But the most important consequence of rain on the soil is in this country connected with the cold which is generated by ordinary evaporation, and by the increased quantity *vaporised by wind.* A surface, therefore, exposed to a considerable fall of rain, and the full sweep of the wind, must be cold, and, however unfit for pasture, unsuitable for agriculture. The importance of *shelter* comes here prominently into view, together with the suitableness of farms in particular localities requiring peculiar treatment and occupancy. While the importance of acquiring accurate information respecting the fall of rain, as exercising an influence on temperature, will not be disputed, few have attended to the *quantity* as a source of supply of water for domestic purposes. The trustworthy results of comparable rain-gauges would speedily indicate the mode in which *scarcity of water during the summer months* could easily be remedied.

In the foregoing remarks we have referred so frequently to the *soil* as exercising a dominant influence on the heat of the air, as to indicate the propriety of keeping a register of its temperature, along with that of the atmosphere. We leave out of view, in the present case, the important researches which have had for their object to determine the depth penetrated by the summer heat and winter cold, and the modification of progress or limits dependent on peculiarities in the strata through which these waves of season temperature pass. The portion of the ground which here claims our notice may be regarded as a stratum extending to about 20 inches in depth from the surface. The temperature of this stratum of soil not only regulates the heat of the atmosphere resting over it, but exercises a dominant influence on the progress of vegetation. We are aware that the leafing and growth of plants above ground, is directly promoted by the heat of the air in which they are immersed; but it is otherwise with the sprouting of seeds. For the commencement and progress of this process, the heat of the soil must have reached a certain point, otherwise the seed remains dormant and exposed to the attacks of insects. We have not indeed any good experiments by which the degree of heat requisite for the germination of wheat, barley, or oats, can be regarded as determined. But it would surely be of importance to ascertain by the thermometer the progress of the heat of this, which may be called the *stratum of germination*, and its connection with the early growth of our plants. The first hint on this subject which we have noticed is by Mr P. Lathbury, dated Woodbridge, May 3, 1800, and inserted in the third volume of Dr Anderson's Recreations in Agriculture, &c., p. 271. The observations of this author, although countenanced by the sagacious editor, appear to have passed unheeded. It seems, however, a subject deserving of deliberate consideration, and we trust that it will not be overlooked by the Scottish Meteorological Association. The process of observation would not be difficult. A protecting tube of copper or zinc, close at bottom, with a diaphragm 3 inches high, the thermometer fitted to act like a plug, a portion of the stem with the bulb projecting into the chamber, and the scale resting on the diaphragm, would constitute the whole apparatus. It would be requisite to form the top of the thermometer so as to act as a cover, and prevent access to air or rain. The chamber at the bottom would always preserve the same temperature as the soil at the same depth, and there would be little trouble given to the observer. Thermometers thus placed from 3 to 20 inches from the surface, would, in the course of a few years, furnish useful results. We should discover the difference of soils as to heat, and the relative importance of deep ploughing and surface scratching. The fishermen on the coast now consult the barometer before going to sea, and it is not improbable that the sower, especially in spring, may yet have recourse to the thermometer in guiding him to the proper season for his labours. We would here earnestly recommend close attention to the temperature of perennial as well as of the variable springs of the districts.

In the preceding remarks we have confined our attention to the air and to the soil, and the different circumstances which influence their temperature, without noticing another agent, hitherto in a great measure overlooked, but which regulates in no small degree the character of our climate, viz., *the temperature of the surrounding sea.* We have, indeed, reference frequently made to our *insular climate*, and the effects produced on certain parts of the coast by the *Gulf Stream*, but what is the actual amount of accurate observations illustrative of these subjects? Generally speaking, our recorded data are either desultory, or too local in character to afford premises for anything approaching to safe generalization.

If register thermometers, with the scales of glass attached by platina wire and enclosed in a copper box, were placed a few feet below low-water mark, and examined every fortnight, we should get at those times of inspection one direct observation, together with the maximum or minimum of the interval. With such observations sufficiently numerous, and in different localities, we might test the truth of the assertions, that "from the intervention of the British Islands, the southern parts of Norway are less open to the warm sea current (Gulf Stream) than the northern parts, and hence in the month of January, the temperature actually becomes warmer in proceeding from south to north;" and "that if we proceed in January from the Shetland Islands down the east coast of Great Britain to the channel, we do not alter the temperature, whilst, with every step to the westward it becomes warmer, and that in no inconsiderable degree."

We do not here enter upon the necessity of attending to the conditions of pressure and moisture, or to electrical and magnetical disturbances, because we think the subjects to which reference has now been made capable of a *ready* illustration, and calculated to recommend science as admitting of practical applications. Keeping this feature in view, the Association may do much good, and speedily secure the cordial and liberal support of the public, in spite of all the evil influence emanating from the centralizing spirit of the age.—(*Communicated from the Literary Spectator*, May 1856.)

MISCELLANEOUS.

Notice of the Rock-Basons at Deo (Devi) Dhoora, near Almorah in Upper India. By William Jory Henwood, F.R.S., F.G.S., sometime Chief Mineral Surveyor, H.E.I.C., North West Provinces. (Read before the Royal Institution of Cornwall.)

Although much has been written on the ancient Druidical worship, it is for the most part of a conjectural character. Rock-basons, cromlechs, erect single stones, and logan rocks, are all supposed to have been used in it. Living amongst objects which have attracted so much attention from antiquaries, it cannot but interest us to know there is a district—though a distant one—in which some, at least, of them are still employed.

Whether the rock-basons now observed in the coarse-grained granite of Dartmoor, of Cornwall, and of Scilly, owe their origin to artificial means or to natural causes, there can be no doubt but their present forms and conditions are mainly, if not altogether, due to the disintegration of their sides by atmospheric influences. To these we also owe the peculiar figures of our logan stones, the strange outlines of our wildest rocks, and the present condition of many cromlechs.

The granitic mountain of Deo (or Devi) Dhoora is about eighteen miles south-east of Almorah, the capital of Kumaon, and rises to about 6800 feet above the sea. It is much visited by Hindoo devotees, as the temples and objects of pagan worship on its summit are considered of peculiar sanctity.

Both before and behind an inclosure which contains the principal temples, facing opposite ways, as well as in front of a smaller place of worship, about a furlong south-east of them, are large granite rocks affording tolerably level surfaces of several feet square, respectively about 4 feet, 2½ feet, and 1 foot above the ground. Each of these rocks exhibits a group of five basons. They are generally about 6 or 8 inches in diameter, and perhaps a foot in depth; their brims are tolerably sharp cut, their sides are perfectly smooth; no trace of disintegration appears in either of them, and they are evidently of artificial origin. No symmetrical arrangement appears to prevail in their positions, and they are at irregular distances apart. The priests of the temples, as well as my native attendants, professed entire ignorance of any object for which these rock-basons were used; and on the subject of their religious rites generally I found none of them communicative.

There are remains of several small granite-built shrines, each still containing a fragment of an idol sculptured out of slate-rock, as well as a stone of about 10 tons weight, obviously once a logan-rock, intentionally overthrown, on the same surface in which the rock-basons occur in front of the principal temple; and at least 4 other similar large stones, which equally bear traces of having been purposely upset, crown wild picturesque granite cairns in the neighbourhood.

The small south-eastern place of worship is not more than 12 or 14 feet long, by perhaps 8 in width and height, and in construction differs

twenty or more rough steps has been laid, thus forming a frowning doorway to a small natural cavern within the cairn. Lighted only through the entrance and through crevices in the roof, the straitened dimensions of the temple disappoint the expectations raised by its Cyclopean porch. The mutilated idol—a representation of some incarnation of the Hindoo deity—carved in slate about 3 feet high, is a loathsome semi-human figure with the legs folded beneath; on a low stone table before it rice and flowers were offered. It was not without horror and disgust that on entering the temple I found myself stepping in the blood of a victim, which spattered the sides and formed a pool on the floor; it had been sacrificed by one of my native attendants but a few minutes previously. The blood alone is offered to the idol, the priest and the worshipper dividing the flesh of the goat, which is beheaded by a single stroke of the heavy, curved Nepalese knife.

It is in vain for me to hope that I can give an idea of the rich wild scenery of the cairn, which forms the roof of this singular temple; enormous blocks of granite of most picturesque forms are piled in the strangest confusion; and flowering pear trees, magnificent blossoming walnuts, noble gnarled oaks, and patriarchal Deodars spring from the crevices.

From the rocky plateau in front, the view is perhaps of unequalled variety and beauty—over mountains and hills in almost endless succession, sometimes rich with fields of waving wheat, fringed with woods, varied by cottages and hamlets, and spotted with patches of Deodars marking the sites of temples; the whole intertwined with torrents threading their way to rivers in the plains, until, indistinct from distance alone, it is bounded at last by glaciers and snows—the highest ranges of the Himalaya.

Egg Albumen in Calico Printing.

We have been permitted by Walter Crowe, Esq., of Thornliebank, near Glasgow, to publish the following curious piece of statistics indicating the extent to which egg albumen is employed in calico printing. This substance is used as a medium for affixing upon the cloth certain insoluble pigments, such as the artificial ultramarine, not attachable by the ordinary processes of dyeing, and is a new and valuable auxiliary to the calico printer.

MM. Dollfus, Mieg, and Co., calico-printers of Mulhausen, use per annum 8000 kilogrammes of dry albumen, at a cost of 10 francs per kilogramme=80,000 francs; 320 eggs produce 1 kilogramme, which ×8000=2,560,000 eggs; one hen produces 200 eggs per annum, and, therefore, 12,800 hens are required to supply this one factory. The albumen is produced chiefly at Annonay near Grenoble.

Hints in regard to Dredging Observations.

The following are the directions drawn up by Mr Patterson of Belfast for the use of dredging parties:—

Points to be noted by Dredgers.

The number of species.—The kinds usually found associating together.

The number of living specimens of each.—The number of dead.

The average age of the specimens; that is, whether young or adult.

The general state of the animals, and particularly as to the maturity of the eggs, or if they have been recently shed.

The kind of ground.—The depth.—The distance from land.

The zone; whether the—1. Littoral; 2. Laminarian; 3. Coralline; or, 4. the Coral. These terms were proposed by the late Professor Edward Forbes, and are fully explained in his writings.

1. The Littoral zone includes the space between high and low water marks.

2. The Laminarian zone is that in which the large tangles or sea-weeds flourish, and extends from low-water mark to a depth of about 15 fathoms.

3. The Coralline zone extends from the depth of 15 to 50 fathoms. Sea-weeds are scarce, but Corallines abound in this region.

4. The Coral zone is that in which deep-sea corals are found, and where the depth is beyond 50 fathoms.

Queries.

Are there any particular currents?

What are the Mollusca found between tide-marks on the neighbouring coast?

Is mud present, and if present, of what kind?

Are any dead shells *common*, of which no living examples occur?

What sea-weeds are found?

Do the different specimens of the same species vary much in size, form, or colour?

Dredging Paper. (Partly filled up as a Specimen.)

Date..................................October 29, 1839.
Locality..............................Ballaugh, Isle of Man.
Depth.................................Twenty-five fathoms.
Distance from shore...............Five Miles.
Ground................................Shelly and gravelly; gravel small.
Region................................Of Corallines.

Species.	No. of living Specimens.	No. of dead Specimens.	Observations.
Nucula nucleus	15	0	In cavities of old shells buried in mud.
Lima hians	1	0	In its nest.
Lima Loscombii	3	2	Free. Dead valves thickened.
Pectunculus glycimeris...	6	7	Young shells common of this species.
Pecten distortus..........	20	6	Both free and fixed; also, same with a Byssus.
Psammobia Tellinella ...	1	7	Dead shells perforated; generally double.
Trochus Magus............	0	2	Much worn.
Trochus zizyphinus......	4	0	In gravelly places.

PUBLICATIONS RECEIVED.

Quarterly Journal of the Chemical Society. April 1856.

Proceedings of the Royal Geographical Society of London. Nos. I., II., and III.

Natural History Review. January and April 1856.

American Journal of Science and Arts. July and September 1855. March, May, and July 1856.

Abhandlungen der Kaiserlich Koniglichen Geologischen Reichsanstalt.

Jahrbuch der Kaiserlich Koniglichen Geologischen Reichsanstalt, 1855, VI. Jahrgang No. 1–2.

Quarterly Return of the Births, Deaths, and Marriages in Scotland, for quarter ending 31st March 1856.

Coup d'œil Geologique sur les Mines de la Monarchie Autrichiene, Vienne, 1855.

L'Institut, 13th February to 14th May 1856.

Colonel Sabine on the periodical Laws discoverable in the mean effects of the larger Magnetic Disturbances.

Colonel Sabine's Coloured Map of Terrestrial Magnetism.

Bibliothèque Universelle de Genève, Sept. 1855.

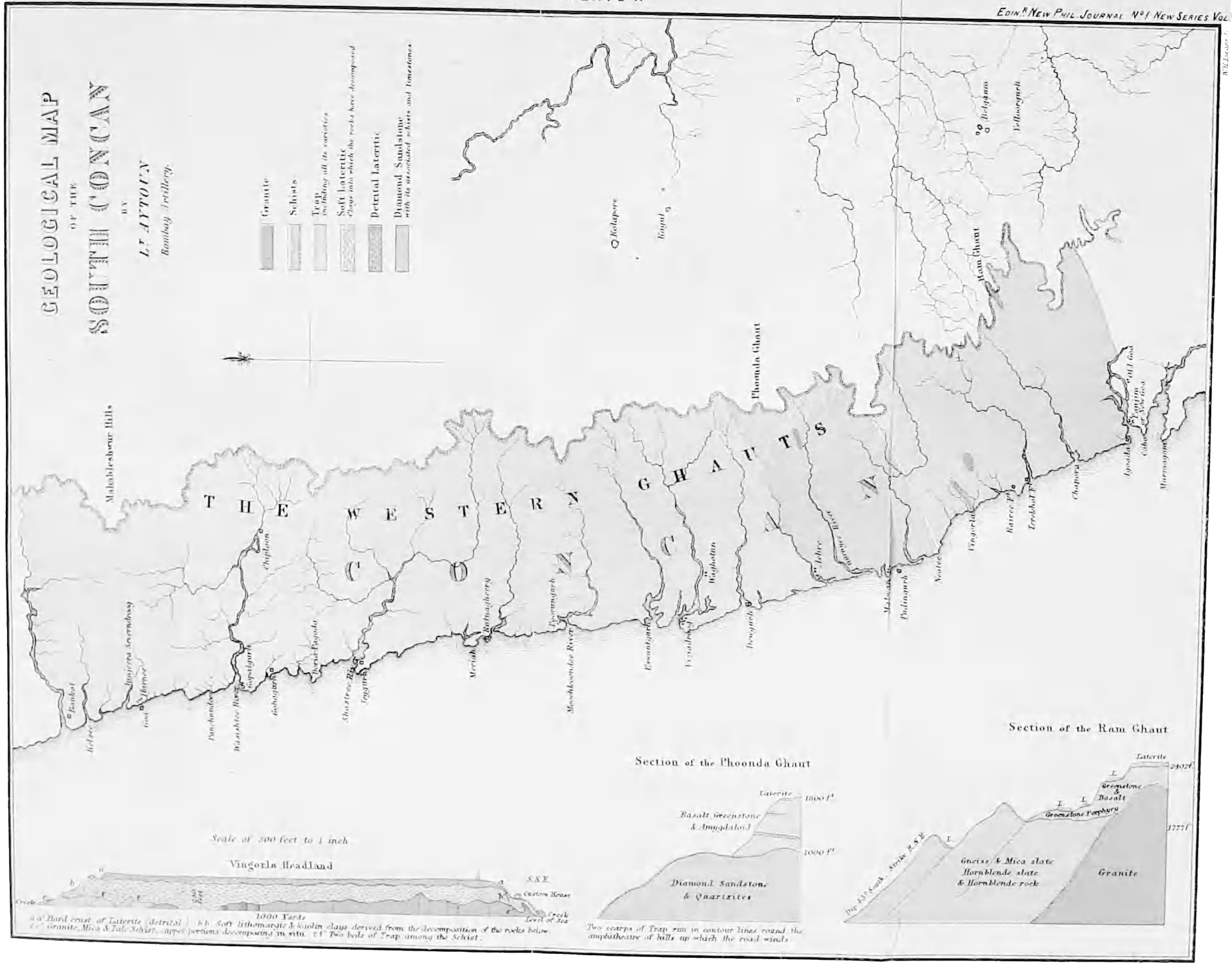
On the Variation of Species. By T. Vernon Wollaston, M.A.

Logan on the Ethnology of the Indo-Pacific Islands. Part II.

Journal of the Indian Archipelago. April to September 1855.


GEOLOGICAL MAP
OF THE
SOUTH CONCAN
BY
Lt. AYTOUN
Bombay Artillery.
Mahableshwur Hills
Bankot
Kelsee
Junjeera Severndroog
Goa
Hurnee
Padingurh
Neotee
Vingorla
Rairee F.
Terekhol F.
Chapora
Agoada
Cabo
Murmagoa
Panjim or New Goa
Old Goa
Ram Ghaut
Belgaum
Yelloorgurh
Section of the Ram Ghaut
Laterite
2402f.
1777f.
Greenstone & Basalt
Greenstone Porphyry
Strike E.N.E.
Gneiss & Mica slate
Hornblende slate
& Hornblende rock
Granite
a a' Hard crust of Laterite (detrital
c c' Granite, Mica & Talc Schist, _upper

Edinᴿ New Phil Journal Nº1 New Series Vol IV



CONTENTS.

REVIEW:—

Erratum.—Page 206, line 28, *for* Crowe, *read* Crum.

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

On the Northern Drift, as it is developed on the Southern Shore of the Moray Frith. By Mr JOHN MARTIN, of Anderson's Institution, Elgin.

The Northern Drift, the subject of this paper, is a name given by modern geologists to those vast accumulations of gravel, clay, and sand, which are spread over the underlying rocks of the north of Europe and America. In few parts of Scotland is the Northern Drift so well developed as in the lower portion of the province of Moray. We have it extending from the Spey to the Beauly Frith, with a breadth varying from one to ten miles. In the immediate neighbourhood of Elgin it prevails everywhere, save on the few spots where the underlying rock crops out, as on the sandstone ridges of Covesea, Quarrywood, and Carden Moor, or as on the rough conglomerates and gneiss rocks which appear near the base of the Mannoch Hill, and the Hill of Pluscarden; so that, stroll where we may, within several miles of the town, either under our feet, or a few inches under the arable soil on which we tread, we have this Northern Drift in some of the many aspects which it presents. Its uppermost beds or banks of pure gravel and sand, of course meet the eye most frequently. The cutting for the Morayshire Railway at Barflathills laid this part of it open to the depth of 50 feet. The whole, or at least the upper portions, of Barflathills, Ladyhill, Gallowhill, Bruceland, and the bank on which Bishopmill is built, are composed of it, as well as the extensive flat on both sides of the Rothes road, about Langmorn, and which extends eastward through Coxton, Lhanbryde, and Urquhart, to the Spey. Its clays, or what is termed "The Till," although seen on a larger scale further inland, are to be met with lying on the limestones, cornstones, and sandstones of the quarries opened up around the town, as at Glassgreen, Bilboahall, and Bishopmill; and they are generally come upon in the digging of wells or deep foundations in and about the town, and are often seen in the trenches dug in the streets for the town's sewers.

While speaking then of this geological formation, do not think that we are digging low down into the bowels of the earth, or describing things dark and hidden, visited only by the miner, or reached only by the hammer of the enthusiastic geologist. No! the Northern Drift, the subject of our present discussion, is something that we see every day, and is well known to us. It lies before us as a constituent part of almost every hill, mound, or plain, and is exposed in the cuttings of every road and ditch in the district. Now, this Northern Drift, which is so well developed and widely distributed in Morayshire, is a superficial deposit, and consists of immense beds of sand, gravel, and clay, accompanied by erratic blocks or boulders of granite, gneiss, micaceous schist, conglomerate, sandstone, limestone, and oolitic rock. The till in this district generally forms the middle portion of the drift, and has always been the more interesting part of the series. It is of a reddish colour, very tenacious, and is devoid of the least appearance of stratification. It is composed of fragments and comminuted parts of all the older rocks, and also contains boulders, many of them of immense size. This till prevails over the greater part of Moray, and on the slopes of our hills presents the outline of well-defined terraces. In the low country it is seen to rest on the secondary rocks of the district, without any intervening beds of sand or gravel, but on the elevated slopes of the hills to the southward, as at Humrich and Logieburn, it is seen to overlie an immense deposit of very coarse gravel. There, at the height of 900 feet above the sea-level, it forms the uppermost portion of a terrace of very great extent, and it presents itself in the various other

ject, and it was questioned, how was it possible that a volume of water, however powerful and extensive, could manage to move boulders of many tons weight, across valleys, and up the sides of steep and lofty mountains? Many ingenious theories were propounded to account for the phenomena, and some of them created no little sensation at the time, but on close examination they were found not to be in accordance with facts; they therefore failed to give satisfaction, and fell successively to the ground. In more recent times M. Agassiz has introduced the terrestrial glacial theory, which has been adopted by many eminent geologists, both in this country and on the continent.* Their views are based on the striking analogy that subsists between recent glacial action, as it is seen in the valleys of the Alps, and all the varied appearances of the boulder formation. M. Agassiz had investigated the subject very closely, and studied the natural history of glaciers in the valleys of the Alps: it cannot therefore be doubted, from his extensive researches in that quarter, that he was qualified to give an opinion on the subject, and to identify any of the peculiar accumulations termed moraines, in whatever locality they might appear; but we must not conceal our suspicion that his disciples, in following out his theory, have confounded the effects of two entirely distinct operations, namely, terrestrial glacial action, and marine glacial action; and, although the results of each show a close similarity, yet, when closely examined, they exhibit a very great difference of character. In short, his followers have made his theory to account for too much, and have created no little confusion by making every isolated hillock, and every terrace bank, either the lateral or terminal moraine of a glacier.

It is well known that glaciers have their origin in the heads of valleys, traversing high mountain ranges, and that these valleys have an inclination or slope towards the low country. The glaciers acquire a slow movement down these valleys, and in their advance, become covered along each margin with masses of rock, and detritus which have fallen from the sides of the valley. These accumulations, if they happen to be deposited on the sides of a valley, are termed lateral moraines.

* M. Venetz it was who, in 1821, first suggested this hypothesis.—*Ed.*

When a glacier has reached the mouth of a valley, or the point where the temperature is powerful enough to dissolve ice, the entire mass undergoes a change, the ice of the glacier is dissolved, and a large stream is formed, which soon finds its way down the valley, while the large accumulation of boulders, pebbles, and mud, which came along with it, forms a bank or terrace, which is termed a terminal moraine.

Let us now examine the applicability of the glacial theory, as propounded by M. Agassiz, to the district under review, and in doing so, we hold it to be an axiom, that the advance of every modern glacier depends upon the superior altitude of the ground behind it. In looking around, and particularly in a north-western direction, whence it is allowed by almost all geologists that the great bulk of our Morayshire drift was derived, we find no very elevated ground nearer than Ben Wyvis. Now, it has been stated, on very high authority, that there are unequivocal signs of glacial action on many parts of this mountain, and we confess we do not presume to question the authority; for if there be conclusive evidence of the existence of ancient glaciers in the valleys connected with Ben Nevis and Ben Macdui, we can see no reason to conclude that they have not existed also in the valleys and gorges connected with Wyvis, which exhibit many similar evidences; but we cannot yield to the conclusion, that a glacier produced in any valley connected with Wyvis, crossed an arm of the sea, such as the Moray Frith, advanced over an extensive plain, and ultimately deposited its contents on the slopes of our hills, at an elevation of 1000 feet. On the contrary, we are fully impressed with the conviction, that, at the era of the drift, which we have no doubt is of immense antiquity, the whole of the lower part of Moray was under the sea, and that the large boulders which we find scattered over the country, and the immense beds of clay, gravel, and sand, which cover the surface, were deposited at the bottom of that sea. That there were glaciers on Wyvis at the era of the drift, we hesitate to doubt; but when they did prevail there, the base of that mountain must have been deep under the sea, and therefore, whatever materials we find in the drift of Moray, derived from Wyvis, were either carried down its sides by a glacier, the terminal part of which broke off, and was floated away as an iceberg, or by ice which had been formed on the sea around it. But the great argument, in opposition to our view of the subject, is the unstratified condition of the boulder clay or till. It is said to possess none of the characteristics of a marine deposit, inasmuch, as whatever is subjected to the action of the sea, whether mud or sand, invariably undergoes an arrangement which presents undoubted lines of stratification. We must confess, that we have never observed any sort of stratified arrangement in the materials which constitute the boulder clay, and if any, it has always presented a plum-pudding sort of arrangement; however, it is always found associated with, and often overlaid by, immense accumulations of stratified sand and gravel; and we have no doubt, that when the peculiar circumstances hereafter referred to, as attending its deposition, are taken into account, the objection to its being deposited on the sea-bottom will vanish.

The following pages are intended to furnish data, in support of a theory which, in our opinion, may account satisfactorily, not only for the origin and present position of the anomalous till, but for the accumulations of sand and gravel, and the erratic blocks which are so often met with in the plain of Moray. It may be proper to keep in mind, that at the period of the boulder-clay, we hold, that the whole of the lower part of Moray was under the sea, or, properly speaking, it was the sea-bottom, and that the climate was intensely cold, very much resembling that which now prevails within the Arctic Circle. When viewed under such circumstances, there can be no hesitation in coming to the conclusion, that glacial action, in the form of icebergs and icefloes, and not glaciers simply, had played a prominent part in the formation of our superficial deposits of gravels, clays, and sands. It is well known that an iceberg of the present day, is the terminal part of a glacier, which had separated by its own weight from the body of a glacier, and fallen into the sea; they are often of enormous size, and are drifted far to the southward, heavily laden with masses of rock and detritus, which had fallen on them from the sides of valleys in their progress over the land. Icefloes are portions of icefields, which had been formed on the

but when the numerous changes which have taken place, since the time of its formation, are considered, there can be less hesitation in pointing it out as a remarkably well-defined terrace. We can trace undoubted indications of a contemporaneous terrace, on the slopes of the elevated lands, both to the eastward and westward of this. In several places it is cut transversely by deep water-courses, which have defaced its original outline very much, and there is every likelihood, that any irregularities which otherwise present themselves, may have originated from very extensive detrition, caused by strong currents sweeping across it.

Now this bank or terrace, in a very remote age formed the sea-shore, and from the vast accumulation of drift in its composition, we have every reason to conclude, that either the land remained at this level for a lengthened period of time, or that the agents then in operation, were vast in number, and enormous in power. All the boulders and fragments of rock contained in it, are derived from very ancient formations. They consist of red, gray, and syenitic granites; gneiss, quartz, and masses of the lower conglomerate. Everything connected with this terrace indicates its very high antiquity. The till does not exhibit the warm red colour which it displays at a lower level. All the boulders are strangers, and are evidently far travelled. The gravel in many places shows little arrangement, being thrown into heaps as if tumbled from a cart, and the fragments of which it is composed are sharp and angular, showing that they had never been subjected to much wearing. It is in vain to look here for a fragment of our Morayshire rocks. The sandstones, cornstones, and wealdens of the plain had never reached this high locality. They were deep, deep under the waters of the sea, and as yet had experienced no violent disturbance.

This terrace has been pointed to as the result of simple glacier-action—that is, that it was formed on land by a glacier, which had been produced in some elevated valley among the mountains lying to the north-west of Moray. Our belief is, that it was formed of materials conveyed by floating ice, when this now elevated part of the land was at the level of the sea; and further, that all the materials, the clays, gravel, and boulders which we find in it, were originally derived from high lands far to the north-west.

In reference to the above remark, we wish it to be understood, that we do not mean to convey the idea, that the sea stood at so high a level as this ancient sea-beach does now. What we mean to imply is this, that the land has been raised to the height of 900 feet since the period that this terrace was formed; and were it the case, that a depression of the land occurred to the same extent, the plain of Moray would again be submerged many hundred feet beneath the sea, and this same terrace, would again become the seashore.

On further examination, we are led to conclude, that the whole of the north of Scotland was emerging gradually from the sea. All the way down the hill, we find a succession of banks and terraces of a similar composition to the upper one, but at the base of the hill, we find a very different kind of drift. Here the gravel is finer, and the pebbles are much more rounded, showing that they had been longer subjected to the action of the sea. The till is also different in character, being of a deeper red, and much more tenacious; while blocks and fragments of the gray sandstones of the low country begin to make their appearance. At the time when the upper terraces were formed, none of the sandstone ridges of the plain had been raised above the level of the sea, but now it is evident, that the whole plain of Moray was undergoing an elevatory movement. Here we find blocks of the Carden Moor sandstone, west of the Knock of Alves, containing perfect scales of the *Holoptychius nobilissimus*,—a characteristic organism of the Old Red Sandstone. It is probable that, about this time, the Carden Moor formed a reef, and that the sandstone beds on the crest of it, received those peculiar scorings which are still seen on the surface, by an iceberg passing across it. These scorings present a very remarkable feature in connection with the history of the drift. They consist of a series of striæ, or parallel lines, distinctly impressed on the surface of the sandstone, and are always seen to extend in a direction from north-west to south-east. Interesting examples may be observed on all the sandstone ridges on Moray. They are well defined on Quarrywood Hill, Carden Moor, and Inverugie Hill. We consider them to have been impressed on the surface of the sandstone by a passing iceberg, whose under surface contained numerous angular fragments of rock, which grated on the opposing surface of the sandstone.

At a lower level we find another differently-constituted drift. Along with the blocks and fragments of the older rocks, portions of the Old Red Sandstone become more prevalent; the gravel is also more rounded and finer, and contains thin beds of very fine sand. The till is of a very compact texture, and bears a close resemblance to the clays about Elgin. It is almost conclusive, that a great proportion of the till at this level is composed of the detritus of the Old Red Sandstone, and that great part of the gravel is derived from the conglomerates of that formation, which have evidently suffered from very extensive denudation. There is every appearance that this terrace, and the very extensive one on the north side of Quarrywood Hill, on which the kirk and manse are built, are of the same age; they bear a striking resemblance to each other, not only in their external appearance, but in their composition, and in the fragmentary rocks which accompany them; and although in levelling, some discrepancy might be detected in their respective heights above the sea-level, yet this should nowise invalidate the conclusion, as it is evident, from the many inequalities of the land, that there had been a very unequal elevatory movement at the time, and we have reason to conclude, that the intensity of that movement was lessened, in proportion to the distance of the locality from the centre of greatest oscillation.

On leaving this terrace, and still directing our course towards the plain, we meet with a very extensive deposit of sandy gravel. It extends from Manbeen to the shore of the Moray Frith, near Speymouth, a distance of twelve miles, and is on an average about a mile in breadth; in some parts it shows a depth of sixty feet. There is not much regularity in the surface of this extensive deposit. In some parts it is level, but is generally of an undulating surface, with here and there, insulated hillocks and elongated ridges of gravel. It is evi-

but in descending towards the shore, it measures only 5 feet in thickness, when it thins out, and is succeeded by a series of very interesting shingle beaches.

There is here, evidently, a point beyond which the till does not descend; and there can be no doubt, that this point indicates an epoch in the history of the earth, when the great northern current, which had long been powerful and impetuous, had either been diverted from its original course, or neutralized by the force of some other current, brought into action by the extensive changes on the surface of the earth; and also, when the internal forces, long in operation, had either become *effete*, or at least had ceased to act, as they had formerly done, in this particular district. The results of these progressive changes were, a complete alteration in the physical condition of the country, and a change in the condition of climate, from an extremely diminished temperature, to a state somewhat resembling that which we now enjoy.

We should here revert to a very singular appearance, which the till exhibits, in some of the sandstone and limestone quarries in the neighbourhood of Elgin. The surface of the rock, for a foot or so downwards, is all shattered; above this, the till commences; but for two feet upwards, it is mixed with numerous angular fragments, about the size of road metal, derived from the subjacent rock. There is a regular line of demarcation between this and the real till, above which the angular fragments do not pass. Again, in the Newton Quarry, the upper beds, which are a kind of conglomerate, appear to have been torn up with great violence. Masses of many tons weight have been moved from their bedding, and large boulders of granite and gneiss have been thrust in between these masses and the underlying beds. Here the drift has in several places insinuated itself between the divisions of the upper strata. On the surface of the western quarry of Spynie Hill, the turmoil has been no less violent. Here the covering of the sandstone consists of clay, sand, and gravel, including blocks of sandstone, torn up from the surface of the rock, with large masses of cornstone, boulders of granite, gneiss, and conglomerate. The drift has no appearance of regular stratification, but is contorted into the most singular and fantastic forms, appearing in some places as if it had been poured down in a stream from above, in others as if it had been thrown down in collected masses, and afterwards covered over with alternate heaps of sand and gravel.

The distribution of erratic blocks or boulders, so extensively over the greater part of the land of Moray, is a circumstance so intimately connected with the history of the drift, and forms so interesting a feature of itself, as to require a few additional remarks. They are met with in almost every part of the country; on the tops and slopes of the hills, on the plains, and in the depths of the valleys. They are also to be seen in the till, in the gravel, and in the sand, and they are found, not unfrequently, reposing on the surface of the bare sandstone; but there are certain localities where they are accumulated in immense numbers. On the high terrace, on the slope of the Brown Moor, when a part of the ground was lately trenched, the surface was completely covered with them, many of great size. These included granites, gneisses, quartzose rocks, and conglomerates. On the north side of Quarrywood Hill, immense numbers of gneiss boulders are to be seen scattered over the surface of its upper terrace. But the boulders which appear on the surface bear no proportion, in number, to those which lie inclosed in the till, and it is only when waste land is trenching, that a proper idea can be formed of the immense numbers which lie concealed under the surface. When a work of this kind is in operation, on any of the terrace banks of the district, the entire surface is often so closely covered with boulders, that it is difficult to get a glimpse of the ground.

On the surface of the gravel, the boulders are not nearly so numerous, but they are often of immense size; and it is worthy of remark, that in several localities, often two, three, or more boulders of conglomerate, of the same mineral character, and apparently derived from the same formation, have been met with, separated only a few yards from each other, while the parent rock may be hundreds of miles distant.

In the neighbourhood of Elgin, the till appears in a position for which it is somewhat difficult to account. At Linksfield, for instance, there is an extensive bed of cornstone, which is overlaid by a very singular deposit, consisting of alternate layers of clays, shales, and limestones, which has acquired the name of Wealden, from a supposed resemblance of the organisms found in it to those in the wealden beds in Sussex. Now, a bed of till has been intercalated, or thrust in between these two deposits, that is, between the cornstone and the wealden. It is a very irregular deposit, being in some places only one foot in thickness, while in others, it increases to the extent of fourteen feet. As the cornstone under it is worked, the wealden beds above are of course removed, and it is observed, that every new cutting exposes a different section of the till. At one place it exhibited a series of arches, of six, ten, and fourteen feet in height, at another, it rose abruptly to the height of fourteen feet, when it terminated in a point like a wedge, amid the dislocated strata of the wealden. But it often extends in horizontal beds, of three or four feet in thickness, when the upper part shows a continued undulating surface. At one point, the till formed the section of an arch fourteen feet in height, when a band of the limestone above formed a complete arch over it, and the limestone, in suiting itself to its new position, was regularly rent at distances of two feet, as if it had been laid on artificially. The wealden appears to have been laid down in regular, horizontal strata, but the displacement of the lower beds, and the intrusion of the till, have occasioned many inequalities and dislocations throughout the entire mass. In some places, where great disturbance had taken place, the wealden is traversed by large vertical rents. These rents are filled with the till, as if it had been forced or squirted upwards, when in a moist state, by the great pressure of the overlying beds. When a section is newly disclosed, these rents, filled with the red till, traversing the blue clays and dark shales of the wealden, are not very unlike the red granitic veins, rising through the gneiss rocks, so interestingly exhibited on the banks of the Findhorn. In this till, fragments and masses of the limestone which overlies it are numerous, and thin bands of blue clay and limestone, are often seen imbedded in the red clay, as if they had fallen from the lower band of the wealden when the till bed was forming.

must also have inclosed numerous fragments of rock, more or less waterworn. When broken up and drifted by a current from the north, of which we have distinct and undoubted proof, the ice would be stranded in floes, on the slopes and shores of the lands lying to the southward, and the various materials which were carried along with them would there be deposited. We have seen, that the masses of drift, accumulated on the higher slopes of our hills, are enormous. We have also seen, that the fragments and masses of rock, inclosed in the drift, are foreign to our district; they are the brash and detritus of very ancient formations, and we cannot identify them with any native rock of this district. To find the parent rock, we must visit localities far to the northward and westward, and there, in the gorges and precipices of the mountains, we can lay our hand on granites, gneisses, and conglomerates, which are identical in mineral character, and may have been the very source, whence many of our numerous boulders and fragments were derived. We have also every reason to conclude, that not only the rising lands in the north of Scotland, but also the extensive countries far to the north-west, contributed largely to augment our superficial deposits; and not only that, but there may have been large supplies derived from other extensive northern regions, then existing, but which may have gradually disappeared beneath the ocean, during the period when the lands to the south were emerging above it.

Continuing this view of the subject, we arrive at the period, when a powerful elevatory movement affected all the northern lands of Scotland, and exposed our first sea-beach, high and dry, with all its wonderful assortment of mineral materials. We wish it to be understood, in making this remark, that the materials which compose these terraces, were laid down, long before the terraces actually became sea-beaches, in the common acceptation of the term. The mass of the materials of which they are composed, was deposited in deep water, for we must consider that icebergs, from their great weight, float deeply, and are therefore stranded before they reach the actual shore. Terraces would therefore be forming long before they reached the surface of the water. Icefloes would, however, from their greater lightness, be drifted to the very brink of the waters, and would deposit their burdens on the actual shore, long after icebergs had ceased to act at that particular level.

We cannot associate a sea-beach of that era, with one on the shore of the Moray Frith at the present day; the one must have been exceedingly unlike the other. Here we find the sea-beach strewed at all seasons with sparkling yellow sands, mixed with numbers of beautifully painted shells, the rocks covered with various kinds of delicate sea-weeds, the haunts of zoophytes, and other minute and tender creatures; and the limpid pools teeming with abundance of animal life. There the sea-beach must have been a bleak, lifeless, and dreary scene, a receptacle for the wreck of mountains, and the scene of incessant warfare, among the huge masses of ice, that were continually thrown upon it. Here the sea-beach, in summer, is a pleasant scene, and one delights to wander on it, and to be fanned by the cooling breeze which comes wafted across the rippling waters. There the sea-beach was a mass of unsightly sludge, mixed with unshapely masses of rock, and the wind which came across it, was a biting, chilling blast, nursed in a rigorous climate of the far north.

It would appear that the violent upheavals to which the land was subjected, at certain periods, were succeeded by lengthened intervals of repose. This is evident, from the masses of drift which are heaped up to one level, on the acclivities of all our hills; and it is evident also, that the movements which then took place, were not limited to the elevation of a single mountain, or hill, or plain, but extended over a very extensive area. This is evident from the different materials which enter into each successive terrace bank. We have already stated, that the drift which is most elevated on the sides of our hills, is the oldest, and is composed of the detritus of the oldest rocks. Now we find the drift, at a lower level, to be composed of the same kind of materials, but to have a mixture of sandstones, showing plainly, that the agents, then in operation, were acting on parts of the earth's surface which had not been previously exposed to their influence. At a lower level, we still find fragments of rocks and boulders, similar in character to those contained in the highest or oldest terrace, but with the addition of sandstones and limestones, again showing, that a general upheavement of the land took place, and still lower down, we find sandstones and limestones, with masses, and fragments of oolitic, lias, and wealden rocks, along with granites, gneisses and conglomerates, similar to those found in the upper terrace, all tending to confirm the opinion, that the land experienced a succession of upheavals, not only in this quarter, but over an extensive range of country both to the northward and westward.

It would appear that the materials conveyed by ice, at an early period of the drift, were very limited. The land was not sufficiently elevated then to afford a great supply; we therefore find the summits of our northern mountains but scantily covered with drift. Indeed many of the summits of the higher elevations, in the north of Scotland, have no other covering than the disintegrated and decomposed parts of the rocks of which they are formed. It is at a subsequent period, when a greater extent of land is raised above the level of the sea, that we find the deposits of drift to increase in depth. At the height of about 1000 feet, the banks of drift appear, in this district, to have attained their greatest proportions. When the sea washed the shore at this level, there must have been a very considerable extent of surface exposed to the action of ice, both in the north of Scotland, and in the countries lying to the north-west of it. Icebergs and icefloes would then become numerous, and would furnish large accessions to our drift-deposits.

It should be here remarked, that the materials of which terraces are formed on the sides of mountains, and at the entrance of elevated valleys, will often be found to consist of fragments and masses of rock, which had been conveyed by glaciers, and also of the detritus of rocks of a very different kind, which had been carried thither, from various distant localities, by floating ice. We may therefore consider, that the terraces which extend along the sides of our mountains, or traverse the entrance of our valleys, on which moving glaciers had been formed, may contain masses and fragments of rock derived from adjacent localities; at the same time, we may find these mixed with boulders and fragments of rock, derived from formations some hundreds of miles distant.

human race? Had the elevation of our country taken place from the depths of an ocean, which had never been subjected to disturbances by violent currents, or whose surface had never been ploughed by an iceberg, our hills and our valleys would have presented little else, than an extensive surface of barren, indurated rock, without a tree, or shrub, or blade of grass, to mitigate the desolation of the scene, but instead, an extensive region, presenting no other sign of vegetation than the gray shrivelled lichen. Or had the surface been altogether covered with that coarse unsightly gravel, which underlies the till, on the slopes of the neighbouring hills, and which would have been as unproductive as the shingle beaches which extend to the south of Lossiemouth, what a miserable picture the plain of Moray would now present. You would look now in vain for our extensive pine forests, for our waving corn-fields, and our rich and luxuriant pastures, with their numerous flocks and herds, and for the happy homes of an industrious and a prosperous people. But when we examine the surface of the country in any locality, we find its asperities entirely concealed. The rugged and steep declivities of our valleys are softened into gentle, undulating slopes, and the harsh features of a rocky and irregular plain, are obscured by a rich deposit of mineral ingredients, derived from numerous sources, and admirably adapted for the support and nurture of the varied forms of vegetable life.

The question may now arise, What proof have you that the deposits to which you have now referred, are really the result of glacial action? The question is a fair and natural one, and deserves an explicit answer. However, one cannot fail to understand that we are not in a position at present to point to existing glaciers, stretching down the valleys of our northern mountains, nor to icebergs, floating in majestic grandeur on the bosom of the neighbouring seas. These are things which have been, and happily for us now-a-days they have long since disappeared. They have, however, left, as it were, the prints of their footsteps. Their bodily presence has vanished, but they have left traces and memorials of their visit, which it is impossible to gainsay. In the first place, we have the striated surface of the rocks, as one of the undoubted characteristics of glacial action. This is an operation which could not have been accomplished by any other agent than ice. Water is not sufficient to do this, even when it rushes with force, and rolls pebbles and larger fragments of rock along with it; it merely scours and smooths a surface, and the impressions are so faint, that they are soon obliterated. The striæ on the surface of our sandstones, are distinct parallel lines. deeply impressed, and evidently effected by the grating of a heavy body, propelled with irresistible force along the surface. Now an iceberg, having its under surface studded with numerous angular fragments of rock, is just such a body as could accomplish this work. In moving along, in a strong and rapid current, it would float deeply, and when its under surface came in contact with a ridge of sandstone, it would not roll, but it would grate on the surface, and impress on the rock the striæ and markings which we now find. These striæ must have been originally, deeply and sharply cut, when they still retain their distinctness, after being so long exposed to the fury of floods, and storms, and tempests. On the crest of the Carden Moor, the sandstone is quite bare, and perhaps has been so for ages, yet the surface still retains the tracings and lines of direction of the huge icebergs which had passed across it. The sandstone on the hill of Quarrywood, is also distinctly marked with striæ.

It is a curious fact, confirmatory of the passing of heavy bodies of ice, that it is only on the crest of the sandstone ridges that striæ are observed to run in continuous lines. There the masses of ice must have cleared the ridge without a single pause, merely grating on it, whereas the sandstones on the declivities are very irregularly striated, the lines being shortened, and often much deflected, as if the body of ice had been bumping against the rock, instead of going clean over it.

Another instance of striated and polished surface, is often remarked on the sandstone blocks inclosed in the drift. These blocks are very hard and siliceous, and generally contain numerous small quartz pebbles, arranged in layers. One side appears fresh and unaltered, as if the stone had been recently removed from its bedding; the other side shows that it had been subjected to severe rubbing, for it is highly smoothed and deeply striated; and running parallel with the striæ, there are numerous other finer lines, as if a lighter body had impressed them, subsequently to the passing of an iceberg. These blocks do not appear to be far-travelled, and perhaps we would not be far out in our reckoning, were we to fix on the parent rock, in one of the sandstone ridges in the plain of Moray. When these blocks received the striated impressions, they formed the surface of the rock over which an iceberg had moved, and, subsequently, when these sandstones were elevated to the surface of the water, they were affected by the masses of ice which were formed on that surface—were torn up from their bedding on the breaking up of the ice, and floated away on an icefloe, when they were either dropped on their journey southward, or stranded on the first land that interrupted their progress.

Another proof of glacial action is the extensive distribution of erratic blocks. Various theories have been propounded, from time to time, to account for their transportation over extensive spaces;—some of them are ingenious enough, but it may be sufficient to state, that they fail to account for many of the phenomena in connection with the transit of erratic blocks; but when ice is introduced as the locomotive power, every difficulty appears to vanish. We can then understand, not only why the elevated terraces on the slopes of our hills, contain masses of rock, which had originally formed portions of formations seated in high mountain ranges, far to the north-west, but also, why the terraces on each hilly ridge, which traverses the plain of Moray, contain masses of sandstone and limestone, derived from the ridges which lie to the north-west of it. But although we are far removed from that remote era, in which so many extraordinary changes occurred, and have no visible representatives, at least in Moray, of the agents which then operated so extensively over these northern regions, yet we have elsewhere, very convincing proof, in modern times, of the power of ice as a medium of transport. In the Arctic Ocean, icebergs of immense size have been observed, drifting southward, deeply covered with masses of rock, and large quantities of mud and gravel. These bergs are often several hundred feet in thickness, and many of them

outline, as if the clay had been thrown down into the intervening hollows. These lines of division are always defined by a trace of fine sand.

Perhaps one of the most distinctive and convincing proofs of the transporting power of ice, and of its former operations in this country, is to be found in the stratified masses of blue clay, inclosed in the till. On the eastern slope of the Coulert Hill, a section of the till was lately exposed, when it was seen to wrap round a bed of finely laminated blue clay, inclosing belemnites, with fragments and masses of oolitic rock, containing several species of fossil shells. And at Sheriffston, a bed of blue clay was lately disclosed in a similar position, containing numerous organisms of the same description. Now, there is every reason to conclude that these imbedded masses of blue clay, evidently the debris of the oolite, had been arranged in layers before they came to be included in the till, and were conveyed to their respective localities on floating ice, without undergoing the smallest disturbance in their arrangement.

The changes which have taken place in these northern regions, changes from the extreme rigour of an Arctic winter, to the temperature which now prevails, may now be accounted for. In looking back to an era, much more remote than that of the Northern Drift, geology furnishes us with data, which prove unquestionably, that the northern parts of the country had been subject to great alternations of temperature. At one time, affected by a climate, which encouraged the growth of a vegetation which is now confined to the regions within the Tropics; at another, by such an extreme diminution of temperature, as would lead to the belief, that every living existence had either become extinct, or had degenerated into forms so puny and feeble, as to bear the most distant relation to their early prototypes. Some writers have endeavoured to account for these vicissitudes of climate, by ascribing them to a change in the position of the earth. We are not inclined, however, to adopt that view of the subject, for we are firmly impressed with the belief, that the agencies which had been in operation, and had acted with such powerful influence in producing the extremes of heat and cold, are neither extinct nor dormant, but still exist, and are only prevented from acting, as they had formerly done, by the extensive changes which have since taken place on the surface of the earth.

The ocean is affected by various causes, and is seldom, if ever at rest, being subjected to greater or lesser movements, by winds and storms, which are often local and temporary, by tidal action, which is permanent, and which extends over its entire surface; and it is highly affected by that combination of causes, which produce those powerful and extensive currents, which move with irresistible force from one extremity of the earth to the other. We intend to revert particularly to these latter phenomena. The currents of the ocean are considered to arise from several causes—such as the expansion and contraction of water by heat and cold; the evaporating power of the sun; and the revolution of the earth on its axis. The great oceanic current, termed the Gulf Stream, which is the principal branch of the equatorial current of the Atlantic, originates in the immense expanse of the Antarctic Ocean; and, after a course of some thousand miles, it enters the Gulf of Mexico; sweeps round its extensive basin; pours forth at the rate of 5 miles an hour, through the Strait of Florida, into the Atlantic Ocean. Flowing in a north-eastern direction, it sweeps along the whole coast of North America, and skirts the bank of Newfoundland; then bending to the east, it crosses the Atlantic in the direction of Europe, and although its power is greatly weakened, and the volume of its waters much reduced, by being divided in its course, and its temperature considerably modified, by mingling with the cold waters of opposing currents from the north. Yet, there can be no doubt, that the climate of Western Europe is greatly ameliorated—not only by the elevated temperature of its waters, which wash the western shores, but by the highly-heated air which is carried along with it. Perhaps we have never sufficiently estimated the great importance of the Gulf Stream, in softening and moderating the asperities of our climate, but there can be no doubt, that the British Isles, and all the countries bordering on the shores of Western Europe, are greatly indebted to its genial influence—not only, in moderating the extreme cold of winter, but in suffusing the atmosphere, in the other seasons, with a healthful and kindly warmth. The position of our country does not bespeak much in favour of the geniality of our climate. We live in the same parallel of latitude with the northern parts of the bleak and inhospitable region of Labrador; and we are not far removed to the southward, from that of Cape Farewell, in Greenland; nor from Tobolsk, in Siberia. Now, what makes this country a kind of Italy in comparison? It cannot be altogether on account of our proximity to the sea; for the coldest weather we experience, is when the wind blows across the sea from any point, except one, and that is the south-west, which blows exactly in the direction of the Gulf Stream.

It might be expected, that our warmest wind would be that which blows across Spain and France—a south wind. This must be a balmy and genial wind in many parts of the world, for it is represented by sentimental writers as lingering among the groves and glades of the south, in gentle zephyrs, mild breezes, and soft whispers; but it has failed to obtain so poetical a character in Moray. It is not, to be sure, a very cold wind, but it has always a chill lurking in it, and is never a faithful wind, having an inclination to claim kindred with its ungenial neighbour, an east wind. On the other hand, a south-west wind is invigorating and warm, and even when the elevated lands to the westward are deeply covered with snow, the chilly air which blows from them, is moderated very sensibly by the kindly south-west wind. We seldom see a person turn his back upon a south-west wind; for one likes to meet it, to feel it, and to brave it. Under its influence man goes trippingly to perform his daily labours; for he feels his spirits buoyant, and his whole frame invigorated. Animals of all kinds also exhibit a lively appearance under its influence, and vegetation puts on a fresher green. Contrast this with an east wind. Who has not felt an east wind? What is it like? Why, it is like the breath of an iceberg, and when it blows hard it pierces you, and feels like icicles, creeping down between your skin and your clothes.

climate. The Gulf Stream is nowise naturally inclined to cross the Atlantic in an eastern direction; for it seems thwarted in being forced to make the curvature in the Gulf of Mexico, but the impetus which it has acquired is sufficient to send it a far way in the wrong direction. In its progress across the Atlantic, it becomes divided, one branch turning southward, along the western coast of Africa, so that it is only a comparatively small portion of its waters that impinges on the shores of Western Europe. Were the entire volume of its waters, as it comes heated and vigorous from the Gulf of Mexico, thrown upon our shores, there could not be the smallest doubt of the result. Our mountains and our valleys would again be covered with a vegetation, similar to that which prevailed during the carboniferous era. Groves of palms and arborescent ferns would everywhere meet the eye, and the coverts would resemble the thick and tangled undergrowth of a West Indian island.

It is probable that the course of this immense marine current, at the period of our extreme cold, was westward, between North and South America, where it rushed in one vast stream into the great basin of the Pacific. This would seem to be its most natural course, for the great highway of the principal current of the ocean, is evidently along the space between the tropics, and this would be its course continuously, being fed by currents from the north and south, were it not for the interruptions which it meets with from continents and islands, and the deflections which it is obliged to make in consequence. But the gradual elevation of the American continent would raise a barrier in the face of the great equatorial current, and prevent its waters from flowing into the Pacific. It is from the period of these interruptions, that we have to trace the changes in the climatal condition of the north. The change appears to have been gradual, for the interruptions were gradual. In this country, we have evidence of the gradual decrease in the amount of glacial action, in the gradual decrease of the till deposits, and we have evidence also, that as the land became elevated the temperature over the northern regions increased, and at the time when the waters of the Gulf Stream were completely checked, by the barrier opposed to their progress westward, and a portion of those waters thrown back upon our shores, we find a complete cessation to all glacial action, for we arrive at a point in the level of the land, where the till breaks off, and is no more seen.

As reference has often been made to an extensive oceanic current, which formerly flowed from the north-west, and carried along with it the various materials which we have had under consideration, one may well remark, "We have no signs of such a mighty current at the present day; pray what has become of it?" We may answer, that the same causes, and the same influences, which led to the amelioration of the former condition of our climate, were the same agents which effected the cessation of that powerful current. At the period of the drift, the present temperate regions of the north were not in the least degree affected by warm currents from the south. The Gulf Stream then careered westward, on the same path which marks the direction of the trade-winds. The rush of water from the north would then be prodigious, and, having neither extensive lands nor opposing currents to arrest its progress, it would move far to the southward, carrying with it a volume of cold air, which had been generated in the Polar regions, and at last mingle its waters with the great equatorial current of the south.

We have now given a very brief account of the Northern Drift, and have attempted to describe the condition of the north during the period of its deposition. We have represented this country, at an early date, to have been wholly covered with the waters of the ocean, and at a later time, to have been affected by powerful subterranean movements, which resulted in a general upheaval of the land, to a certain extent. We have described the country then, as exhibiting but a very limited extent of surface, or rather as consisting of numerous islands, which are now represented by the more elevated parts of our hills and mountains. We have also referred to a series of successive elevatory movements of the land, during lengthened periods of time, and have pointed to the numerous terrace-banks which mark the extent of those movements, and as clear and undoubted indications of ancient sea-margins. Throughout these remarks, we have strongly supported the idea of this being a glacial country at the time of the drift, and have reverted to the very low temperature which then prevailed, and as being somewhat analogous to that which is now experienced within the Frigid Zone. We have represented the surface of the country, in that remote age, as being covered with ice, and the seas with extensive ice-fields. We have alluded to the power of glaciers in moving masses and fragments of rock with detritus, from a high to a low level, and to floating ice, as a medium of transport for such materials. In course of the remarks, reference has been made to a decrease, in the amount of materials, in each successive terrace-bank, when we arrive at a point where they cease to be formed of drift, and are succeeded by shingle beaches; and this circumstance has led to the conclusion, that in proportion to the elevation of the land, the temperature of the climate increased, till at last ice ceased to be formed, and of course was no longer a medium of transport. Reference has also been made to the powerful and rapid movements of oceanic currents, one of which, that from the north, threw immense masses of ice on the shores of all the lands to the southward, and deposited the materials which now form the Northern Drift. Allusion has been made to the gradual weakening of this current, by the movement of the warm waters of the Gulf Stream, far to the northward, which highly affected the climatal condition of all the countries lying within its influence. The new direction given to this current, has been ascribed to the gradual elevation of the lands in Central America, by which a barrier was raised, which shut it out of the Pacific, and obliged it to take an easterly course, and throw its waters on the shores of western Europe.

sozoic forms. Again, we find that beds in the Jura containing vegetable remains of *carboniferous species* alternate with strata containing belemnites, and that "the weight of evidence appears to be in favour of referring the whole formation to the *oolitic* rather than to the *carboniferous* period."* The very term carboniferous no longer applies legitimately to the *palæozoic* coal-bearing rocks alone. The Virginian coal-field in America is of the age of the oolite; the age of the *Bengal* coal-field belongs to the mesozoic period, the brown coal of Germany and Switzerland is miocene, while a seam of coal *nine feet thick*, which is worked at Wildsfluth in Austria, belongs to the *upper* division of the tertiary formation, and the vegatation of which was probably extant with some of the existing races of animals.

The February number of the Quarterly Journal of the Geological Society contains two papers on crustaceans lately discovered in the beds of passage between the upper Silurian and the Old red sandstone. The first is by Sir R. Murchison on the Upper Silurians of Lesmahagow, and the second by Mr Salter, describing fossils from that locality and from Kington. The Kington fossils I had the pleasure of examining, some two years since, in the cabinet of Mr Banks, and of acquainting Sir R. Murchison of their existence. I mentioned in the Geologic Section at Glasgow, that the remains of the Cephalaspis occurred in the Kington tilestones,—a statement which Sir R. Murchison called in question as affecting the character of his Upper Silurians. It now appears that Cephalaspidean remains *are* found in the tilestones, together with Pterygotus and other crustaceans, called "Pteraspis," "Eurypterus," and "Himanopterus," although it is doubtful whether the so-called cephalaspides belong to fishes or crustaceans.† The point, however, to which I wish to call attention is the fact of the Pterygotus of the Caradoc sandstone and Ludlow beds, ascending from beds containing *Nucula Estnori*, *Lingula minima*, and *L. parallela*, through strata charged with *Cardiola*

* President's Anniversary Address, Quarterly Journal of Geological Society, May 1, 1856.

† Banks' Tilestones of Kington, Quarterly Journal of Geological Society, May 1, p. 100.

interrupta, *Graptolithus Ludensis*, &c., into tilestones with Cephalaspides, which, if not *identical* with *Cephalaspides Lloydii* and *Cephalaspides Lewisii*, are at any rate "*closely allied*" to those fossils.

Under such circumstances, may we not learn a lesson respecting the great and general changes of life, and that they have not been so *universal*, so *absolute*, or so *complete* as was formerly imagined. Passing onward from the transition-beds of the Silurians and Old red, I would say a few words respecting the transition-beds between the Old red and the Carboniferous group above. In the first place, we should ever bear in mind that the thickness of the Old red sandstone is estimated by Sir R. I. Murchison at not less than 10,000 feet, and must therefore, even in the calculation of the most rapid of geological theorists, have taken *some time* in accumulating.

Mr Godwin Austen supposes the Old red sandstone formation to have been a *lacustrine* formation, and it is not impossible that such may turn out to be the case as regards some of the strata; but the Devonshire beds must have been *marine*, as also the contemporary deposits in Russia and America, for corals are not generally found inhabiting fresh-water lakes. We learn from Messrs Jukes and Salter* that the Old red sandstone of Ireland is overlaid by the "yellow sandstone" group, and that the two form one continuous series, characterized by the remains of a *large terrestrial* vegetation (*Knorria stigmaria*, &c.) It is in this series that the large fresh-water anodons (*Anodon Jukesii*) are found.

There are no traces of land plants, so far as geologic evidence goes, until we reach the uppermost bed of the upper Silurians (the bone-bed of the upper Ludlow rock), and there, for the first time, we meet with seed-vessels of a club-moss (Lycopodium); but in the upper strata of the Old red of Scotland and Ireland (the yellow and gray sandstones) many land plants have been discovered, and apparently are generically allied to those of the coal. It is this upper band in Scotland which is remarkable for the first well characterized fern (*Cyclopteris hibernicus*), also so marked a feature of the

* British Association, 1855.

yellow sandstone of Ireland. Calamites also appear in this stratum for the first time, with fruit-like bodies, believed to be the seed-vessels of some ancient and undefined tree. At all events, these beds of passage into the great accumulation of carboniferous strata which succeed must ever be interesting to the geologist; for whether these yellow beds in Dean Forest are fresh-water or marine, they are seen to be *perfectly conformable* with the limestone shale above, and which contains an abundance of *marine* organic remains.

Again, it is necessary to remember that these yellow beds in Scotland also contain many remains of that singular Old red sandstone fish (Holoptychius), of which no less than six species are now enumerated. It is of one of these that Mr Hugh Miller declares that " the armour in which it is cased might have served a crocodile or alligator of five times the size," and that the jaws " are composed of as solid bone as we usually find in the jaws of mammalia." The air-breathing reptile *Telerpeton Elginense* was also detected in these beds. These facts should be remarked by the young geologist, as, of the numerous ganoid fishes of the Old red sandstone, the Holoptychius alone is found in the carboniferous rocks, while it is a question whether some actual coal plants do not occur in the same upper Devonian beds.

In two excellent sections in the Forest of Dean the junction beds of the Devonian and Carboniferous rocks are to be seen graduating into one another. One is near Drybrook, on the Ross and Cinderford road, and the other between the tunnel at Sudely and a place called Ruspitch, near Cinderford.

At both places the yellow sandstone of the upper Devonians may be seen in contact with the carboniferous limestone shale. Wherever these sections are beheld for the first time, let the young geologist look upon them as strange records in geologic history.

There are certain physical and geographical features in geology which it is impossible to condense, and the student must make up his mind, if he would understand them, to become thoroughly acquainted with the phenomena, and to study the life-long researches of the masters of the science. Local and elementary works can do little but make broad state-

friend, I said that there did not appear to be any evidence that the storms of the British Islands were rotatory in their character. My friend, treating this assertion as a sort of challenge, promised to select one in illustration of the rotatory hypothesis. Accordingly, an account was sent of the February storm, in which the veerings of the wind, and the fall of the barometer, were supposed to furnish evidence of the views that have been so ably advocated by Redfield and Reid.

It is no doubt true, that the directions of the wind at the same moment in different parts of the British Islands sometimes roughly resemble what they would actually be were a gigantic whirlwind to pass over their surface. In the February storm something of this kind occurred. My friend supposed that the storm of the 6th and 7th February was a vast whirlwind, the centre of which passed a little to the west of Glasgow, from *south-west to north-east.* Mr Martin of Dorchester expressed the same opinion in a communication to the *Agricultural Gazette.* In the sketch in Plate IV., segments of circles have been drawn with a diameter of 800 miles. The centres of these circles represent the supposed centre of the storm as it was supposed to progress along its path from south-west to north-east, and revolving from right to left, as the arrows indicate.

From this sketch it will be observed that the wind on the rotatory hypothesis should have set in from the south-east when the storm commenced in the south of Scotland. This was the case, and it is also worthy of observation that the wind at the same time was south-west in the Isle of Wight, and east in the Orkney Islands. These facts are, so far, all in conformity with the rotatory theory. But as further facts were collected, they became unfavourable to, and indeed quite irreconcilable with, the idea of rotation.

On the supposition that the minimum pressure indicates the passage of the centre of storms, the centre passed Dunse at two o'clock on the morning of the 7th. The minimum pressure occurred at Christiania about noon of the 7th (very probably a little before it). Dunse and Christiania are nearly 600 miles distant from each other; and on the supposition that the storm was rotatory, and travelling from south-west to north-east, its rate of progress must have been at least 60 miles an hour. But the direction of the wind at Christiania was entirely against the idea of rotation, for instead of being south or south-east, it was due north as the storm approached.

In the next figure, I have put down the indications of the barometer during the 6th and 7th February in curves, which show more readily the periods when the minimum pressure occurred at Sandwick (Orkney), Dunse, Isle of Wight, North Foreland (Kent), Christiania, Heligoland (off the coast of Denmark), and Brussels. The darker cross lines represent a pressure of 30 inches of mercury, and each of the lighter divides the spaces between the darker into two-tenths of an inch, so that those curves which cross the dārker show the barometer to have stood below 29 inches. (See Plate V.)

A glance at these curves brings out several important facts. The fall of the barometer is much greater in the higher than the lower latitudes. At Sandwick, at midnight of the 6th, the mercury indicated a pressure of only 28·49 inches; at Dunse, at 2 A.M. of the 7th, 28·63 inches; while in the Isle of Wight, at 3 A.M., 29·37 inches. The Isle of Wight and Orkney are about 600 miles apart; and on the supposition that the storm was rotatory, and progressing from south-west to north-east, the barometer should have fallen to its minimum twelve hours sooner at the southern station than at the northern; but the barometer falls as soon, or sooner, to its minimum at Sandwick than at Dunse, or in the Isle of Wight. The minimum pressure was nearly simultaneous at these three places.

On the other hand, Christiania is 400 miles distant from Heligoland; but the minimum pressure of the barometer at both occurs at the same time, or nearly so. The wind also at these two places was blowing almost right towards each other for several days.

The curves of the barometer clearly show that the line of minimum pressure was travelling from a little to the *north of west* to the *south of east* at the rate of about 40 miles an hour, instead of from *south-west* to *north-east* at 60 miles an hour. The great majority of the winter storms of Europe are characterized by the minimum line of barometric pressure that attends them having a progression from *west* to *east;* and, as Professor Espy was the first to point out, a little from the *north* of west to *south* of east, as was the case in the February storm.

The depression of the barometer in the winter storms is of great length from north to south, and it usually sweeps the whole continent of Europe. The mercury begins to fall sooner in the north of Norway than in the south of France. I have little doubt that the minimum pressure occurred at least ten hours sooner in Iceland than it did in Orkney.

It is very evident that the phenomena of the 6th and 7th February cannot be explained on the supposition that a rotatory storm approached the coast of Denmark from the west. The objections to such a view are quite endless; and the directions of the wind at Christiania are altogether anomalous on this hypothesis.

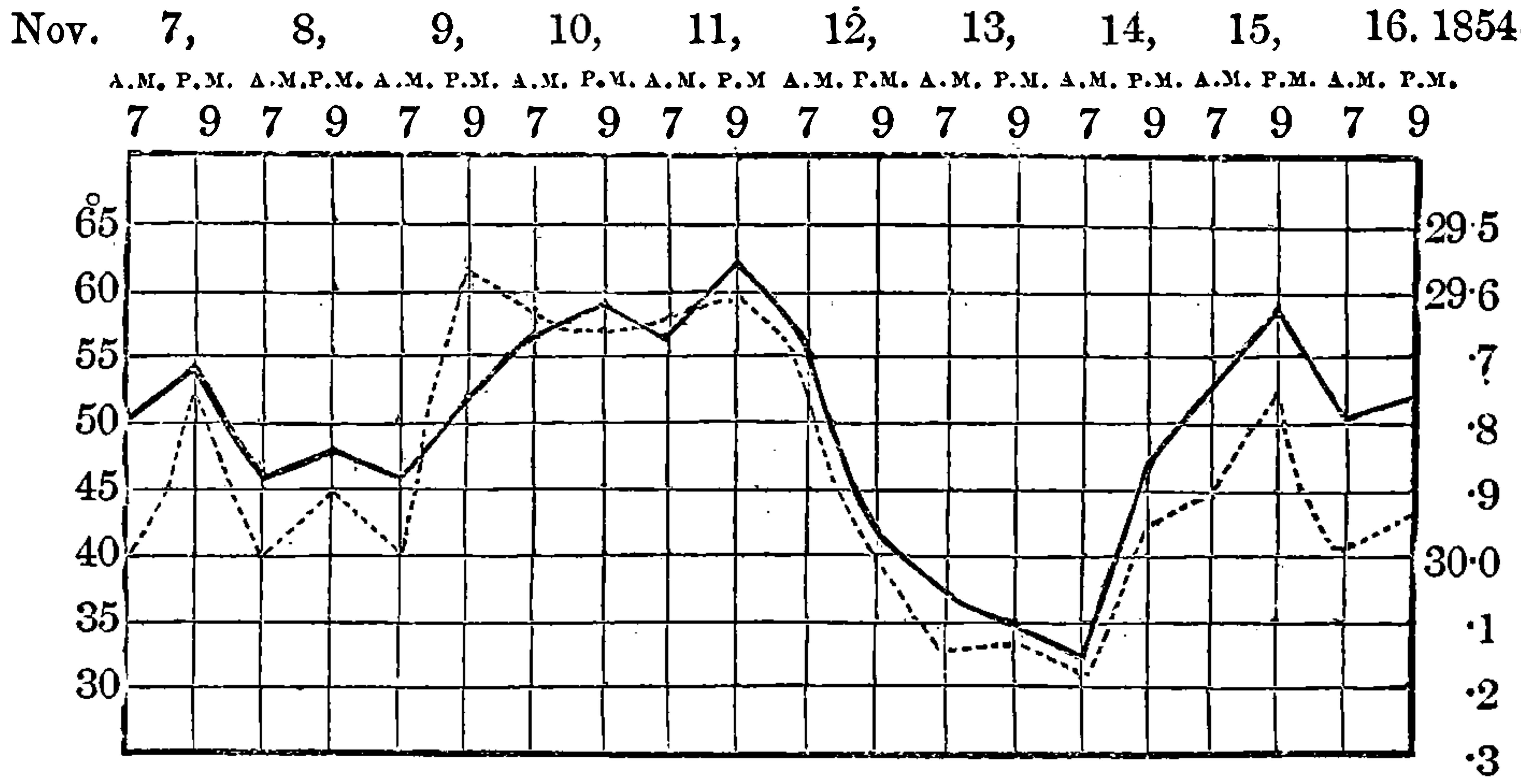
Professor Hansteen, Christiania, writes me that "the sudden fall of the barometer between the 6th and 7th is remarkable." The winds in this instance were certainly not rotating round a centre. My object in this short paper is not to urge and enter minutely into my own views of the action of this storm ; but to show that the phenomena are totally inconsistent with the idea of rotation; for most people think that the rotatory theory is proved beyond all doubt. For my part, I have never met with evidence one whit more convincing as to the existence of rotatory storms than this irreconcilable case. A hearing for other views will only be got, I am now persuaded, after the advocates of the rotatory theory begin to recognise their difficulties. One is therefore very glad when some who have subscribed to these views are forced to confess that "the behaviour of the winds at Christiania during the February storm were anomalous, and irreconcilable with the rotatory theory in its simple form."

I regard the indications of the barometer, the thermometer, and the wind-vane, at Christiania during the 6th and 7th February, as beautiful instances of the operation of very simple laws. The temperature at 7 A.M. of the 6th was 12° below the freezing point, with the barometer at 29·75 inches, and

Therefore, 32° : 6 : : 5° : ·094 tenth, or nearly one-tenth inch for 5° of temperature.

The temperature and the pressure of the air at Tuscaloosa, Alabama, at 7 A.M. and 9 P.M., from the 7th to 16th November 1854, are laid down in curves, which are inverted to exhibit the parallelism betwixt the rise of temperature and the fall of the barometer, and *vice versa*.

The continuous line represents the changes of the barometer, and the dotted line those of the thermometer. The figures on



the right hand margin of the wood-cut indicate height of the barometer in intervals of one-tenth of an inch, and those on the left hand side of the thermometer in intervals of 5° of Fahrenheit's scale.

A single glance at these changes of temperature and of pressure is sufficient to show the relation which subsists between them. I have also compared the fluctuations of the barometer at 7 A.M. and 9 P.M. with the changes in the temperature at these hours, from the 7th to 16th November 1854, in the States of Maine, Vermont, New York, Michigan, Wisconsin, North Carolina, Kentucky, Missouri, Florida, Alabama, Texas, Virginia, and Canada. The same scale was adopted of making 5° of heat correspond with one-tenth inch of mercury. In none of them were the inverted curves so nearly parallel as those in Alabama were, but all furnished remarkable instances of the general truth of the law.

Exceptions are met with, but these are quite as interesting; for in many instances, the heating takes place in the upper strata, and the barometer may thus be made the means of indicating the changes that take place in the higher beds of the atmosphere, which are entirely beyond the reach of our observations. And further, a careful study of such graphic curves might be made available for determining the height of the different currents in the atmosphere, and how far certain changes extend from the surface of the ground.

But whence came the warmer air during the 7th February at Christiania, with the wind from the north? This question will be best answered by asking and answering another. Where did the air flow to on the night of the 6th and morning of the 7th, that was rushing over the southern half of Scotland, from the south-west, and committing such devastations in our forests? It made its escape as an upper current that flowed far above the Kolen mountains in Norway. The upper beds of the atmosphere, for this reason, had a much higher temperature communicated to them than their mean temperature for that month. The passage of this body of warm and light air, as an upper current, over Christiania, lowered the barometer, and also warmed and moistened the north wind that prevailed.

And whence did the northerly winds go to, that were blowing so steadily into the German Ocean from Christiania? By looking at the diagram containing the curves and directions of the wind during the 6th and 7th February, it is seen that the north winds did not reach Heligoland, on the coast of Denmark, as the winds there were blowing almost right towards them; nor did they reach the British coast. This cold wind from the frozen regions of Sweden and Norway was a mere surface current during the 6th and 7th February. It was forced into the warmer body of air resting upon the German Ocean by the action of similar agencies that force the colder air resting upon the sea toward the land, when the air over the land is heated by the sun to a greater degree than the air over the sea. The action of the sea-breeze, and that of our north-east rainy storms, are parallel phenomena in many particulars.

To explain all the phenomena of the sea-breeze is not quite so simple a matter as is generally supposed; at least, the particular conditions under which it occurs on our own coast have never been fully discussed. I hold that the action of the sea-breeze furnishes an explanation of the action of the greater number of the storms of high latitudes. All the directions and veerings of the wind can be accounted for on a modification of the same principles. The propelling power in the sea-breeze is maintained by the direct action of the sun's rays, while the propelling power of storms is due to the unequally heated strata, and to the extrication of latent caloric, as water passes from its gaseous to its fluid or solid form.

Parallel phenomena to the fall of the barometer, and the rise of temperature with the north wind, which is usually cold, is often seen in Scotland. The weather during the early part of this summer may be taken as an illustration. The latter end of April and beginning of May, were unusually cold for the season. North-east winds prevailed, which were attended by a high barometer. So long as the cold and dryness continued, this easterly current not only prevailed at the surface of the earth, but also in the higher beds of the atmosphere. The morning of the 9th May was frosty, as well as many others which had preceded it. After this date, fine cirri began to drift towards the north-east, and by the 11th, warm-looking cirro-cumulus, which float at a still lower elevation, showed that the upper current from the south-west was gradually propagating itself in the lower strata. The wind still remained from the north-east, but it was now no longer either so cold or so dry. The opposite currents continued, and copious rains followed on the 14th, with the wind still in the east, and the barometer low. At last the south-west wind predominated, and flowed both below and above. It is well known that a south-west wind brings heat at the level of the sea when it succeeds a north wind. The same thing occurs in the upper beds of the atmosphere, when a south-west current relatively warm displaces a colder and heavier body of air. A fall of the barometer thus takes place in easterly winds, when the warmer and lighter currents from the south-west prevail above.

But to return to the great storm, in looking at the curves and directions of the wind in the diagram, it is seen that the minimum pressure takes place at Christiania between 9 A.M. and 2 P.M. on the 7th February. The rise is very small even at 4 P.M., only two-tenths of an inch of mercury; but, at this time, it is worthy of remark, that the wind then changed to the south-west. It could scarcely do otherwise, because the minimum pressure being then to the eastward of Christiania, the air would be forced towards the low barometer in the same

which the winds tend either obliquely or directly, is one which is likely to occupy considerable discussion before there is a general agreement on the subject. The sea-breeze blows toward the land, and the diminished pressure over the land is constantly maintained by the sun's rays rarefying and rendering the air over the land lighter, and therefore, like the heated air in a chimney, liable to be forced upward by the colder air. But, unless the sea-breeze, as it rose over the land, was swept away by an upper current, the mere heating of the air would not make it lighter. The sea-breeze on the east coast of Scotland only occurs when a westerly upper current prevails; and as the strength of the sea-breeze *gradually* decreases as it travels into the interior, the air which forms the breeze must only be *gradually* absorbed into the upper current. There is, therefore, no focal area over which the sea-breeze rises in a body, but the area over which it is absorbed extends nearly over the whole area swept by the breeze. The principle of a gradual rising into the upper current, I believe, is the one which takes place in storms; but I agree with Professor Espy, that the diminished pressure is maintained by the extrication of latent heat, as the vapour of water is precipitated in consequence of the air expanding as it ascends, and, in doing so, cools below the dew-point of the vapour which it contains.

The Rev. Mr Clouston, Sandwick Manse, Orkney, writes me that "there was a great fall of the barometer on the 6th without any of the storm," and "at midnight the barometer stood at 28·49 inches;" nor did the storm extend beyond the Grampians, although the barometer stood lower there than in the south of Scotland. Towards this immense area of diminished pressure the winds were all directed, and, as I believe, they were rising over the whole space that they prevailed. As they rose into the higher strata of the atmosphere, they were swept away by the westerly upper current which frequently prevails in this latitude in winter. The concluding winds of this and of other storms is the descent of this upper current, which imparts the westerly precession to the rise of the barometer in the winter storms of Europe.

To enter into a minute analysis of the mode in which I conceive the low barometer is propagated from west to east in the storms that are similar in their action to the February one, would require a very lengthened discussion. The few remarks which I have made here, may serve to impress upon meteorologists the enormous area over which the winter storms of Europe extends, and the necessity which exists of combining observers not only in this country, but over the Continent. Many errors have arisen in consequence of drawing conclusions from observations collected within too limited an extent of country, whereas the law of storms can only be fully elucidated by simultaneous and wide-spread observations.

I take this opportunity of thanking Professor Hansteen, Christiania; M. Quetelet, Royal Observatory, Brussels; Rev. C. Clouston, Sandwick, Orkney; Mr Stevenson, Dunse; Rev. S. King, Jersey; and Mr Martin, Dorchester, for the ready manner in which they furnished the observations for making these few remarks on the February storm.

On the Preparation of Sugar and Arrack from Palms in Ceylon. By ALEXANDER SMITH, M.D., Staff-Surgeon, 2d Class. Communicated by the Director-General of the Army Medical Department.

The flowers of all the palm tribe yield a sweetish juice, which might be turned to account, either by extracting its sugar or by fermenting it, and distilling the resulting spirit; but I am not aware that, at least in Ceylon, it is collected from more than three of the order. These are the Cocoa-nut palm (*Cocos nucifera*), the Palmyra palm (*Borassus flabelliformis*), and a third known in the island by the various names of Kittûl, sugar, or Jaggery palm (*Caryo taurens*). Of the palms of Ceylon, the coco-nut is by far the most abundant. It is found in all parts of the island, with the exception of the very high land in the interior; but it is met with in greatest abundance along more than a hundred miles of coast, extending from considerably to the northward of Colombo to a little beyond Matura, in the south of the island. Along the range of coast above indicated, it forms almost uninterrupted groves, bounded towards the sea by the high-water mark, and varying in breadth on an average from a few yards to a quarter of a mile. Within these limits, the cocoa-nut palm occupies the ground almost to the exclusion of other trees; but as the distance from the sea-shore increases, it becomes mixed with various timber trees, and its importance among them as regards relative numbers, although it is still found in abundance, rapidly diminishes. The Palmyra palm is chiefly confined to the northern and north-eastern parts of the island, and is met with in large numbers near Jaffna; whilst the central provinces, at a moderate elevation, form the peculiar locality of the Kittûl palm.

From each of these three palms the juice of the flowering stalk is collected under the name of *toddy;* and from it, sugar, known in the East as *jaggery*, is regularly prepared; but it is from the Palmyra that almost the whole palm sugar of commerce is obtained. It is usually exported in the *soft* form, in baskets made from the leaves of the tree which yields it. The jaggery made from the cocoa-nut and Kittûl palms is almost entirely consumed by the natives of the island, who use it with their coffee. It is sold in the form of small cakes of a circular form, and slightly cup-shaped. They weigh about half-a-pound, are very tough, and when broken across present an imperfectly crystalline fracture. All the varieties are capable of purification, but are seldom so prepared, excepting in the form of a tolerably pure sugar-candy. Whilst the juice of each of the above named palms yields jaggery, and might therefore be employed in the manufacture of *arrack*, it is, practically speaking, from that of the cocoa-nut palm alone that the whole arrack made in Ceylon is prepared; and as the same mode of collecting the juice, and extracting jaggery from it, is, with the exception of a few unimportant local modifications, followed in every case, a description of the process used in that of the cocoa-nut will suffice for all; whilst what follows will explain the manufacture of arrack.

Cocoa-nut palms, when planted in favourable soil, and with a due proportion of space for each tree, generally come into flower and bear fruit between the fourth and fifth years; but when closely planted, they shoot up with greater rapidity, and do not become productive before the sixth or seventh. If toddy is not collected from it, it is generally calculated that a good tree will bear fruit for more thon sixty years; but

taste, and is believed by the natives to retard fermentation. So soon as the receiving vessels are taken from the trees, the contained toddy is roughly filtered, to separate the pieces of bark and accidental impurities, and at once boiled in a common earthen pot. Impurities are from time to time removed in the form of scum, and when concentration has been carried to the necessary extent, it is poured in small quantities into cocao-nut shells. From these, when cooled, it is removed in the form of small cakes, as has already been noticed, and these are stored in a dry place to which the smoke of a wood fire has free access.

The jaggery of the Central provinces is entirely made from the Kittûl juice, which yields a much larger quantity of sugar than that of either of the other two palms, and of a quality much more highly prized by the natives. The Kittûl does not come into flower until between its tenth and fifteenth years, and only one spadix is at a time prepared on each; but that, being of very large size, continues to furnish toddy for a period of between six and eight months. Unlike the sugar of the other palms, the Palmyra jaggery is not preserved in the form of cakes, but is broken down into the form of soft sugar convenient for packing in baskets, in which it is exported.

When toddy is collected for the purpose of making arrack, no care is taken to prevent fermentation, and as it is brought from the trees, it is poured into wooden vats, in which that process rapidly advances, the mean annual temperature (not under 80° F.) of the districts in which arrack is made highly favouring its progress. In the vats it is allowed to remain until enough toddy has been collected to fill the arrack still, or until it may suit the convenience of the manufacturer to distil it,—so great is the indifference manifested in actually conducting that stage of the process, which of all others ought to be watched with the greatest care. Want of attention to the fermentation of the toddy is the cause of the presence of a large quantity of acetic acid, not only in the toddy when undergoing distillation, but also in the arrack—a condition which cannot but play a very important part in causing arrack to remove a trace of lead from any portion of that metal with which it may, in the course of preparation, be brought into contact. Toddy, when put aside in an open vessel, is usually converted into vinegar in about eight days. If, however, portions of fresh toddy are added from time to time, that change will not so soon occur, although even then there will be a very large proportion of acidity. The latter is that generally followed in conducting fermentation, fresh toddy being added to each vat, morning and evening, through a period of from two to eight days.

From my own inquiries made at arrack distilleries, I have arrived at the conclusion that the average time allowed to elapse between the collection of the first portion of toddy and its distillation, is three or four days. The actual process of distillation divides itself into two parts; 1st, the distillation of spirit from the fermented toddy; and, 2d, the subsequent concentration of that so obtained. Spirit to equal one-fourth of the bulk of fermented toddy in the still is distilled over, and it is stored as collected, in earthenware jars under the name of *first distilled arrack*, until enough to fill the arrack-still has been collected. Until that quantity has been prepared, fresh portions of fermented toddy are, from time to time, operated upon,—the refuse of the previous distillation being merely run off by the bottom tube, and no other measures taken to clean the still. When, however, it is desired to redistil the arrack first obtained, the still is thoroughly washed before that part of the process is commenced. One-half the bulk of the *first distilled arrack* is collected as it flows from the still-worm, and is then known as *double distilled arrack*, and the *arrack* of commerce. It is this which is used by the troops, as well as by the natives of the island, under the latter name. There is no uniformity in the strength of arrack made at different distilleries, but as a general rule, that usually met with is considerably *under proof*. Owing to the above irregularity, arrack dealers find it necessary to provide themselves with *treble distilled arrack*, known as *spirits of arrack*, by the addition of which to the weaker kinds, they are enabled to cause some approach to uniformity; but it does not appear that much care is observed in the matter.

Beyond enforcing the annual payment of L.3, as a licence for each arrack-still, the Ceylon government exercises no control over either the processes followed or the apparatus employed. It lets annually for a large sum to the *arrack renter* the exclusive privilege of purchasing all arrack made in his district, and of licensing the arrack taverns throughout the same. It is therefore from the arrack renter alone that all purchases are in the first instance made.

My own observations lead me to conclude that in Ceylon one method alone is almost without modification followed in the manufacture of arrack, of which fermented toddy from the cocoa-nut palm is, practically speaking, the only source. In the apparatus of Ceylon distilleries a like uniformity exists, so far as regards the number and form of the articles employed; and it was only in the methods followed of lining the still that I met with any departure from the rule. That invariably seen consisted of:—1st, One or more large wooden tubs or vats for the fermentation of toddy; 2d, The arrack-still; 3d, A large vat, within which the worm of the still is coiled, and which is filled with water to keep the latter cool; 4th, A small wooden tub, or an earthenware pot, to collect the spirit as it distils over; 5th, Several large earthenware jars, the majority of which are glazed internally—some, however, free from that coating—in which *first distilled arrack* is kept during the interval which elapses before it is re-distilled; (in one instance I found a jar used to store regular arrack;) 6th, One or more large casks, capable of holding 120 gallons, and called *leaguers*, constructed either of Ceylon woods called Halmalille, and Moroota, or of Moulmain teak, in which the regular arrack is stored, whilst it remains on the premises.

The arrack-stills of this island range in size from 20 to 160 gallons, the average being about 50 gallons, and are invariably, in all their parts, made of sheet copper about $\frac{1}{24}$th part of an inch in thickness. The pieces of the body and of the head of the still are always joined with copper rivets, those of the *worm* or refrigerator by soldering with an alloy of lead and tin. I have been informed that, in the construction of the worm, brazing is sometimes substituted for soldering; but, although I have sought for those made in this manner, I have been unsuccessful in finding them; if any such exist they are rare. In the majority of instances, the whole interior of the

a slight trace of lead, my inquiries have caused me to conclude that there are three; from one or all of which a little of that metal may be yielded. Before enumerating these, however, it may be well to state that the arrack of this country always contains a considerable amount of acid, which, I think, must be derived, in a great measure, from the fermentation of the toddy being allowed, through the carelessness of distillers, to overstep the vinous stage of the process, and thus generate acetic acid, which afterwards distils over with the spirit.

Of the quantity of acid present in the fermented toddy, some idea may be formed from the fact that, at three distilleries, chosen at random, two fluid ounces apothecaries' measure of toddy, which, in neither of the instances, had been kept beyond what is considered an average period, required, when carefully tested on the spot, as taken from the fermenting vat, in one case eleven, in a second thirteen, and in a third fifteen grains of bicarbonate of soda to render it neutral, it having before been decidedly acid.

The sources which probably supply lead are—1*st*, The tinning of the still. 2*d*, The soldered joinings of the worm. 3*d*, The glazing of such of the earthenware jars as are so prepared. That the acid toddy must act on the tinning of the still, cannot, I think, be doubted; and as the fluid frequently boils and froths over during working, a portion of the contents of the still becomes mixed with the arrack in the receiving vessel, and in that way, if not in any other, lead may find its way into the spirit. That the soldering of the worm is a fruitful source of lead in arrack can still less be doubted, when it is remembered that, in a worm of 15 or 20 feet in length (the usual length), a considerable surface of solder actually exists in the joinings of the pieces composing it. In this case, however, I presume that the manner in which lead is chiefly removed from the solder is by the arrack washing off, in its passage along the worm, the carbonate, which may have been formed by the action of the atmosphere on the lead in the solder during the intervals of working.

From the well-known action of acids on the glazing of earthenware, I think it is highly probable that arrack containing so large a proportion of acetic acid, as my experience of that made in Ceylon leads me to believe always exists in it, cannot long remain in jars, such as I have above described, without removing some portion of their glazing. But, in this instance, as in the case of the tinning of the stills, since it is usually only *first distilled arrack* which is kept in the jars, it is possible that any lead withdrawn by it from their glazing, may be again separated when redistillation takes place. At one distillery, and one only, I found glazed jars used to store the regular arrack. In such a case, any impregnation yielded by them would be likely to continue.

In consequence of the several modes in which lead may obtain admission into sugar and arrack, according to the mode of manufacture described above, it is evident that slow poisoning with lead may be apt to attack those who make use of these articles. Accordingly, a virulent epidemic of colic, which attacked a detachment of troops stationed at Newera Allia, was traced by me to the cause in question. An account of this epidemic, and of the investigations connected with it, has been published, partly in the *Edinburgh Monthly Journal of Medical Science*, 1853, vol. xvi., and finally in the *Edinburgh Medical Journal* for July 1856.

On the Animalcules and other Organized Bodies which give a Red Colour to the Sea. By M. Camille Dareste. (Translated from Annales des Sciences Naturelles.)

Mariners frequently observe in the ocean spaces of greater or less extent, the water of which presents colours passing through all the shades of yellow, blood-red, and brown. These coloured waters form bands, often of great extent, the edges of which are very clearly distinguished from the water which continues transparent. They have often been mistaken by seamen for shallows, though almost always observed in localities where the depth is considerable.

It has been long known that this colour does not belong to the water itself, but is produced by substances suspended in it, although their nature has generally been misunderstood. The prevalent opinion among seamen is, that it is chiefly caused by the spawn of fish, but naturalists, who have studied these phenomena, have thought that they were produced by organized beings; although, from not having had good microscopes at hand, they have frequently been unable to determine their exact nature.

Having had occasion to study one of these coloured spaces at the beginning of last year,* I felt desirous of becoming acquainted with facts of the same kind which have been mentioned by navigators and naturalists, and I have collected about fifty. The comparative examination of all these observations has enabled me to determine, in several cases with certainty, in others with a greater or lesser probability, the nature of the different organized beings which produce these colours. And it has also led to a result which appears to me as interesting to Physical Geography as to Natural History itself, that these colourings are, for the most part at least, permanent in certain localities, where they are generally reproduced at the same time of the year.

I have arranged these observations according to the certain or probable nature of the cause which produces them.

* See Memoire sur la Coloration de la Mer de la Chine.—*Ann. des Scien. Nat.*, 4e ser., t. i.

selves opposite Tor. . . . During this interval the packet making 8 knots an hour, as the sailors say, and had run over a space of 256 miles, or about 85 leagues."

M. Dupont saw that this water owed its colour to a particular colouring substance which he collected on a filter; and M. Montagne recognised in it the characters of the plant described by Ehrenberg. These observations, made with every possible care by eminent naturalists, cannot leave any doubt as to the results. We may, at the same time, presume that this phenomenon was observed at a much earlier period, because it gives us a satisfactory explanation of the term *Red Sea*, a name which that sea has borne since the time of Herodotus.

After many bibliographic researches, I happened to meet with a very curious passage in the Memoirs of Albuquerque, which shows that the phenomenon of the colour of the Red Sea has been observed under circumstances which render this observation very interesting on many accounts. "This name of *Mer Rouge* or *Mer Vermeillé* suits it better than any other, and Albuquerque well knew *why* it had been thus named in old times: it was because the whole entrance of the Red Sea is filled with a great number of patches as red as blood. Alphonse Albuquerque having arrived with his fleet at the entrance of the strait, on the point of returning to India, saw, from the stern of his vessel, issuing from the strait, and expanding outside, a stream of very red water, which flowed towards Aden, and extended on that side of the strait as far as the eye could reach. Astonished at this fact, he asked the Moorish pilots the cause of this red colour which spread itself so widely over the sea; they told him that he need not be astonished, for the eddy made by the waters during the ebb and flow of the sea bristling with rocks and not very deep, was the cause of this red colour; and that it is principally during the reflux, because the force of the waters is greatest when they are going out, and there is no current inside the strait; also when the wind is strong, and from the west, the sea becomes more red. These reasons appeared satisfactory to Alphonse Albuquerque; he therefore gave his assent, and moreover thought that the earthy matter from the bottom of the sea was the cause of the colour."

The exact date of this observation is unknown, but it is certain that the fleet of Albuquerque appeared before Aden on the 7th February 1513; and it would long since have determined the ideas of geographers upon the colour of the Red Sea, had it not been contradicted some years later by another Portuguese, whose name is equally celebrated in the history of the conquest of India, João de Castro. In the account of his voyage to the Red Sea, under the direction of Don Estebam de Gama, there is a curious dissertation (p. 257) upon the origin of the name Red Sea.

In this dissertation, João de Castro remarks that the Portuguese who preceded him on the Red Sea referred to the existence of the red patches: yet he does not mention the name of Albuquerque. "Portuguese who have navigated the Red Sea in times past, affirm that the sea is quite covered by patches of a deep red. The cause to which they attribute this phenomenon is the following: they say that the soil on the coast of Arabia is by nature very red; and that this coast is subject to very great hurricanes, during which clouds of dust are raised and carried away by the force of the wind, and falling into the sea, communicate their own colour to the water: this is why it has been called the Red Sea." João de Castro cites this opinion, in order to contradict it. He never observed either this red earth or the clouds of dust, and he never saw the water coloured red. He tells us that almost every day during the expedition he brought up some of the water, in order to observe it, and that he always found it perfectly clear and transparent; but we know, from the observations of M. Ehrenberg and M. Evenor Dupont, already referred to, that the colour of the Red Sea is neither a constant nor a general fact; and this explains how, during the course of his voyage, which lasted a little more than four months, João de Castro never observed this phenomenon, although he had devoted his special attention to it. He says, besides, with perfect truth, that he does not pretend to deny that the water of the Red Sea may sometimes present particular colours, but that for himself he had never met with them.

In order to explain the origin of the name Red Sea, there is also an imaginary hypothesis, which has become celebrated; and which attributes this name to the coral reefs carpeting the numerous shallows of this sea, and which, owing to the transparency of the water, are easily seen. This hypothesis cannot be maintained; for, even if it could be applied to some red and immovable patches, it certainly could not explain the movement of the great band of coloured water which Albuquerque saw issue from the Red Sea and flow into the Gulf of Arabia. It is true that Barros, who adopts João de Castro's explanation, supposes, in the latter case, that the colour of this band of water proceeded from the particles of coral carried away by the eddies. But, for many reasons, this is difficult to admit; and besides, we have a much more simple explanation in the phenomenon observed by MM. Ehrenberg and Evenor Dupont.

Nevertheless, this opinion of João de Castro, founded upon facts, collected with very great care, by an able observer for his time, and which, it is necessary to remember, had some very good arguments in its favour, was adopted at once by contemporaries. All the authors of that age who have spoken of the Red Sea, have, more or less, repeated the opinions and even the phrases of the "Roteiro;" and these ideas are circulated generally in treatises on physical geography even to our day, while the remarkable observation of Albuquerque has been entirely forgotten.

The *Trichodesmium erythræum* is likewise found in the Chinese Sea; I have proved its presence in the coloured water which was brought from it by M. Mollien; and have spoken of this fact in detail in a previous memoir. It will suffice to repeat here that the Chinese Sea presents many parts which are coloured red and yellow, the latter predominating to the north of the island of Formosa, and the former to the south; that the water which I examined was procured from a red patch, and was taken up in lat. 10° N., long. 106° E. On the same occasion, I mentioned the very curious fact of a shower of sand, observed at Shanghai, 4th March 1846, by Dr Bellott, surgeon in the English navy, and which, from the observations of Mr Piddington, appeared to be composed, for the most part, of a microscopic alga.

ships had crossed the line, that their course was towards the south at a short distance from the shore; and that on the 29th January they perceived the island of Lóbos, situate at the mouth of the river de la Plata; consequently this phenomenon must have occurred in passing along the coasts of Brazil. Almost in the same altitude the following observations were made, and are much more explicit.

"On the 9th of December 1768, we observed the sea to be covered with broad streaks of a yellowish colour, several of them a mile long, and three or four hundred yards wide: some of the water thus coloured was taken up, and found to be full of innumerable atoms pointed at the end, of a yellowish colour, and none more than a quarter of a line, or the fortieth part of an inch long: in the microscope they appear to be fasciculi of small fibres interwoven with each other, not unlike the nidus of some of the *Phyganeas*, called Caddices; but whether they were animal or vegetable substances, whence they came, or for what they were designed, neither Mr Banks nor Dr Solander could guess. The same appearance had been observed before, when we first discovered the continent of South America."

This observation is confirmed by that of Kotzebue in his First Voyage round the World. "On the 6th December 1815, we were in the neighbourhood of Cape Frio, of which I wished to determine the latitude, but continued bad weather rendered observations impossible, and we steered for the island of St Catherine. Next day we observed on the surface of the sea a band of dull brown colour, about two fathoms in breadth, and which stretched in length as far as the eye could reach. I at first took this appearance for a shoal, but having brought some of the water on board, we found this coloured band was composed of an innumerable quantity of small crustacea, and of the seeds of a plant which our naturalists thought grew at the bottom of the sea."

This observation, very imperfect as to results, is fortunately completed by the observations of the two naturalists of the expedition, Eschscholtz and Adelbert von Chamisso—"On the 7th December, in the neighbourhood of the coast of Brazil, we sailed across a long yellow band of some fathoms broad.

We brought some of the water up in a bucket, and we observed that the colour proceeded from an innumerable quantity of very fine small yellow threads, about half a line in length. Under the microscope there were to be seen a great number of transverse divisions in each of these threads. Two days after, we again met with similar bands in the sea. On the 10th we perceived the coast of Brazil."

This last observation is remarkable in many respects, inasmuch as, instead of being made by mariners, it belongs to distinguished naturalists, of whom one above all will remain celebrated for his discovery of the double generation of the *Salpa*, which, long disputed, has become in our days the starting point in the theory of alternate generation. The characters of the *Trichodesmium* were there found very clearly indicated.

These observations refer to bands of coloured water at a short distance from Rio de Janeiro. Mr Darwin observed a phenomenon of the same kind in the neighbourhood of the islands of Abrolhos. "March 18th, we sailed from Bahia. A few days afterwards, when not far distant from the Abrolhos islets, my attention was called to a discoloured appearance in the sea. The whole surface of the water, as it appeared under a weak lens, seemed as if covered by chipped bits of hay with their ends jagged. One of the larger particles measured ·03 of an inch in length, and ·009 in breadth. Examined more carefully, each is seen to consist of from 20 to 60 cylindrical filaments, which have perfectly rounded extremities, and are divided at regular intervals by transverse septa, containing a brownish-green flocculent matter. The filaments must be enveloped in some viscid fluid, for the bundles adhered together without actual contact. ' I do not know to what family these bodies properly belong, but they have a close general resemblance in structure with the Confervæ which grow in every ditch. These simple vegetables, thus constituted for floating in the open ocean, must in certain places exist in countless numbers. The ship passed through several bands of them, one of which was about ten yards wide, and judging from the mud-like colour of the water, at least two and a half miles long.' —*Darwin's Jour.*, p. 14.

The explanation of all these phenomena is to be found in an observation of Mr Hinds, made from the *Sulphur* in a calm sea near the islands of Abrolhos, where, on the 11th of February 1836, and some days after in lat. 30° 52′ S. and long. 37° 80′ from Greenwich, the 15th, 16th, and 17th February, he collected several specimens of this plant, and discovered that it exhaled a very strong smell, resembling that of cut hay, attributed at first to exhalations proceeding from the ship. This plant has been described by M. Montagne under the name of *Trichodesmium Hindsii*.

From the comparison of these observations, it results that there exist on the east coast of South America, at least three bands of water coloured by *Trichodesmium Hindsii*, and which are situate on the north and south, and nearly in the latitude of Pernambuco (Mr Hinds), the islands of Abrolhos (Mr Darwin), and Rio Janeiro (Bougainville, Cook, and Kotzebue). All these observations have besides been made about the same time of the year, which, in the southern hemisphere, is the hot season. The observations of Cook and Kotzebue were in the month of December; those of Bougainville and Mr Hinds in January; and those of Mr Darwin in March. Mr Hinds also again found this plant during three days, in the month of April 1837, in the latitude of Libertad, near San Salvador, upon the west coast of California, lat. 14° N. This time, the smell was much stronger than at the islands of Abrolhos, so much so as to produce in several of the passengers, and Mr Hinds himself, a smart irritation of the conjunctiva and pituitary membranes.

§ III. *Colours produced by a microscopic Alga, of a species not yet determined, but which also appears to belong to the genus* TRICHODESMIUM.

These colours have been frequently observed on the coasts of Polynesia, and are distinguished from the preceding by their tint, which is nearly brown or gray. They were first observed by Cook in his first voyage, on the 28th August 1770, in lat. 8° 52′ S., long. 221° E. from Greenwich, during the passage from New South Wales to New Guinea:—

ticle thence appeared somewhat torn. The particles exhibited no motion when in salt water; and the sole effect produced by immersing them in spirit of wine was the separation of each into its component fibres."—*Flinders*, i., p. 92.

Captain King, in his voyage round Australia, observed this phenomenon on the 9th Sept. 1819. "The sea was covered with a brown scum, which Captain Cook's sailors called 'sea sawdust' from its resemblance to that substance. The position of these bands of coloured matter was between lat. 14° 1′ 30″ south, long. 130° 27′ 30″ west, and lat. 14° 28′ 30″ south, long. 130° 17′ 15″ west."—*King's Survey*, i., p. 279.

It is likewise mentioned in the first voyage of "l'Astrolabe," by Dumont-Durville, who met with these plants in his passage from Hobart Town to the island of Vanikoro, where, guided by some vague indications, he went to seek for the debris of the wreck of Lapeyrouse. "21st Jan. 1828. The wind very light, and at intervals the sea, though calm, presents immense spaces entirely covered with a thick, yellow and slimy dust, resembling saw-dust. Examined through a magnifying glass, it exhibits an infinity of small equal atoms, homogeneous, linear, almost cylindrical, and attenuated at both ends, without any motion. In many of these atoms, one of the ends seemed divided into very loose points, which sometimes spontaneously detach themselves. M. Quoy has referred this animalcule to the genus *Bacillaria*." This observation was made in lat. 29° 4′ S., and long. 166° 15′ W. The same phenomenon was again met with on the 26th Jan., in sight of the volcanic island Mathew, in lat. 22° 34′ S., long. 169° 15′ W.

Bands of coloured water were also seen near the Moluccas, by M. Frecyinet, during the voyage of the "Uranie," and by Mr Darwin, near Cape Lewin, on the west coast of Australia.

All these observations, related in almost the same terms, show us the existence in the ocean of an alga of the genus *Trichodesmium*, which, according to Mr Darwin, who has studied it, specifically differs from that of South America. It will be of great importance if some botanist makes known its characters.

§ IV. *Colours produced by* Cetochilus australis.

Cetochilus australis is a very small crustacean first described by Roussel de Vauzème, and which belongs to the order *Branchipodes* of Latreille, or *Copepodes* of M. Edwards. M. Edwards, in his "Natural History of Crustacea," (Pl. III.), considers this genus *Cetochilus* to come very close to the genus *Pontia*, if it be not identical with it.

The first observation of a colour produced by these small crustaceans dates from the end of the sixteenth century, and is to be found in the narrative of a voyage made by a Dutch fleet in the South Seas, under the command of Simon de Cordes, Jacques Mahu, and Sebald de Veert:—

"At the beginning of the year 1599 we left Annobon for the Straits of Magellan. On the 10th of March, not far from the Rio de la Plata, in lat. 42°, the sea appeared quite red, in such a manner as to make us believe that it was mingled with blood. Some of the water being brought up, we found it full of small red worms, which, placed upon the hand, jumped like *fleas*. Some believe that, at stated times, they are cast off by the whales."

These animals have been found nearly in the same locality, in November 1615, by two Dutch navigators, J. Lemaire and W. Schouten, in their voyage to the Australian seas, a voyage signalized by the discovery of Cape Horn and New Zealand:—

"About lat. 35½° we perceived these insects, of which Sebald de Veert had spoken to us, which made the sea quite red. They are horned fleas, clear as crystal, and marked upon the head with a spot as red as fire."

These observations are commented upon and explained by the more recent ones of Roussel de Vauzème:—

"When crossing from the islands of Tristan d'Acunha to Cape Horn, in the month of February, we one morning saw the surface of the sea furrowed with red bands of the colour of blood, and extending over several leagues. The men of the ship told us that we had arrived in the locality of whales. We soon perceived life in the midst of these reddish bands, the sea around us being in a constant turmoil, from the movement of the living atoms. I collected a great quantity, which

I brought to France, and M. de la Chaize, the surgeon of a whaler, has sent to me those procured during his last voyage to the islands of Chiloe. This crustacean has been found in the Pacific and in the middle of the Atlantic Ocean, lat. 42° S. It swarms in very extended banks, which redden the sea, and serve as food to the whales."

Roussel de Vauzème has devoted a special memoir to the description of the little animal which produces this colour, and to which the reader is referred.

The description he gives of the organization of the *Cetochilus*, and of the states in which he has observed it, explains and completes the details transmitted to us by Sebald de Veert and Schouten. The long antennæ of these animals, much longer than the body, are evidently the horns of which Schouten speaks, and their mode of progression, consisting in a rapid movement of the hinder feet, which, when at rest, are directed forwards, explains why Schouten and Sebald de Veert have compared it to the jump of a flea.

These animals afford nourishment to the whales; and the banks which they form are very well known to whalers, who designate them under the name of "*faux banc du Brézil*." R. de Vauzème has given some details on this subject, which I ought not to omit:—

"The whales devour myriads of them; they dart across the long plates of Baleen, among which I have often found them. These crustacea are also to be found among the tentacula of the *Coronulas* and *Tubicinellas*, which draw them in and afford them nourishment. The excrements of these latter, like that of whales, are of a red colour, similar to that of shrimps boiled and bruised. The American fishermen call these crustacea "Nourriture de Baleine." They have assured me that, during the good fishing days of October and November, these little animals remain concealed at the bottom of the sea. Later, when they lay their eggs, they appear upon the surface of the water. This circumstance is the signal to the sailors of the approaching departure of the whales, which soon retire to the bays. Before spawning time, the red banks which furrow the sea become yellow; they say then, in the fisherman's language, that the "food" is ripe, and

account of this voyage, gives more details. "The day on which we set out for these islands, we saw a great troop of small shrimps which reddened the sea for a mile round, and we took in several with the buckets. They were not longer than the end of a little finger, and the large and small had feet like those which the English call lobsters.

These animals were again found, by Captain de Gennes, who commanded a French squadron, on 31st January 1696. "The sea was so covered with little shrimps, that we might have called it Red Sea. We took up more than ten thousand with some buckets." The locality where these were met with is not given exactly, but the squadron was then on the coast of Patagonia, between Cape San Antonio and Cape San Ynez, and was probably not far distant from the spot where the preceding observations were made.

This bank of crustacea was seen on the 20th and 21st January 1741, at Port S. Julien, by the squadron of Admiral Anson, during his celebrated voyage round the world.

On the 8th March 1747, Captain Lehen met with these banks of crustacea in lat. 47° 22′, that is to say, always in the same position. "8th March 1747, we saw, about 6 o'clock in the evening, an infinity of little red fish, about the size and thickness of a middle-sized shrimp; they had in the front of the head two very long claws."

Lastly we have an observation by Mr Darwin which confirms the preceding:

"In the sea around Tierra del Fuego, and at no great distance from the land, I have seen narrow lines of water of a bright red colour, from the number of crustacea, which somewhat resemble in form large prawns. The sailors call them whale food. Whether whales feed on them I do not know; but terns, cormorants, and immense herds of great unwieldy seals, on some parts of the coast, derive their chief sustenance from these swimming crabs."— *Darwin*, p. 18.

Commodore Byron observed several banks of crustacea upon the coast of Brazil.

"As morning approached, the gale became more moderate, but we had still a great sea, and the wind shifting to S. by W. we stood to the westward under our courses. Soon after it was light, the sea appeared as red as blood, being covered with a small shell-fish of that colour, somewhat resembling a cray-fish, but less, of which we took up great quantities in baskets."

Analogous facts are also met with upon the west coast of South America. They are mentioned by Lesson in the narrative of the voyage of the "Coquille." This naturalist saw on the 8th March 1823, the roads of Callao, lat. 70° 22′ 31″ S., long. 82° 54′ 33″ W., reddened by little crustacea about one inch long. M. Guérin Méneville, who described the entomological collections brought by the naturalists of the "Coquille," indicates this small crustacean under the name of *Grimotea gregaria*, believing it to be the same species as that of Leach. But M. Milne-Edwards (*Hist. Crust.*, tom. ii.) is certain that this animal differs specifically from the *Grimotea gregaria* of the east coast of America, and makes it a species under the name of *Grimotea Durvillii*, in honour of the celebrated navigator Dumont Durville, who served as lieutenant on board the "Coquille."

§ VI. *Colours produced by Noctilucæ.*

The remarkable phenomenon of the phosphoresence of the sea has been in our days the object of important researches. It has been observed that upon our coast of the Channel, it is produced by an animalcule of the class of the Rhizopodes, described under the name of *Noctiluca miliaria*, which, already long noticed by different observers, has now been completely studied by MM. Suriray, Verhæghe and Quatrefages.

From the observations made by Suriray at Havre we learn that the noctilucæ occasionally assume a red colour, and that they then colour the sea to a certain extent. Of the nature of this colour we are entirely ignorant. Whether it proceeds from the development of reproductive bodies, in which case it must manifest itself periodically, or whether it be accidental, and produced by some matter which the noctilucæ have imbibed, are questions which merit the attention of naturalists. The abundance of noctilucæ on the coast of our channel, from Havre to Ostend, causes me to hope that this important point of comparative physiology may soon be cleared up. Whatever the cause may be, the coexistence, in certain cases, of the phosphorescence and the red colour, deserves mention, and may possibly enable us to account for a great many colours in the sea.

The details of Suriray's observations at Havre are:—"On the 17th of June 1809, and some days following, the wind S.E. and a little rain, the water of a small dock was covered by large patches of a tint similar to a mixture of lees of wine and cider. I believed, with many others, that it proceeded from the residue of some tubs of dye, and at first paid very little attention to it; but the next day towards evening, in addition to the permanent colour, I observed that the stroke of the oars and the track of the little boats developed large bluish zones, which remained for about a minute; the fall of a large stone produced a luminous centre, from which phosphorescent drops sprung out and attached themselves to neighbouring bodies. I have never seen the luminous phosphorescence so brilliant as during the same night, which was extremely dark. On the 8th, about 10 P.M., the wind had formed, in an angle of the dock, a large bank in form of a trapezium, upon which a gentle rain developed a beautiful starry phosphorescence; the other parts of the dock, although their surface was broken by the same cause, remained dark. From the centre of the phosphorescent portion I filled a long tube of glass two inches in diameter, and brought it into my room; the three upper quarters were soon occupied by a red mass, half opaque, and appearing all in a flame in the dark, every time it was slightly shaken. . . . . . On the 9th, the wind blew strongly from the N.E. and scattered the globules, which reappeared on the 12th in almost as great number; but this was for the last time."

It might be supposed that a phenomenon of this nature, produced so near to us, ought to be frequently observed; but Suriray's observation is the only one I know of, unless we except a curious passage in Tacitus, repeated by Dion Cassius, who mentions that about the year 51 of our era an appearance of blood spread over that part of the ocean which separates France and Great Britain. But this passage is too incomplete to enable to decide whether it was a real fact, or merely a false statement superstitiously believed.

and our boatswain, in his coarse way, observed 'It is as red as the blood from a butcher's shambles; if we were to tell this in England, we would not be believed.' In the evening, as it grew dark, the mollusca (which he had intentionally preserved) became luminous, having, when undisturbed, that kind of appearance which quicksilver assumes when spread on the back of a looking-glass; on their being agitated they emitted a bright silvery light, and on being then taken out with the hand, and thrown on the deck or any other object, they retained their luminous appearance for half a minute."—*Salt, Trav. Abyssinia*, p. 195.

The observation of Salt is the more interesting in connection with this subject, as we possess a much older account of a phenomenon, which is very probably related to one which we are about to mention. It is an observation of the phosphorescence of the sea, made by João de Castro during the voyage of which we have already had occasion to speak, at some leagues to the north of the little island of Massawah,* on 24th February 1541. This is one of the first indications which we have of the phosphorescence of the sea; and although it does not necessarily bear upon my subject, I think it worth quoting:—

"21st February 1541, at the beginning of the second watch, we came upon some large very white patches, which shone and darted like lightning. Afraid of this phenomenon, which appeared strange, we immediately shortened sail, and believing that we were upon the top of some rock or shoal, I gave orders to sound, and found 26 fathoms; then, as this novelty made no impression upon our native pilots, and as we were in deep water, we again proceeded."

Upon the south-east coast of Arabia, the phenomenon of the red colour was observed by João de Castro, near Cape Fartak; and though his observation is very incomplete, his various considerations induced me to think that it may be attributed to the noctilucæ. In fact the phenomena of phosphorescence have been frequently noticed on the south coasts of Arabia, and particularly in the neighbourhood of Cape Fartak. On the

* Massawah is 15° 35′ N.

other hand, the English voyager Salt reports, in reference to the observation already mentioned, that a milky appearance of the waters has been frequently observed in this sea, which, like that I am trying to establish, seems to be allied to phosphorescence, and produced by the same cause. If we recall, besides, the curious observation of Suriray upon the red colour occasionally assumed by the noctilucæ, I believe that it may be considered very probable that these animals are the cause of the colouring observed by João de Castro.

This phenomenon has also been met with in the Gulf of Guinea:—

"M. de Tilleul, commissioner of the marine, made, during a voyage on the coast of Coromandel, some analogous observations along the coast of Guinea. The sea, for several days, appeared as if it were covered with blood; this phenomenon, which at first frightened the sailors very much, appeared to be caused by a thick bed of microscopic animals."

This observation is very incomplete, both the locality and date being deficient. But we can complete it from a somewhat more detailed observation, made during the memorable expedition of Captain Tuckey in 1816, for the exploration of the course of the Zaire. It is twice referred to in the account of this voyage—first in the journal of Captain Tuckey, afterwards in that of a Danish botanist, named Christian Smith, who belonged to the expedition, and who unfortunately perished, with a great number of his companions, in consequence of the fatigues which they experienced. It was made during the last days of the month of June 1816, in the Bay of Loango, near the mouth of the river.

"Some days ago the sea had a colour as of blood. Some of us supposed it to be owing to the whales, which at this time approach the coasts in order to bring forth their young. It is, however, a phenomenon which is generally known, has often been described, and is owing to myriads of animalcula. I examined some of them taken in this blood-coloured water; when highly magnified, they do not appear larger than the head of a small pin. They were at first in a rapid motion, which, however, soon ceased, and at the same instant the whole animal separated into a number of small spherical particles."—*Prof. Smith's Journal in Tuckey's Narrative*, p. 263.

I only class these observations as doubtful, because they are extremely incomplete; at the same time, the details of the observation, even the *diffluence*, which is found clearly indicated, and which is only met with among the most simple beings of the animal kingdom, makes me presume that these phenomena are produced by the noctilucæ. I may add, in support of this opinion, the extreme frequency of the milky aspect of the sea in the Gulf of Guinea, and which has been particularly mentioned in the narrative of the voyage in which I found this latter document.

It is to an analogous cause, probably, that the observations made upon the coast of Peru are due.

The first is that of Admiral Anson; it was made in the month of November 1741, in lat. 10° 36′ S.:—

"Here we found the sea for many miles round us of a beautiful red colour. This, upon examination, we imputed to an immense quantity of spawn spread upon its surface; for, taking up some of the water in a wine glass, it soon changed from a dirty aspect to a clear crystal, and only some red globules of a slimy nature floating on the top."

This phenomenon was also seen by Captain Colnett in 1793 and 1794. Neither the dates nor the localities of his observations are exactly indicated; but he speaks of the coloration of the sea as very common upon the coasts of Peru and Chili, from the 1st to the 38th degree of south latitude, and mentions certain circumstances which seem to indicate that these vesicles must be noctilucæ, though they have not been described. In short, he names several localities where the sea was white, and even mentions, near the Gallapagos Islands, a band of coloured water containing medusæ, "*cream-coloured blubbers.*" We may suppose that these different colours are produced by noctilucæ, or animals very near to them, which, in certain circumstances, would become red, as Suriray observed at Havre, and, as we have supposed, was produced in the Gulfs of Guinea and Arabia, and which, under other circumstances, would appear of a white colour sufficiently distinct, as we shall see in the note which follows this memoir.

is no ice in the green parts; whilst, where ice is abundant, the sea is of an azure blue, which depends, according to Scoresby, upon entirely local conditions. I have not thought it necessary to quote here the passages in Hudson's narrative where he mentions this phenomenon, because we find it described by Scoresby with much more detail.

This latter navigator, who, during his many voyages, whale-fishing in the Arctic regions, collected scientific documents so numerous and interesting in every way, has perfectly described the phenomenon in question.

"The colour of the Greenland Sea varies from ultramarine-blue to olive-green, and from the most pure transparency to striking opacity. These appearances are not transitory, but permanent; not depending on the state of the weather, but on the quality of the water. This kind of water occurs in considerable quantity, forming perhaps one-fourth part of the surface of the Greenland Sea, between the parallels of 74° and 80°. It is always renewed, near certain situations, from year to year; often it constitutes long bands or streams lying north and south, or north-east and south-west; sometimes I have seen it extend two or three degrees of latitude in length, and from a few miles, to ten or fifteen leagues in breadth. In 1817 I fell in with such narrow stripes of various-coloured water, that we passed streams of pale-green, olive-green, and transparent blue in the course of ten minutes' sailing. The food of the whale occurs chiefly in the green-coloured waters. It therefore affords whales in greater numbers than any other quality of the sea, and is constantly sought after by the fishers." Examination of this water by the microscope showed the colouring matter to consist of "semitransparent globules of from one-twentieth to one-thirtieth of an inch in diameter, and of fibrous or hair-like substances, which varied in length from a point to one-tenth of an inch, and when highly magnified were found to be beautifully moniliform."

The description which Scoresby gives us of this little animal, which he compares to the *Beroë globulus* of Lamarck, shows us that it belongs to a species near to the noctilucæ, but that it will, very probably, form a distinct genus. One cannot suppose, in short, that the coloured and regularly disposed patches which these animals present, and of which Scoresby speaks, belong to accidental and transitory colours like those we have remarked in the noctilucæ of the Channel. Further, their dimensions are much larger. We have seen that Scoresby gives their diameter as about the one-fourth of an English inch. According to M. de Quatrefages, the diameter of the noctilucæ observed by him at Boulogne, was only one-third or one-fifth of a millimetre. We see also that Rigaut, who, in the last century, had observed noctilucæ in the Atlantic Ocean, from Brest to Newfoundland, and at the Antilles, gives them a diameter of one-fourth of a line; this would be about half a millimetre, and, cousequently, a larger size than the noctilucæ of the Channel, and therefore twelve times smaller than those of the Arctic Seas.

It would be interesting to ascertain whether the species found in the Arctic Seas are phosphorescent; but unfortunately the direct observation has not been possible, from the peculiar state of the northern climates, where the sun is above the horizon during one part of the year, and below it during the other. Arctic countries do not present the repeated alternations of day and night, and can only therefore be visited during the day, which lasts for several months, so that the question of the phosphorescence of these animalcules cannot be resolved, though Scoresby considered it as probable.

Scoresby's observations regarding the green colour of the sea may appear, at first, foreign to the subject of this memoir, but later observations by this navigator have proved that the animalcules described in the passage I have just quoted produced also a red or brown colour. Nor is this surprising, because we know with what facility red and green colouring matters (which exist in vegetables, and in many inferior animals) can change themselves, the one into the other; and that even the amount of matter suspended in the water may cause it to change its colour.

In fact, Scoresby has mentioned other localities where the colour of the sea, instead of being yellowish-green, was brown, probably from the same cause. The observation was made in lat. 69° 28′, and long. 13° 40′ W., on the 1st September 1822.

This observation, which applies to a point not far from the south coast of Iceland, acquires some interest, because it seems to explain some colourings earlier noticed upon the coasts of this island, and which were related by Olafsen and Povelsen, in the narrative of their voyage to Iceland in the last century; so that they have not been observed by them alone. If, as I think, these observations refer to the same phenomena, they are more favourable to the opinion which refers these animals to noctilucæ; because the fact of their phosphorescence is indicated in the observations mentioned by Olafsen and Povelsen.

"This phenomenon (*that of blood in the sea*) is common enough in other countries, but more rare in Iceland. It was observed in 1712, upon the coast of Reykestrand, from the shore to a considerable distance in the sea. The fishermen's oars were painted red, like the algæ and the rocks at low water, of which the historian says (for we make use of his own expressions), that they were the colour of '*blod lifar*, that is to say, congealed blood; which proves that he, like the people, took it for blood. For a number of years, and in 1649, the same phenomenon was noticed on the west coast in two places in the sea, and the same year in the Gulfs of Seidisfiord, Alptefiord, and the Vestfiord. The preceding night the sea appeared as if on fire, and the day following it appeared red like blood. Here is something like phosphorescence; we cannot decide whether it may proceed from some sea insect, or marine plant, as for example Jungermannia. One of us has remarked something of a similar nature on the southern side."

Further:—"In 1638, we are ignorant in what season the fishermen of the east coast perceived some congealed blood in the sea, which was thrown up in oblong bands upon the shore. We mention this relation in order to compare it with what we have narrated."

This is probably the same cause which produced the colour observed in Davis Strait and at the entrance of Baffin's Bay, by Captain Parry, during his second voyage in search of the northern passage. Captain Parry gives some details which I ought not to pass over in silence. In all the localities where the sea was coloured, the depth was very considerable. A sort of green-coloured slime was brought up from the bottom

going to survey the lines of his vessels, and encourage his adherents. "More recently," says he, "the ships bringing Caius, on his return from Andura to Antium, was stopped by an *Echeneis*. But his astonishment was not long when he saw that, of all his fleet, his galley alone did not advance. Those who went overboard to ascertain the cause, found an *Echeneis* sticking to the helm, and showed it to the prince, who was indignant that such an animal had been able to get the better of 400 rowers, and was very much surprised that this fish, which in the sea could keep back his vessel, had no longer any power when brought on board." Caius would seem not to have been quite free from doubts on the subject.

It is long, however, since the *Echeneis* has lost all claim to such supernatural properties. It is now only known as a very interesting little fish provided with the sucking apparatus I have referred to, and most associated with the shark, so much so, as to be known by mariners under the name of the pilot-fish, from its playing around and before it.* But it by no means confines itself to the shark. It attaches itself to almost any large fish that comes in its way. Yarrell records a specimen as having been taken in the British seas on the back of a cod, and it is frequently observed adhering to vessels. It usually swims upon its back, and from the under jaw being more projecting than the upper, and the colour of the upper and under surfaces being the same, one, at first sight, would imagine that the belly was the back, and that the disk was placed under the chin, instead of on the top of the head. The colour is a uniform deep olive-brown (except in the case of some albino varieties, which are wholly white); and Lacepede remarks, that the colour of the belly in this fish would seem to indicate that it was the less exposure to light which made the bellies of other fishes pale.

Four species of *Echeneis* have been described — the *E. remora*, *E. naucrates*, *E. osteochirus*, and the *E. lineatus*. I have recently received from Old Calabar, through the kindness of my friend Mr Wylie, another species, which I propose to name *E. tropicus*. It approaches the Mediterranean species, *E. remora*, in its characters, and I think it by

* The name *pilot fish* is now commonly applied to the *Naucrates ductor*, but it equally belongs to the species in question. See Lacépède, &c.

no means improbable that, from its resemblance, it has hitherto been overlooked or confounded with that species. It will presently be seen, however, that its specific characters are sufficiently distinct. The character which has been most relied upon for distinguishing the species of *Echeneis* is the number of the plates in the disk on the head. For instance, the *E. remora* has a double row of eighteen plates, the *E. naucrates* of twenty-two, the *E. osteochirus* of twenty-seven, and the *E. lineatus* of six plates. The species which I have now to describe has a double row of seventeen plates. I believe this character to be constant, and susceptible of as little variation as the parts of the internal skeleton of the fish, or of the external skeleton of an articulated animal. Indeed, we may look upon these parts of the disk as dermal plates, and therefore as a modification of the external skeleton. It should follow, that wherever we find a difference in the number of the plates, we may be satisfied that there is also a difference in the species. Mr Yarrell seems not to have assigned a sufficient value to this character, for I find him in his "British Fishes" describing the *E. remora* as having seventeen *or* eighteen plates on the disk. I do not find Cuvier, or any other author, stating the number at anything but eighteen, nor in their descriptions do they give any latitude as to number. I have myself examined a good series of specimens of the *E. remora*, and I have never found an instance in which there were more or less than eighteen plates. I have no doubt, therefore, that Mr Yarrell has had the species I now describe through his hands, and that, finding the number of plates so close to that of the true *E. remora*, and the general appearance much resembling it, he has supposed it to be the same species, and thence concluded that the character in question was variable. The constancy of this character is the more important in this genus, that the formula of the fin rays to which ichthyologists are accustomed to trust, is so difficult of ascertainment, that it cannot well be relied on. The fins are covered with a thick untransparent leathery skin, which makes it very difficult to count the rays correctly. Almost invariably in counting them I have been in doubt whether I had not omitted one or two minute rays at the commencement or ending of the fin. Nothing but dissection can allow a satisfactory enumeration of them. It is no doubt owing to this element of error that Cuvier and Yarrell give a different formula of the fin rays of *E. remora.* I do not think that either of them are quite correct, and I give the following comparison of the result come to by these authors and myself, to show the difficulty to which I allude:—

	D.	P.	V.	A.	C.
Cuvier,	22	25	6	22	17
Yarrell,	21	22	4	20	20
Murray,	20–21	25	6	19–21	17–19

In giving this latitude in my enumeration, I do not mean to say that the number of rays varies from 20 to 21, 19 to 21, and 17 to 19, but simply that, from the causes above mentioned, I have been unable to make out, to my own satisfaction, which of these numbers is the correct one.

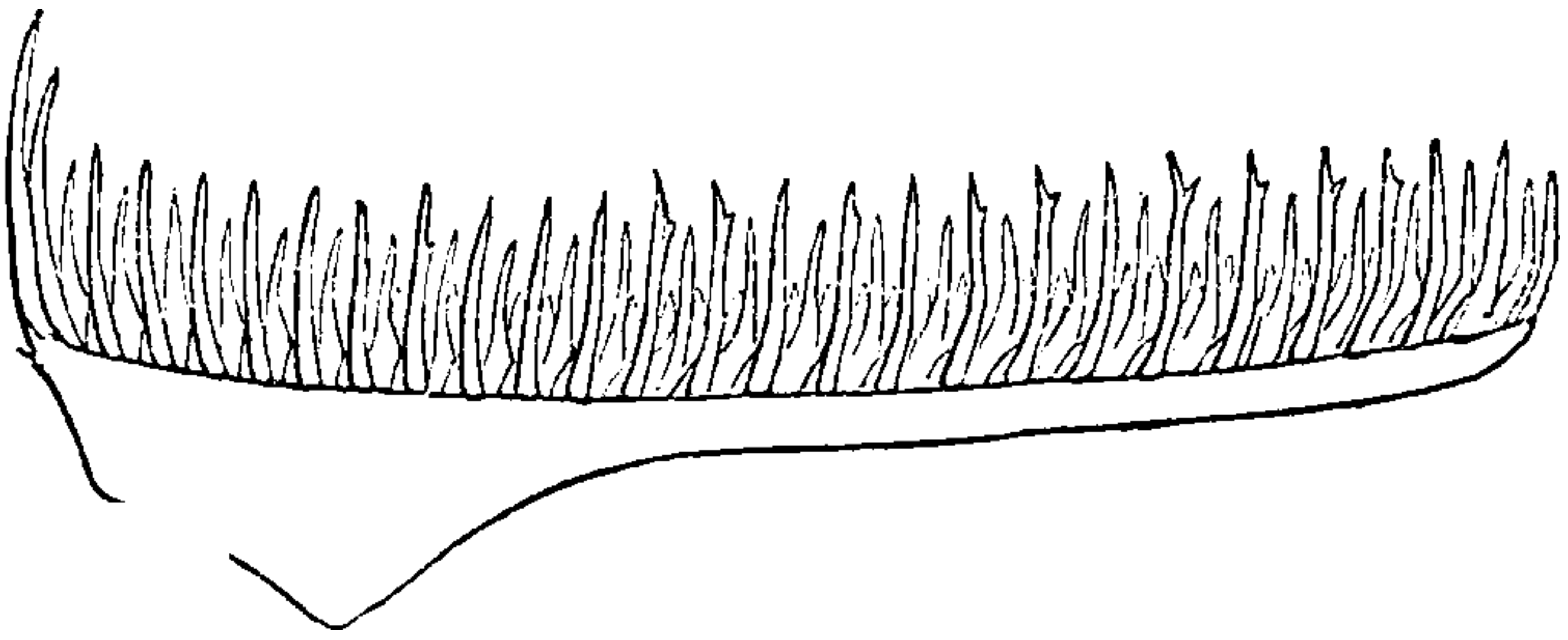
With these observations on the specific characters of the genus, I shall now give the description of the new species, merely premising that some parts of it, more particularly those relative to the mouth and teeth, are equally applicable to the *Echeneis remora.* Had I found a detailed description of these parts in any account of the latter species, I would merely have referred to such description, but as I have not done so, and the structure of the mouth in both species is curious, I have given a more careful description of it.

Echeneis tropicus.

Head, from the symphysis of the lower jaw to the end of the operculum, very nearly one-fourth of the length of the whole body; if the tail is included, it is rather less that one-fourth. The tail is nearly two-thirds of the length of the head. The depth of the body, taken immediately behind the operculum, is nearly one-twelfth part of the whole fish, and continues about the same depth till it meets the tail. It is deepest just in front of the dorsal and anal fins, which both commence about the same distance from the head, but even there the depth is not quite a tenth of the whole length; the head is very much depressed and flattened, the body in the middle nearly round, and the tail compressed. The mouth is wide; the opening nearly horizontal, with an outer fringe of close-packed, even, and regular

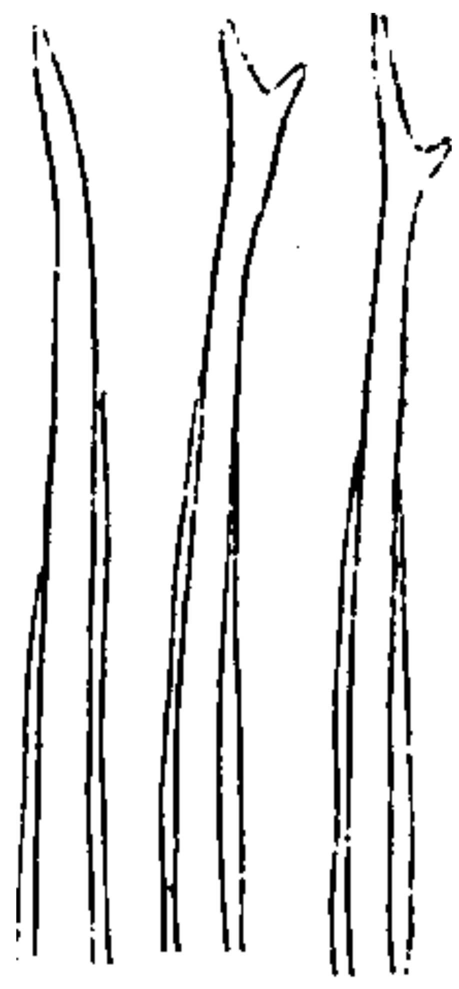
tends backwards not quite so far as the line of the ends of the pectoral fin rays. Its length is very nearly one-third of the whole fish. Each of the laminæ is furnished with three rows of teeth, the lowest row longest, the next shorter, and the uppermost shortest. See fig. 2, which represents a plate as

Fig. 2.



seen from the under side. Many of the teeth, particularly those placed towards the outer side of the disk, are bifurcate, as shown in fig. 3. There is a curved tooth longer than the rest at the inner end of each lamina next the mesial line. The pectoral fins are small and rounded; the ventrals narrow and very close together; the dorsal and anal fins are both placed behind the middle of the fish; they commence at a like distance from the head. They are equal in length, and about one-third of the whole length of the fish, excluding the caudal fin. The end of the caudal fin is concave shaped. The lateral line takes a sudden rise, and then falls again a little behind the pectoral fins. The formula of the fin rays is as follows, viz.:—

Fig. 3.



Dorsal 20. Pectoral 26. Ventral 6. Anal 23. Caudal 19.

The colour is dusky-olive brown; the under part of the body as dark as the upper, the fins a little darker than the body. The length of my specimen is seven inches.

The principal differences between this species and the *Echeneis remora* are as follows:—The plates on the disk are seventeen in number instead of eighteen. The disk itself is elongate oval, and not broader behind than in front, while in *E. remora* it is broader behind, as will be seen in fig. 4, p. 299, which represents the outline of the disk in *E. remora*. The disk in the latter also is comparatively shorter than in *E. tro-*

picus. In *E. remora*, the posterior half of the body is wedge-shaped, tapering uniformly and pretty rapidly backwards from the disk to the tail. In *E. tropicus* it tapers more gradually, giving more of an eel-shaped appearance to the body from the disk backwards. The skin appears to me to be softer and less leathery than in *E. remora*, but as I have only one specimen, and it has suffered somewhat from coming home in spirits, I cannot say positively as to this.

I have never seen any account which to my mind was perfectly satisfactory of the *modus operandi* by which the *Echeneis* attached itself to the fishes or vessels to which it has been found adhering, and as I think I have ascertained what the process is, it may not be uninteresting if I endeavour to explain it.

The difficulty I felt was not how the fish sustained itself fixed after it had once put its sucker in action. The familiar example of the limpet sufficiently explains this. But the puzzle was, how the remora got its apparatus set agoing upon a fish or vessel in rapid motion; for although vessels may be becalmed, and sharks may be basking motionless for hours, I assume that it is not alone at such times that the *Echeneis* fixes itself. I have not met with any author or any observer who was an eye-witness of the fixing, but the possession of an apparatus peculiarly adapted for fixing itself upon bodies in motion (which I shall presently explain) entitles us, I think, to hold that it does fix itself upon them while in motion, without exposing us to the charge of reasoning in a circle. It is obviously something more than a mere air-exhausting apparatus which enables it to do this. If we find a limpet thoughtlessly standing at ease on its rock, and push it along the surface, it makes an effort to hold on before starting, but after its travel is fairly commenced, it in vain attempts to stop its onwward course. It cannot get the edges of its sucker placed so as to exclude the air. So a cupper could never fix his cupping-glasses if it were made a condition that they should never stand still, but must be constantly kept moving over the body of the patient; but this is what the little remora has to do. A gigantic whale or voracious shark rushes past him, going almost with the speed of light; but quick as he has been, the remora has been quicker, and in the twinkling of an eye rests firmly seated on his slippery back, or side, or belly, for all positions seem alike to him. How does he manage this? The structure of the disk will explain it. It is composed of two organs which appear to be distinct and independent of each other, each fulfilling separate functions, although both employed to bring about a common result. It has a sucking apparatus composed of a free fleshy flexible lip or margin all round the disk, similar to the edge of the sucking apparatus of the limpet. This, as well as the skin of the whole disk, is furnished with pores, which doubtless exude a mucous or slimy fluid to secure an impervious edge. This apparatus seems quite sufficient for the purpose of establishing a vacuum, and thus securing the adhesion of the fish. But besides this, it has the double row of transverse cartilaginous plates shown in fig. 2. These plates, as already mentioned, are furnished with these rows of teeth; there is a spongy gum-like substance through which three teeth project, so that they reach very little beyond its surface, and yet it can be pushed back until they are laid almost bare.

The account Lacepede gives of their action is this:—"It (the remora) attaches itself often to whales, and to fishes of a very great size, such as the sharks, and more particularly the white shark. It sticks to it very strongly by means of the plates of its buckler (disk) of which the little teeth serve like so many hooks to keep it clutched on (*cramponné*). These teeth, which bristle the edge of all the plates, are so numerous, and multiply to such a degree the points of contact and of adhesion of the remora, that all the strength of a very powerful man is not sufficient to tear this little fish from the side of the shark to which it has attached itself, so long as one attempts to separate it in a direction opposite to that of the plates. It is only when we attempt to follow that direction, and take advantage of the inclination of these plates, that we are able easily to detach the *Echeneis* from the shark, or rather to make it slide over the surface of the shark, and finally to separate it from it."*

* Although it is perhaps a little irrelevant to the immediate point under consideration, I may continue the quotation for a few lines. "Commerson relates, that having chosen to bring his thumb near the disk of a living remora which he had under observation, he experienced a power of cohesion so great that a remarkable numbness, and even a sort of paralysis, seized his finger, and

the rest, at the inner end of each plate, next the mesial line. Under a lens, the teeth are seen to be in no way shaped like hooks; most of them are simple straight spikes, but those nearer the outer edge of the disk are bifurcate (see fig. 3), as if to give additional power of resistance where it is most needed, in the same way as a palisade or paling is strengthened by an oblique supporter nailed to it and driven into the earth. The plates cannot be forced up so as to stand perpendicularly, as would be best their duty, if their purpose was to give the greatest area for a vacuum. They lean backwards, lying very flat when at rest, the mere points of the teeth only then projecting, but elevated to about an angle of 45° when raised. If the finger is passed down along the disk, from the head towards the tail, it glides easily and smoothly over it, but if passed however slightly in the reverse direction, it is at once caught by the teeth, and if the motion is persisted in, the plates are forced backwards as far as they can go, and the teeth penetrate the skin of the opposing object. The action of a fish passing the remora would have the same effect as the finger. As it glided along, the row of long teeth in the plate would be first touched, and the more rapid the motion, the deeper they would be buried; the second row below the long ones would next be reached, and they too would be imbedded in the skin of the fish, and would be, in their turn, supported by the third and lowest row. To allow the disk thus to operate, both the larger fish and the remora must be going the same way, and the former must pass the latter. If passing in the opposite direction, the fish would glide smoothly over it; but let it brush ever so lightly past the disk of the remora while going in the same direction, and it is instantly caught by the projecting teeth, and, as it pursues its course, it carries the remora along with it; it has run upon the little palisades of the remora, and all that the latter has now to do, is to put its sucking apparatus into operation, which it can do at its leisure (though we may be sure much time will not be required), for the teeth of the disk will maintain it in its position, so long as it does not seek to move forward. It must remain stationary or pull in the reverse direction to allow the teeth to continue to hold. If it wishes to release itself, all it has to do is to dart forward; the teeth are then taken with the hair, drawn out of the skin of the fish, and move softly and harmlessly along.

The above, I imagine to be the sole purpose of these plates. The sucker is quite sufficient for the mere purposes of adhesion; and may be probably used without the teeth or plates, when the remora fixes itself upon rocks or stationary objects; but the plates and teeth are required to enable it to fix itself upon bodies in rapid motion. A necessary consequence of my view (if correct) is, that the remora must always fix itself with its head in the same direction as the fish or vessel it attaches itself to, is going; it can never be found with its head to the tail, for the only way by which it could fix itself, if placed in that position, would be by either it or its supporter swimming backwards, which they cannot easily do. I do not know how the actual fact stands in regard to this position of the fish, and invite observers to notice it in future; but I feel sure that it is an impossibility for a remora to fix itself with its head pointing towards the tail of its supporter. And its being so is only another instance of the beautiful harmony and adaptation of things which are daily forced upon our attention. It would have been as easy to have made the plates and teeth point forwards as backwards, and then the remora would only have had to meet its supporter, and fix itself in brushing past him; in that case, it would have always been looking towards the tail, which would have entailed more serious inconveniences than at first sight appear. In the first place, the rapid motion of the creature to which it has attached itself through the water could not be met by the tail of the remora in a straight position; it would always be bent aside, which would not be comfortable. Again, if the remora opened its gill-covers to breathe, the rush of water would fill them, and keep them open, so that in a short time it would be drowned. Instead also of meeting its food and snapping it as it came, it would be like Tantalus, and never see it till it was borne resistlessly away from it. And supposing it to escape all these dilemmas, and, heartily sick of its position, to have resolved to lead a life of independence and self-reliance henceforward, how was it to escape from the false position it had assumed? Instead of easily escaping by moving forward (as the real remora does), our inverted animal would only fix itself the more firmly the more it attempted to escape. The only release would be by swimming backwards, but it would find it as difficult to do so against the onward impulse of the larger fish, as we ourselves too often find it to retrace a false step.

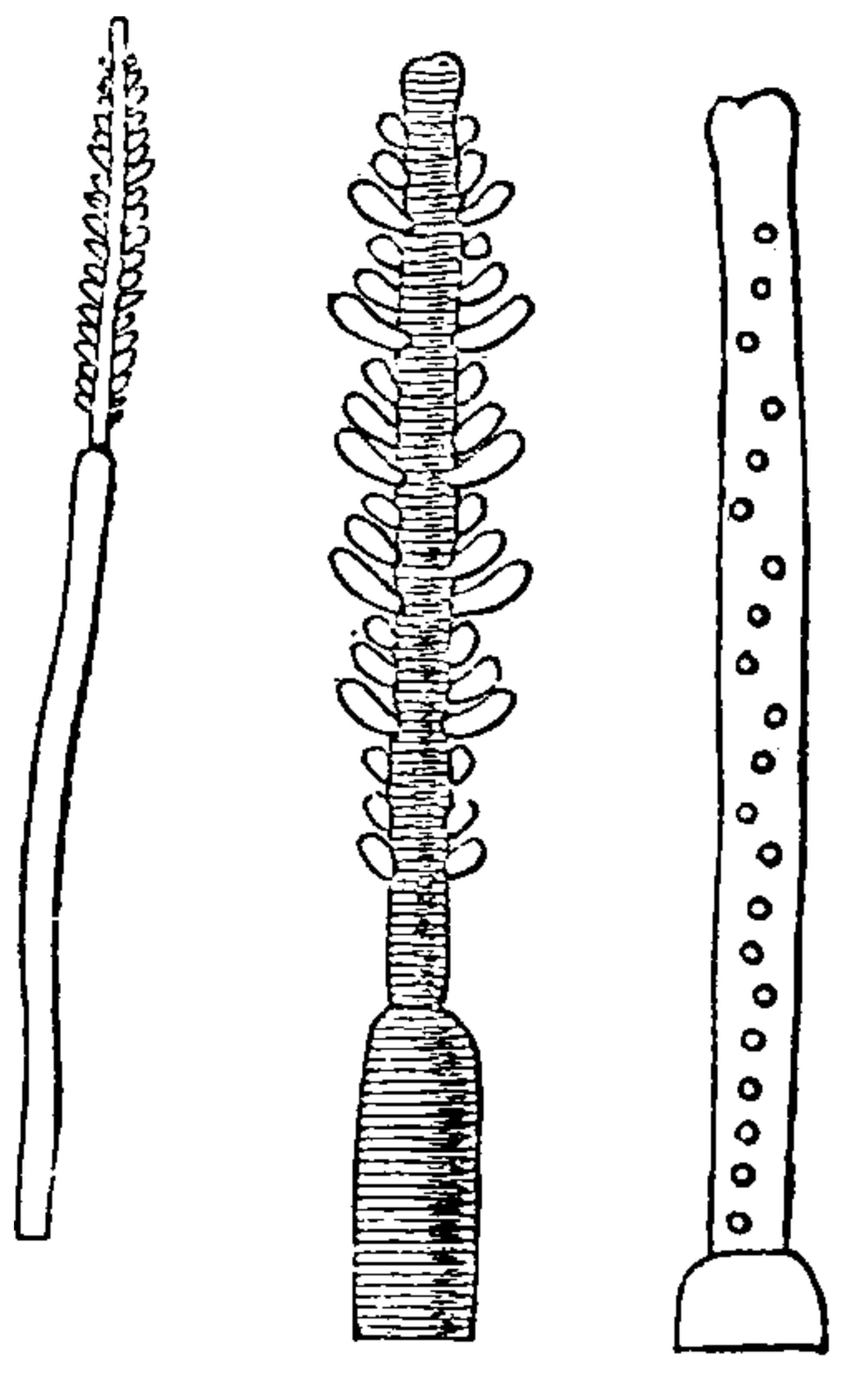
The mention of their food suggests to me that the curious conformation of the teeth, which I have above described, may help us to a knowledge also of this subject; for that is a point which is not as yet quite certain. Sir Wm. Jardine, in the *Naturalist's Library*, says it feeds on small fishes. The usual belief of sailors is, that it feeds on the fragments of the prey of the shark. Commerson thought this likely enough; but Lacepede mentions that in some seas they are in great numbers, and that they follow vessels in shoals in order to feed on the animal matter thrown away. This, he says, has been particularly noticed in the Gulf of Guinea, and that is the reason, according to Barbot, that the Dutch who frequent the west coast of Africa have called the remora "*poisson d'ordure.*"

The teeth, I think, show that this is very probable. The mouth is wide, with the lower jaw very much projecting beyond the upper, which, as it were, fits into the cavity of the mouth, just within the teeth of the lower jaw. The lower jaw has several rows of small sharp teeth, curved inwards; but the upper jaw alone has the peculiar outer fringe of close-packed regular pedunculated teeth already described. These are apparently admirably adapted to serve the purpose of a sieve. Suppose the small sharp curved teeth in the lower jaw, along with the inner irregular row in the upper jaw, to seize a portion of comminuted matter, and the mouth to be then closed, the water would escape out at the intervals between the peduncles of the upper fringe, and the food be retained within. The small size of the seizing teeth, and the several rows of still smaller ones, show that they are not adapted for seizing any solid very coherent body. It must be something that it requires a great many points of contact to lay hold of, and which is probably in a soft semi-fluid state. The thick velvet-like pavement of minute teeth in the interior of the mouth is obviously constructed for comminuting some substance which has been very much comminuted already, and the apparatus on the branchial rays

advancement—one or two only a couple of lines in length, and two of them nearly an inch, and buried at least as deep in the head of the fish. All these, with the exception of one, had merely the appearance of threads hanging out from under the edge of the disk. One, however, emerged from the side of the mesial line nearly in the centre of the disk. They all entered the head at some chink or cranny, where the young crustacean had found a hiding place. The individual that occupied a position on the disk itself was thinner, and had less substance than the others; from which we may infer, that although it had been able to live and grow in an occasioual vacuum, it was not altogether insensible to the injurious effects of such treatment.

They were all annular, of a dirty olive colour (the same as the colour of the fish), and semi-transparent. At the termination of one of them, I made out, by a little pressure under the microscope, that there were two nipples or slight elevations, which were probably, as was suggested to me by Professor Owen, the points of attachment of the two ovaries which had dropped off. These traces of ovaries were found on one of the thread-like individuals; and this would seem to imply that it was fully grown, although the great difference of form in another specimen, which I am going to describe, shows that if full grown, it was at least not fully developed. The one I refer to was a somewhat larger specimen than any of the rest, of the form and with the appendages shown in fig. 5. This shows that it is a species of the genus *Penella*, one of the *Lerneans* which has appendages at its termination like the wing of an arrow. This specimen had very much the appearance of a miniature arrow with a well-feathered shaft sticking in the flesh. Seen sideways, the feathers are found to be buds arranged in a double or treble oblique row, as represented in the sketch on the right hand, which is a magnified outline, intended to show the position and arrangement

Fig. 5.



of the buds when looked at in profile. The left hand sketch is a representation of it as seen in front; the middle sketch is the same, but more highly magnified.

Milne Edwards divides the genus *Penella* into two sections, one distinguished by the head (which penetrates deep into the victim, burrowing through flesh or bone indifferently, and generally attacking some part of the head) being furnished by two horns or diverging prolongations; the other by having three such arms or horns on its head.

Two species of each section have been described. The *Penella sagitta*, Lin., and *P. filosa*, Lin., fall under the former section, and the *P. Blainvillei* and *P. Sultana*, Nord., under the latter. The present species corresponds with none of these. I have endeavoured to dissect out one or two of them to find to which section it belonged, but their minute size, fragile texture, and great length to which it was buried in the head, combined with the degradation of the tissues, owing to their having been long immersed in spirits, have got the better of me. I am, therefore, obliged to confine myself to the above external description of the portion of the creature which I saw. From its habitat, I have named it *Penella remoræ*.

On the Discovery of Paradoxides in the altered Rocks of Eastern Massachusetts. By Professor WILLIAM B. ROGERS, F.G.S., &c.

It is well known that the altered slates and gritty rocks which show themselves interruptedly throughout a good part of Eastern Massachusetts, have, with the exception of the coal measures on the confines of this state and Rhode Island, failed hitherto to furnish geologists with any fossil evidences of a Palæozoic age, although, from aspect and position, they have been *conjecturally* classed with the system of rocks belonging to that period. Indeed, the highly metamorphic condition of these beds generally, traceable, no doubt, to the great masses of igneous material by which they are traversed or inclosed, would naturally forbid the expectation of finding in them any distinguishable fossil forms.

Lately, through the kindness of Mr Peter Wainwright, who resides in the neighbourhood, I have been led to examine a quarry in the belt of siliceous and argillaceous slate, which lies on the boundary of Quincy and Braintree, about ten miles south of Boston, and, to my great surprise and delight, I have found it to be a *locality of trilobites.*

It appears that, for several years past, the owner of the quarry, Mr E. Hayward, and his family, have been aware of the existence of these so-called *images* in the rock, having from time to time quarried the stone as a ballasting material for wharves, but, until now, the locality has remained entirely unknown to science.

The fossils are in the form of casts, some of them of great size, and lying at various levels in the strata. So far as I have yet explored the quarry, they belong chiefly, if not altogether, to one species, which, on the authority of Agassiz, as well as my own comparison with Barrande's descriptions and figures, is undoubtedly a *Paradoxidis.* Of its specific affinities I will not now speak, farther than to remark that the specimens agree more closely with Barrande's *Par. spinosus* than with any other form.

As the genus *Paradoxidis* is peculiar to the lowest of the Palæozoic rocks in Bohemia, Sweden, and Great Britain, marking the *primordial* division of Barrande and the Lingula flags of the British survey, we will probably be called upon to place the fossiliferous belt of Quincy and Braintree *on or near the horizon of our lowest Palæozoic group*, that is to say, somewhere about the level of the Primal rocks, the Potsdam sandstone, and the Protozoic sandstone of Owen, containing *Dikelocephalus* in Wisconsin and Minnesota. *Thus, for the first time, are we furnished with the data for establishing conclusively the geological age of any portion of this tract of ancient and highly altered sediments*, and what gives further interest to the discovery, *for defining in regard to this region the very base of the Palæozoic column, and that, too, by the same fossil inscriptions which mark it in various parts of the Old World.*

I am satisfied that the more conspicuous fossils, at least from this locality, are identical with the *Paradoxidis Har-*

highly altered, and so contiguous to sienitic and other igneous masses, as are the fossiliferous slates of Quincy, may well encourage us to make careful search in other parts of New England, where, heretofore, such an exploration would have been deemed useless. Although we cannot hope to build up a continuous column of New England geology from the Protozoic base just established as high as the carboniferous rocks, supposing all the intervening formations to be represented in this region, we may at least succeed in determining by fossils hereafter discovered some of the principal stages in its structure, and thus be able definitely to relate its strata to the great subdivisions of our Palæozoic geology.

On the Lignites of the Giant's Causeway and the Isle of Mull. By Robert Harkness, F.R.SS.L. & E., F.G.S., Professor of Geology; and John Blyth, M.D., F.C.S., Professor of Chemistry, Queen's College, Cork. (Plate VI.)

The occurrence of lignite in connection with the igneous rocks of the north of Ireland, has long been known. Allusion is made to the circumstance in Dr Berger's memoir on the Geological features of the north-east of Ireland in the year 1816 (*Trans. Geol. Soc.*, vol. iii., p. 188), where it is stated that wood-coal has been found in seams varying from 2 inches to 4 or 5 feet in thickness, alternating with trap rocks near Ballintoy, associated with beds of wacke, underlying the upper columnar stratum in the cliffs of Portnoffer on the east of the Giant's Causeway, at Killymorris, near the centre of the basaltic area, and at Portmore and other places along the eastern shore of Lough Neagh. In the memoir, at page 177, we have a section given by Dr Richardson of the cliffs near the Causeway, which is as follows:—

	Feet.
1. Basalt rudely columnar, ...	60
*2. Red ochre or bole, ...	9
3. Basalt irregularly prismatic, . . .	60
4. Columnar basalt, ...	7

* Laterite bed.

		Feet.
5.	Intermediate between bole and basalt, .	8
6.	Coarsely columnar basalt, . . .	10
7.	Columnar basalt, the upper range of pillars at Bengore Head, ...	54
8.	Irregularly prismatic basalt,—in this bed the wacke and wood-coal of Portnoffer are situated, ...	54
9.	Columnar basalt, the stratum which forms the Causeway by its intersection with the plane of the sea, ...	44
*10.	Bole or red ochre, ...	22
11. 12. 13.	Tabular basalt, divided by seams of coal, .	80
14. 15. 16.	Tabular basalt, occasionally containing zeolite,	80

Colonel Portlock, in his report of the Geology of Londonderry, page 113, also notices the appearance of lignite in connection with basalt, and mentions that small lumps of amber are found in the pores or cells of this substance. At page 227 of the same memoir, it is stated that, at the north end of Rathlin Island, lignite occurs between two seams of indurated clay in the trap rocks.

As concerns the geological age of these basalts, and their accompanying lignite beds, their position above the chalk distinctly indicates that they are subsequent to the secondary epoch, and his Grace the Duke of Argyll was, we believe, the first to assign them a definite position among the tertiary group. At page 101 of His Grace's interesting memoir on the Ardtun leaf-beds, it is stated that "there is only one sheet of trap in the British Isles which can be identified in point of geological age with the *uppermost* basalt of Ardtun. That one sheet of trap is on the coast of Antrim, and it bears to the columnar basalts of the Giant's Causeway the same relation which I have supposed between the corresponding Ardtun beds and the basalts of Staffa." His Grace goes on to show that the position of the lignite stratum probably occupies a zone which is "similar to that of the leaf-beds of Ardtun,"

* Laterite bed.

and he regards this substance as appertaining to the same age, and as occurring in nearly similar circumstances as the leaf-beds of the Island of Mull, an age which the late Professor Forbes regarded as most probably miocene. Sir Charles Lyell, in the last edition of his Manual, is disposed to agree with the conclusions of the Duke of Argyll as to the age of the trappean out-bursts which now form the Giant's Causeway.

Having had an opportunity last summer of examining the basalts of this locality, and also the mode in which the lignite is associated with these rocks, we fully acquiesce that, so far as these are concerned, there is great affinity to the Mull beds; and if the evidence could rest upon this alone, it would justify the inference as to the contemporaneous age of the Mull leaf-beds and the Antrim lignite stratum, as this is exhibited in the section at the neighbourhood of the Giant's Causeway. The simple relations or agreement of mineral conditions is not, however, sufficient to warrant identity of age as an absolute conclusion, and we are under the necessity of seeking other evidence before a definite result can be obtained. The agreement of the organisms from these localities would be the most satisfactory means for arriving at a conclusion on this subject, but the *nature* of these from the two localities does not correspond, therefore other means must be sought for comparing the products of these localities. The lignite of the Giant's Causeway, so far as we could discover, affords no trace of foliage, while the Mull leaf-beds are well characterized by this. We have, therefore, to examine the structure of the lignite, and see if this bears any affinity to the lignite mentioned by the Duke of Argyll as found at Loch Scridden (page 95), which also belongs to the tertiary age.

On submitting a transverse section of the Giant's Causeway lignite to microscopic examination, it is found to exhibit a structure resembling coniferous wood, justifying the inference of Dr Berger as to the nature of the trees forming this substance, who states that it appears to be composed of firs; and also accounting for the presence in the pores of the amber alluded to by Colonel Portlock. The structure of the lignite of the Giant's Causeway, although decidedly coniferous, is in an

The occurrence of vegetable tissue under such circumstances is favourable for the comparison of the structure with other coniferous woods in lignites; and from this comparison, we can arrive at some degree of information concerning the affinity which these lignites have to each other.

His Grace the Duke of Argyll mentions that lignite is seen in the Isle of Mull under like conditions to those in which it presents itself at the Giant's Causeway.* This substance is stated to be so various in its nature that it passes "from a state in which it is so slightly altered that every fibre of its original structure remains, to one in which it is converted into the highly altered mineral coal." From specimens of this substance which we received through the kindness of His Grace, from the Ross of Mull, two very distinct forms of coal could be recognised. One of these was a compact, shining, bright coal, having a cubical and conchoidal fracture, and this bore a great resemblance to the moor-coal of the Germans. This was altogether devoid of structure, and presented very little traces of lamination. The other form had much more of a lignitic nature, and afforded abundant evidences of its vegetable nature, consisting of laminated masses only slightly coherent, and the faces of the laminæ exhibiting surfaces covered with woody fibre. Some of these masses of woody fibre had the silky aspect, and the loosely coherent nature, of the substance known as mineral charcoal; and when in this condition, were capable of affording sufficient evidence of the nature of the plants to which they belonged when submitted to microscopic examination. The coniferous nature of the wood was manifested by the pores lining the walls of the elongated cells; and the size and arrangement of these showed that the conifers which entered into the composition of the Mull coal had a close affinity to those which form the lignites of the Giant's Causeway. Fig. 2 exhibits the appearance which the Mull coal presents—an aspect which, as regards size of pores, and the relative distance of them from each other, justifies the inference that the lignite of the Giant's Causeway and the Mull coal have derived a

* Quart. Journ. Geo. Soc., vol. vii., p. 96.

portion of their vegetable matter from the same description of trees. The microscopic examination of the structure of these two substances corroborates the inference of His Grace the Duke of Argyll, and leads to the conclusion, that in Ireland, as well as in the Scottish Isles, we have miocene strata covered up by masses of igneous rocks, the products of miocene volcanoes.

There is another lignite of the British Isles having sufficient structure still remaining to enable us to form some knowledge of the nature of the plants which have, in part, entered into its composition. This is the deposit of vegetable matter which occurs at Bovey-Tracy, in Devonshire. Here, too, we have traces of coniferous wood in the form of mineral charcoal; and from this we can learn the nature of the pine wood which occurs in the Bovey coal. Fig. 3 exhibits the pores of the cells in this lignite, and shows how much the coniferous wood of the Bovey-Tracy lignite differs from that of the Giant's Causeway and the Isle of Mull. In the Bovey lignite the pores are of larger size than in the other forms, and they are also surrounded by a well-marked concentric ring, which serves well to distinguish this form of pine wood from the other two.

There are other features in connection with this lignite which indicate a difference in the nature and geological age of the Bovey-Tracy beds. Dr J. Hooker alludes to the occurrence of pine-cones which seem to be specifically identical with those of the *Pinus sylvestris*;* and there are many circumstances which support the inference that the lignites of this locality belong to a much more recent tertiary period than those of Mull and the Giant's Causeway.

The chemical constitution of these lignites affords important information concerning the changes which woody fibre undergoes in its conversion into coal. The Giant's Causeway lignite, when exposed to a flame, takes fire slowly, and gives out volatile products, burning with a dull, red, and very smoky flame. A portion of the powdered substance, carefully dried at 220° Fahr., and burned, with proper precautions, with chromate of lead, gave the following composition :—

* Quart. Journ. Geo. Soc., vol. xi., p. 566.

0·350 grammes gave
0·880 „ of carbonic acid.
0·160 „ of water.
0·335 grammes left on incineration an ash amounting to 0·012 grammes.

On heating a portion of the powder with soda-lime, distinct indications of ammonia were obtained, but the quantity of nitrogen was not estimated, as the average quantity of this element in coals seldom rises higher than 1·5 per cent. It is given in the following analysis, together with the oxygen. Composition calculated from the above numbers is:—

Carbon, ...	68·57
Hydrogen, ...	5·08
Oxygen and nitrogen, . .	22·77
Ash, ...	3·58
	100·00

The ash of the Giant's Causeway lignite is of a brown colour, dissolves with effervescence in hydrochloric acid, and consists chiefly of sulphuric acid, silica, alumina, iron, lime, and magnesia.

The following are the results obtained from analyses of the Mull lignite. The laminated variety contained a considerable quantity of mineral matter interspersed in the coal, either in distinct layers, or generally mixed up with the organic matter, so as to raise the percentage of the ash of this coal. When this variety is exposed to heat, either in mass or in powder, a large quantity of volatile matter is evolved, which takes fire, and burns with a lurid red smoky flame. An organic analysis of a portion dried at 220° Fahr. gave the following composition:—

0·343 grammes of substance yielded, when burned with chromate of lead,
0·855 grammes carbonic acid,
0·177 „ water.

Two grammes of the powdered substance, when carefully burned, left 0·220 grammes of ash, with very distinct indications of ammonia. The composition calculated from the above numbers is

which it dissolves with effervescence) the same constituents as the laminated variety.

In a comparison of the composition of the lignites of the Giant's Causeway and the two varieties of the Isle of Mull, it is necessary to take into consideration the large amount of ash afforded by the one form, from the latter locality, which has resulted from the mechanical intermixture of mineral with organic matter in the laminated variety. As the exact amount of matter in this ash of a mechanical origin cannot be known, a better comparison of the real percentage composition of organic matter will be obtained by deducting the ash in each case. The three analyses thus calculated exhibit the following relations:—

	Giant's Causeway lignite.	Mull lignite, laminated variety.	Mull lignite, bright variety.
Carbon, . . .	71·12	76·44	76·21
Hydrogen, . .	5·26	6·42	6·04
Oxygen and nitrogen,	23·62	17·14	17·75
	100·00	100·00	100·00

The foregoing analyses justify the conclusion of Bischoff, "that the composition of brown coal differs from that of ordinary coal, inasmuch as there is a smaller proportion of carbon, and a larger proportion of oxygen," in the former than in the latter,* since we find that the Giant's Causeway specimen is not only more woody in its nature, but that it also possesses the true elements in such relative proportion as might be expected from the comparatively small amount of decomposition which this form has undergone. The change which converts woody fibre into coal, consisting principally in the evolutions of carbonic acid gas, by means of which the proportion of carbon and hydrogen become increased, and a substitute capable of yielding a greater amount of flame is usually produced.

* Chemical and Physical Geology, vol. i., p. 266.

Description of two Tubicolar Animals. By T. STRETHILL WRIGHT, M.D., F.R.C.P.E.* (Plate VII.)

In February last I received a number of Caryophylliæ from Ilfracombe, and, on examining one of these, I found three specimens of an animal, which I am led to believe is undescribed, inhabiting the stone to which the Lithophyte was attached.

The body of the largest specimen (fig. 1, Plate VII.), when fully extended, consisted of a hollow tube or tunic about $\frac{6}{10}$ths of an inch in length by $\frac{1}{100}$th of an inch in diameter, smooth, and bearing no trace of annulose structure. Its summit was crowned by an expansion of sixty undivided tentacles, similar to those of a Polyzoan mollusc, and clothed with cilia, the motion of which presented the usual appearance of teeth moving in opposite directions on opposite sides of the tentacles. The tentacles were united at their base by a thick membrane, and were arranged in a crescent as in Polyzoa of the Hippocrepian type. The concavity of the crescent dipped downwards, and consisted of shorter tentacles, as in Plumatella.

The animal inhabited a transparent tube or cell of membranous texture, the mouth only of which could be detected, as the rest of the tube was deeply buried in the stone. Although it was frequently found extended in a remarkable degree from its cell, the slightest shock caused it to retract itself and disappear with a quick jerk within its retreat. As its posterior extremity, therefore, was never visible, it was only possible to examine part of its anatomical structure. This consisted of the alimentary system, the vascular system, the muscular system, and the integument.

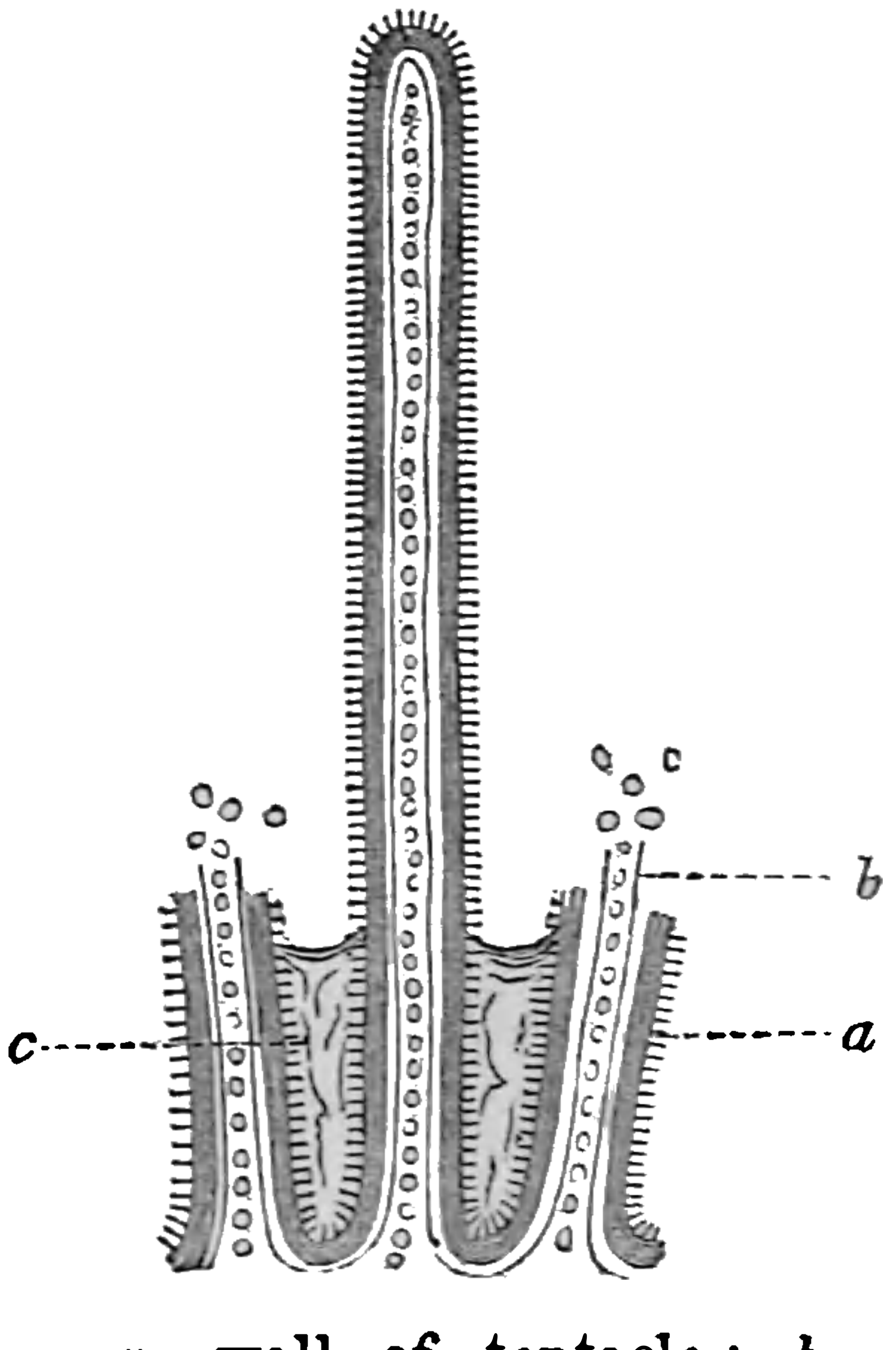
The *alimentary system* consisted, as in Plumatella, of a mouth placed within the tentacular cup, and closed by a semilunar lip or valve. The mouth opened into a long tube or gullet, which passed down the axis of the body and disappeared within the cell of the animal. The alimentary canal probably communicated there with a stomach, and then

* Communicated to the Royal Physical Society of Edinburgh, April 1856.

returned upwards to the mouth of the cell, where it again became visible as a thin membranous tube passing up the body, and terminating, as in Plumatella, in an anal orifice, situated immediately beneath the tentacular crown on its concave aspect. The mouth was generally in constant motion; and when the animal was undisturbed, ciliary action and the passage of nutritive matter were detected within the interior of the gullet, while the ejection of the peculiar fusiform fæces, which formed so striking a feature in the economy of Plumatella, was frequently observed to take place from the anal orifice.

The *vascular system* consisted, as far as could be seen, of an artery which passed up the axis of the body, in close connection with the gullet, until it arrived at the tentacular cup on its concave side; it there divided at right angles into two branches, which passed within and around the tentacular cup, and sent a capillary twig into each of the tentacles. These capillaries had distinctly contractile walls, and were loosely attached by cellular tissue to one side only of the cavity of the tentacle. (See woodcut.)

The artery pulsated rather irregularly at the rate of about fifteen beats in the minute, and at each pulsation a wave of red blood (red blood globules floating in a pale *liquor sanguinis*) passed, like a railway train, along the artery and its branches up into the very end of the hollow tentacles. The blood, after momentarily resting in the capillaries of the tentacles, was ejected from them by an undulating contraction of the walls of those vessels, and returned in a regularly-flowing stream along the venous system. The venous system was first detected as four branches, viz., one from the outside, and another from the inside, of each of the horns of the crescentic tentacular cup. The two branches on each side immediately united, and the two



a, wall of tentacle; *b*, capillary containing blood-globules; *c*, membrane uniting tentacles.

length. The long gullet terminated in a globular gizzard, the interior of which was paved with bodies apparently cartilaginous, and of prismatic shape. The gizzard communicated below with a thick walled stomach. No ascending rectum was detected; but I inferred it to exist, hidden behind the stomach, as a thin membranous tube containing fusiform fæces was observed passing upwards to the tentacular crown. The bloodvessels were displaced, and lying twisted together within the body.

These animals have been examined by the most eminent naturalists in this city, who consider that they possess great interest. They appear to me to possess characters common to the Polyzoa (*Plumatella*, *Pedicellina*), the Tunicata (in which the circulation of red blood has been noticed by Milne-Edwards), and the Annelida, in which last class they probably ought to take their place. I propose to designate the first of these animals *Phoronis* hippocrepia*, the second *Phoronis ovalis*.

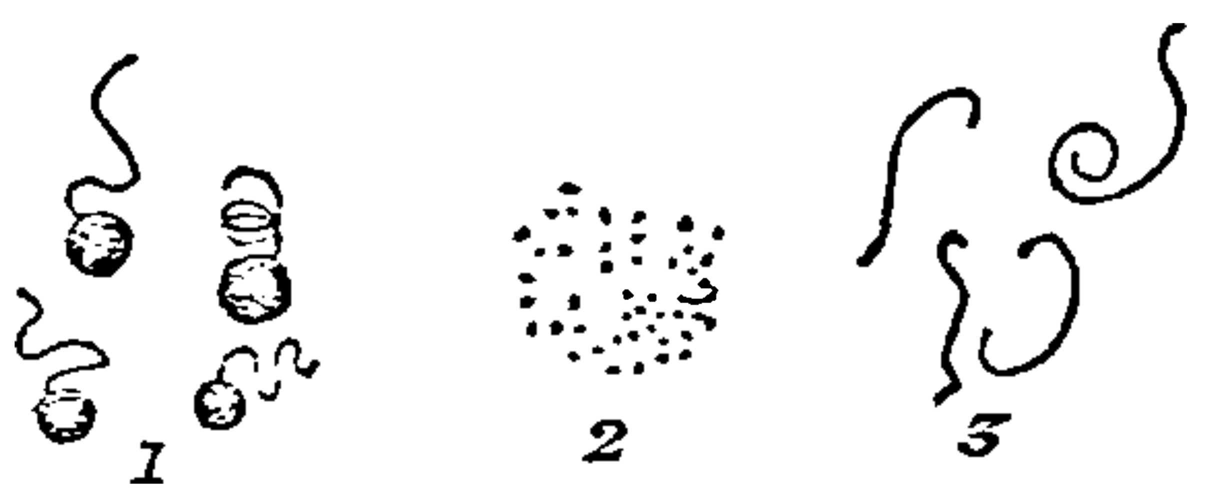
On the existence of Thread-Cells on the Tentacles of Cydippe.

By T. STRETHILL WRIGHT, M.D., &c.

In my description of the tentacles of Cydippe, contained in the last number of this Journal, I stated that their surfaces were crowded with minute thread-cells. I was therefore surprised to find it remarked by Professor Huxley (*Medical Times and Gazette*, June 21, 1856), that true thread-cells had not been observed in the Beroida, to which class Cydippe belongs. At that time the Firth of Forth was swarming with a small variety of Cydippe, distinguished by the rufous colour which tinged the bases of the tentacular cirri. The amputated tentacles of this species adhered with extreme tenacity to bodies applied to them. When examined under a power of 300 diameters, they were seen to be so closely studded with small cells, that their surface had a granular appearance. These cells were spherical, and opaque from the presence of molecular matter in their interior. When ruptured by pres-

* PHORONIS, one of the surnames of Isis.

sure, they were found to contain a simple short thread, more or less closely coiled in a spiral form. The application of distilled water burst the cell-walls and uncoiled the threads. In the annexed sketch I have shown at 1, the thread-cells burst by pressure ; at 2, the molecular matter evacuated from the cells, and which is in constant motion ; at 3, the threads uncoiled by distilled water.



On the Terraces in the Valley of the Tay, north of Dunkeld.
By H. C. Sorby, F.G.S.

Most geologists, passing up the valley of the Tay north of Dunkeld, must have observed the remains of terraces, at various elevations above the modern alluvial tract. These are seen to the best advantage on the west side of the river, for the first five or six miles, especially near Dalmarnock and Glenalbert. I shall not trespass on the valuable space of this Journal, by describing the manner of their occurrence in the various localities, but confine myself to such peculiarities in their structure as have probably not been previously taken into consideration, and which, I think, very strongly confirm the conclusions of those who have argued that such terraces were formed by the combined action of the river and sea, when it was at a relatively higher level.

In my paper on the Physical Geography of the Old Red Sandstone Sea of the Central District of Scotland, published in this Journal for January 1856,* I have briefly explained some of my conclusions respecting the determination of the direction of the currents present during the accumulation of stratified rocks. Other facts connected with the same subject are given in my papers in the Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire for 1852 and 1855, and the Report of the British Association for 1855, p. 97. The general results to which I particularly wish

* New Series, vol. iii., p. 112.

to call attention are, that when a current moves continuously in only one direction, like that of a river, the stratula of the bands of ripple-drift, or drift-bedding, though perhaps having a considerable range of variation in the direction of their dip, yet on the whole dip along a mean line only to *one* side—that towards which the current flows—as shown in fig. 1 of the paper in this journal cited above; whereas, if it move backwards and forwards—like the rise and fall of the tide—the dip of the stratula is towards *both* sides alternately, or variously mixed, according to circumstances, as seen in fig. 2. That these phenomena are the necessary effect of simple or oscillating currents, may easily be seen by examining what takes place when such structures are being formed in rivers with a current moving continuously in one direction, or when they are generated by such as move backwards and forwards alternately, as in the case of stranding waves or the rise and fall of the tide. By cutting into and examining such deposits, when laid dry, the peculiarities in their structure just described, may be seen to be the same as those in very many stratified rocks of earlier periods. Of course, much material thus deposited is often washed up again—it is a *temporary deposit*, and not a *permanent accumulation*—but when circumstances occur so that it is no longer within such disturbing influences, it is finally left and permanently accumulated, with such structures as were formed during its deposition, whether by a simple or oscillating current.

The various theories that have been propounded to account for such terraces as those under consideration may be grouped into such as would include a simple one-sided current, for instance, the operation of a river, either alone or passing through a narrow lake, or those where it would be of an oscillating character, as when the sea, with its tides, is supposed to have acted in addition. If, then, the structure of the material of which the terraces are composed be examined, according as it shows that the currents were *simple* or *oscillating*, so may we be led to adopt one or other theory to explain their formation. Applying, then, this method of inquiry to the case before us, I must state that the structure indicates that, though in some parts there was a simple current down the

an angle under half a degree, being much the same as the present fall of the river.

The above observations are indeed very limited in numbers; but so few good sections are seen, that this could not be avoided. However, as far as they go, they are so very decided in their characters, that I think they are sufficient to lead to a tolerably satisfactory general conclusion. It will be seen that, at the lower part of the district under consideration, the currents were oscillating; that, proceeding northwards up the valley, there was an excess of current down it, until at Glenalbert this predominated to the entire or almost entire exclusion of that from the opposite side. This agrees remarkably well with what would occur towards the mouth of a large tidal river. From the very nature of tidal action, the upward motion of the rising tide would be greatest near the mouth, and gradually diminish in advancing up the river, until it disappeared.* On the contrary, the river stream would be nearly constant, or even less towards the mouth, where the width and depth would probably be greater. Hence in this part there might be oscillating current action, with nearly equal quantities from each side, whilst, in advancing up the river, the relative amount in a direction down the valley would become greater and greater, until that from the opposite ceased to have any influence; which facts thus agree perfectly with the actual observations described above.

Oscillating currents are indeed also produced by the action of surface waves, as I have described in the various papers already cited; but it appears to me that those present during the formation of the terraces cannot have been due to their operation. The valley, being seldom above half a mile wide, is too narrow and confined for waves to have been formed of sufficient magnitude to act at any material depth; and, besides this, stranding waves give rise to currents oscillating in a direction more or less perpendicular to the coast, and not, as in the case before us, parallel to it. I may here also remark, that the intimately oscillating currents at the lower part, and the simple, higher up, which agree so well with the phenome-

* See Airy's Treatise on Waves and Tides, in the Encyclopædia Metropolitana, Part 36, pp. 242 and 334.

na at the mouth of a tidal river, do not appear to me at all likely to occur if the terraces had been produced by any such diluvial action as has been suggested by various authors to explain those of some other districts.

It must not be supposed that I wish to make it appear that the terraces in all other valleys are due to the same cause,—one set of circumstances may have formed some, and another set, others. Nothing, in my opinion, can be a greater obstacle to a correct interpretation of such phenomena, than to conclude that all things which appear *similar* are actually *identical*, and have had a similar origin; for each case should be investigated and judged of from its own peculiar conditions. My object has been, not to suggest any new explanation of the facts, but to show with what existing theory the characters of the current structures agree the best; and I must say that their evidence most strongly confirms the conclusion,—that the terraces in the lower part of the mountain course of the Tay were produced by the combined action of the river and a tidal sea, when the elevation of the land was such as to cause it to stand at a level corresponding to their several altitudes.

REVIEWS.

Researches on Colour-Blindness, with a Supplement, on the Danger attending the present system of Railway and Marine Coloured Signals. By George Wilson, M.D., F.R.S.E., Regius Professor of Technology in the University of Edinburgh; and Director of the Industrial Museum of Scotland.

We are not idealists. We do not subscribe to the theory, that the material universe has no existence beyond our own minds. Yet we are too well aware of the fact that its beauties receive discolouring tints from ourselves. We know that many of the works of God, which are in themselves full of harmony and loveliness, are to us discordant and unlovely, because we view them through a distorting medium. All of us lose much of the good that lies in our path, from want of the clear mental eye to see it. Every body knows this as well as we do. But there are some amongst us who do not know how much they lose from want of a clear physical eye; who, flattering themselves that their vision is like their neighbour's, grope their way through the dull monotony of life, with hardly a glimpse of the change which takes place when the bright green of spring is succeeded by the rich yellow of summer, and the red brown of autumn. These are the colour-blind. To this extreme extent of privation they indeed form a very small class, but there are vast numbers who do not fully appreciate the nice distinction between colours, and a pretty numerous class who confound colours which, to an ordinary eye, are the opposite to each other,—red and green. Happily, there is reason to believe, that this defect is more prevalent with males than with females; we say happily from selfish motives, for we are sometimes compelled to follow a lady in the streets, clad in a garment of green with a yellow shawl and blue bonnet to match, and it has occurred to us, that if all the gay dresses were thus assorted, it were well too if our eyes were colour-blind, as is most probably the case with those of the wearer. Happily, therefore, the ladies are, for the most part, both by birth and by education, better colourists than ourselves of the other sex. We wish we could include in the same category with the ladies, those whose profession is the combination of colours,—calico-printers, decorators, artists. Many of them are, unfortunately, sadly deficient in a nice appreciation of harmony in colouring, as their works prove. But we must be

cated, intelligent men, who afforded me every facility for testing their sense of colour, I soon learned what were the points of most importance in examining such cases."

After a brief introduction, in which the nature of colour-blindness and the name are successively discussed, the author proceeds to detail the results of an examination of a great number of very interesting cases, some of them investigated by himself, others by his friends, and not a few by the subjects of the defect. Amongst the last we select one example. Dr K. writes to the author thus: "When a boy at school, my attention was directed to my want of knowledge of colour, by finding I could not see what my father called the bright red berries of the holly. When other children easily found out the trees which were loaded with ripe cherries, I never could till I came so near the tree as to detect the form of the fruit. The discovery of this defect in vision distressed my father exceedingly, and he endeavoured to cultivate in me a knowledge of colour by giving me lessons in painting, making coloured charts for me of the prismatic and other colours, wishing to believe that the defect resulted from want of education in colour, not from a visual defect. I destroyed many a painting of flowers, &c., by putting on wrong colours, as blues for purples, green for some kinds of red, and yellow for others. I still remember the surprise he exhibited when he found I could not detect a red cloak spread over a hedge, across a narrow field; hedge and cloak appeared to me the same exact hue, and they do so to this day. Blue and yellow are to me the brightest of colours. Red (that is, scarlet) is to me a pleasing, sober colour, which refreshes my eye as much as green; indeed I cannot tell any difference in colour between certain shades of these. Red sealing wax and grass, for instance, are absolutely the same exact colour. Some shades of brown, green, and red, I cannot detect to be different. Prussian blue and rouge have the same hue. A rose, the lips, a ruddy complexion, and the face of a man discoloured by nitrate of silver, are to my eyes absolutely the same. Yet my eye can appreciate most delicately the various shades of all these colours, but they are all to me but shades of *one* colour, and that colour varieties of what I see in the pure deep sky or in Prussian blue—in fact blue in various dilutions.

"Red-hot coals and gamboge yellow are to me identical in colour. Infusion of red cabbage, deepened by alkalies, or reddened by acids, to me exhibits *no change of colour*, but only a greater intensity or depth of colour in the acid jar—the actual colour remains absolutely the same. I cannot detect cherries, strawberries, or the red fruits from the leaves, but by their form.

"In purchases, I have consequently made many mistakes. For instance, I bought a red dress thinking it a green one. I have, on more than one occasion, bought red and green trousers, thinking they were brown, and had to get them dyed afterwards to get them worn. In Paris I bought a red cap to wear instead of a hat, thinking it a green one; in fact, I could give very many instances of similar mistakes. The only fact which somewhat staggered me relative to phrenology was, that a phrenologist, then unknown to me, now a valued friend, asked me one day to answer him candidly whether I knew colour, as in me the bump of colour was absent. Several phrenologists who have seen my head since, have agreed as to the absence of the so-called bump.

"As to hereditary transmission I can say nothing. So far as known to me, none of my relatives had any defect in the perception of colour. My three eldest children distinguish colours accurately: it would be premature to speak of the others who are under six years.

"I believe the affection to be much more common than is imagined. In the cases where I made mistakes in purchases, the shopmen who served me could not put me right; for, knowing my defect, I always took especial care to ask what the colour was, lest I should make a blunder."

The author adds: "It is quite certain that dyers, painters, weavers, clothiers, and the members of other callings much conversant with colours, are "not unfrequently colour-blind." I myself have very recently been offered "any reasonable fee" if I would cure a worthy working tailor of almost total inability to distinguish colours. Dr K. may have encountered a similar case; for I know of cases among haberdashers and silkmercers; and on inquiring at one of the latter, who had served under a colour-blind master, and thereby had his attention directed to the matter, what became of those haberdashers who could not distinguish colours, he made the unexpected reply, "that they generally ended in mourning warehouses."

This appears like a gloomy termination, and the author acts wisely in following it up by presenting the cheerful side of the picture. This he does in the shape of a letter from an engraver, elicited by a notice sent to the Athenæum. The following extract will be read with pleasure: "Strange as it may appear, my defective vision is, to a certain extent, a useful and valuable quality. Thus an engraver has two negative colours to deal with, *i. e.*, white and black. Now, when I look at a picture, I see it only in white and black, or light and shade; and any want of harmony in the colouring of a picture is immediately made manifest by a corresponding discord in the arrangement of its light and shade, or, as artists term it, the *effect*. I find, at times, many of my brother engravers in doubt how to translate certain colours of pictures, which to me are matters of decided certainty and ease."

It becomes now an interesting question to ask, what proportion of the population are colour-blind? Thanks to the labours of

Professor Wilson and his precursors in this research, we are able to give something like an answer. The most striking and remarkable phenomenon is the confusion of red with green, such as occurred to the great chemist and philosopher Dalton. About one in fifty of the male population appear to be similarly affected. Nearly the same number confound blue with green; and only a few less confound brown with that colour; so that altogether rather more than one person in twenty is to some extent colour-blind.

We ought to add that the defect is usually congenital, though in some rare instances it has been produced by accident or disease. As might be expected, it exhibits itself largely in certain families. As it has nothing whatever of the character of an external defect, this cannot be accounted for on the principle which we presume would explain the fact recorded by the biographer of Nicholas Nickleby, in the case of Miss Squeers, whose father had lost an eye. We are told that she inherited (!) from that parent "a remarkable expression of the right eye, something akin to having none at all." The prevalence of albinism is equally difficult to account for. We are acquainted with a family in Aberdeenshire in which four out of six children are strongly marked albinos; the father and mother being both ordinary brown-haired, dark-eyed persons.

It becomes also interesting to inquire, what is the cause of colour-blindness? Does it arise from some discoloration of the eye itself? There is reason to think it does not, spite of Dalton's opinion. Or does it arise from some affection of the retina or of the brain, whereby certain colours either produce no impression at all, or at any rate produce no colour impression? There can be little difficulty in answering this question in the affirmative. We are, it is true, hardly able at the present time to give the hypothesis a perfectly defensible form, but as a first approximation, we certainly can claim a hearing for it. Suppose, for instance, we rest on the analogy between light and sound; and from the fact that certain ears are insensible to very acute sounds, assume that the eyes of the colour-blind are insensible to certain colours. For example, if an eye is insensible to the impression of red, or if it perceives that colour as a gray or neutral tint, then the light which to ordinary eyes is white, will, to this eye, which admits no red in the mixture, be tinged with the complement to red—that is, will be greenish. Green is, therefore, to such an eye, the shading or neutral tint, and is equivalent to red. On this supposition, the contrast between blue and yellow must be very marked, even more so, we should imagine, than in the case of normal vision. We may exhibit this hypothesis in another form. Suppose the action of the colour-blind eye to be such that there is a tendency in every colour to produce its complement simultaneously with itself. We should expect green and red—co-

PROCEEDINGS OF SOCIETIES.

British Association for the Advancement of Science, Cheltenham, August 5–12, 1856.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

Professor Powell on Luminous Meteors.—The report on these meteors is to be printed in full in the next volume of the Association Reports. The following are a few of the notes and letters contained in the Appendix :—

Extract from Professor C. P. Smyth's Communication.—"The meteor was apparently below the clouds, for there were thick and compact cirro-strati in all that part of the sky, shutting out all the stars, and reflecting the glare of distant ironworks; and the meteor showed no symptom of shining through this cloudy medium, for it was well defined. The clouds were such as have an altitude of four or five miles attributed to them, and exercise a very scattering effect on rays of light passing through them, and must have been composed of frozen particles. One or two stars were hazily seen through the clouds in the S. and S.W."—The next was an extract from a letter of Mrs Smyth :—"On Monday, the 7th of January 1856, as I was returning homeward from the northward with a friend, about a quarter before five o'clock P.M., my friend suddenly exclaimed, 'There is a rocket!' pointing to the southward, in the direction of the Chiltern Hills. She saw it explode at the lower end of a long and rather slanting fiery train. The sky being very clear, it was still bright daylight. Supposing it only a rocket, although a gigantic one, we resumed our conversation; but the stationary character of the train again attracted our attention, though we ascribed it chiefly to the stillness of the air. It was //, or not quite so oblique : after upwards of five minutes it gradually became less dense, as if the fiery flakes or atoms receded from each other. Then it gradually assumed the appearance of very bright small clouds at sunset, only the brightest side was turned to the eastward. Elevation of the phenomenon above the horizon at first about 35°. Length of the train about 5° : when the train became dismembered it seemed to have risen higher in the atmosphere by about 10°."—The next was an extract of a letter from E. J. Low, Esq., respecting a meteor seen at Highfield House on the 19th of December 1855, at 6^h 13^m A.M., accompanied by five sketches of the successive appearances of the train of the meteor. It was first seen in the N.N.W., moving towards the west. At first it more closely resembled a brilliant flash of lightning than a meteor. The train was like a comet, with parallel sides. When first seen it was not far from the position of H 17 Camelopardi, and moving downwards to midway between Capella and μ Persei. The size was about the apparent diameter of the moon. There was no noise of explosion heard. After the meteor itself had vanished, a belt of light, similar to that of a comet's tail, was visible along the whole path of the meteor. This gradually became less bright, and expanded in breadth after a short time ; the lower portion became curved towards the east. This curving gradually increased until finally it assumed the form of a nearly circular band, not quite closed at the upper part. The upper portion never moved its position in the heavens. Finally, on breaking up, the base of the circle disappeared first. It was visible fully ten minutes. A falling star, of about the first magnitude, crossed over the band horizontally from W. to E., near Capella, and moving towards ϵ Cassiopeiæ. The night was cloudless, with a cutting E.S.E. wind.—No. 6 in the Appendix is an extract from a letter of E. J. Low, Esq., from the Observatory, Beeston, near Nottingham, dated July 25, 1856:—"From the appearances presented in the several large meteors seen at the end of last and at the beginning of this year, it appears evident to me that these bodies are *not self-luminous*—the light seems to be *owing* to the meteor instead of being the light *of the meteor*. Probably the great speed causes a peculiar property of the upper regions to ignite, at the instant of ignition being an intense blaze, and then subsiding into a phosphorescent flame, which may linger for a length of time, and be wafted along by currents of air, as was the case in several instances. In the case of the meteor of December 19, 1855, it moved over $18\frac{1}{2}°$ in less than a second of time. It cannot, therefore, be supposed that the meteor itself could be within 5° of this path ten minutes afterwards. Now, if we suppose the meteor burst at this point (which to me seems improbable), it must have burst in a medium where light could shine; and if so, it is as easy to suppose some substance could be ignited as that the meteor itself should blaze: the intensity of the light is too great for reflected light."—*Athenæum.*

On a Model of a Self-Registering Anemometer, designed and constructed by Mr R. Beckley, of Kew Observatory. Described by Mr Welsh.—In this model Mr Beckley has adopted Dr Robinson's method of measuring the velocity of the wind by the rotation of a system of hemispherical cups, the direction being indicated by a double wheel-fan like the directing-vane at the back of a windmill. A stout tubular support carries the whole of the external part of the instrument, including the measurer of velocity, the direction-vane, and a rain-gauge. This support is so made that it can be easily adapted to the roof of any building upon which it may be necessary to mount it. All the rotatory parts of the anemometer run upon friction balls. The shaft of the apparatus for measuring the movement of the wind, by means of a diminishing train of wheels, is made to turn a cylinder, upon which is wrapped a sheet of paper of the kind used for "metallic memorandum books," this paper having the property of receiving a trace from a style of brass. The sheet of paper is divided into two sections, upon one of which is recorded the motion of the wind, and upon the other the direction. As the cylinder is being turned by the action of the wind, a clock carries a pencil along the cylinder at a uniform rate of 12 inches in the twenty-four hours. To the lower end of the direction-shaft is attached a spiral of such a figure that equal angles correspond to equal increments of radius; the edge of this spiral consists of a thin slip of brass, which touches the paper and records the direction of the wind on a rectilinear scale. When the sheet of paper is unwrapped from the cylinder after twenty-four hours, the motion of the wind and the direction are both found projected in rectangular co-ordinates. The author also stated that as it was well known to be difficult, if not impossible, by any method at present in use to judge of the true direction of the wind when in a ship moving swiftly at sea, the method suggested in the following extract of a letter will be found effectual:—"By means of a portable Robinson's anemometer, provided with a means of observing the total number of turns made by the rotating part in any given time, observe the *apparent* velocity of the wind, and record it in knots per hour. By an anemoscope of any kind register the *apparent* direction of the wind. From the log-book take the rate and direction of the ship's motion. On a slate or other similar surface *scratch* a permanent compass circle. Set off from the centre of the circle, or the radius of the direction of the ship's head, by any convenient scale, the number of knots per hour the ship is going; from this point draw a pencil line parallel to the direction of the wind as observed by the anemoscope (*i.e.*, the *apparent* direction *to* which the wind is *going*); set off on this line the number of knots per hour as shown by the anemometer; draw a line from the centre of the circle to this last point. The length of this line by the scale adopted gives the *true* velocity of the wind, and its direction (carried backwards) shows the point *from* which the wind is *coming*. A parallel ruler divided on the edge is all that is required besides the slate. It would be easy enough to contrive some mechanism to save the trouble of drawing lines; but it would not, I believe, be any real simplification, and would increase the expense. The train of indicating wheels might be so arranged that they at once indicate knots per hour without reference to tables, and can be readily set to zero for a fresh observation."—*Athenæum.*

On the Law of Electrical and Magnetic Force. By Sir W. S. HARRIS. —The author prefaced the exposition of the views he himself had adopted, after a lifetime of experimental research on the subject, by stating that the discovery of the beautiful and comprehensive law of universal gravitation by Newton had predisposed all physical inquirers to entertain the notion that every other force associated with ordinary matter was subject to a similar law. The author then went on to illustrate the law of the inverse square of the distance as applicable to forces emanating from one central point and to other emanations from a centre, and to point out how far this might safely be relied upon as applicable to the electrical and magnetic forces of attraction and repulsion, and stated that the object of the present communication, which the author submitted with all due diffidence, was to investigate the physical condition under which these forces manifest themselves,—what are the general laws of the operation of such forces,—how far we may safely consider them as central forces, such as gravity, or whether they are to be considered more in the light of parallel forces, distinctive in their character and in all their relations to common matter, and in the elementary conditions of their character. He then pointed out one, in particular, essentially distinctive character of these forces. In gravitation, the attracted body, as far as we can observe, remains in the same physical condition before and during all the changes of distance and force to which the bodies are mutually subjected. But in the electrical and magnetic phenomena of attraction and of repulsion, supposing it in a distinctive sense to exist, the very first step was, that the body acted upon had its physical condition changed; and this change again, by a kind of reflex influence, affected what had been the instant before the physical condition of the body producing the change; and thus, during the action and its changes, new physical conditions of both had to be investigated and taken into consideration, if we wish truly to interpret the facts. The author then proceeded to illustrate the truth and importance of these general views, and concluded his memoir by showing with what caution the results of the experiments of Coulomb, with the proof plane and balance of torsion, although in themselves statements of most certain facts, which do and must manifest themselves, should be applied as they have been by mathematicians to establish deductions from theories, the very basis of which assumes the bodies to be in such very different physical conditions from those which, when we duly consider them, obtain in nature during the progress of these very phenomena.—*Athenæum.*

On the Tides of Nova Scotia. By Professor CHEVALLIER.—The observations to which reference is made were taken by a tide-gauge fixed upon a wharf at the north end of the naval yard at Halifax. The tides there are small in amount, the spring-tides rising from 6½ to 9 feet at Halifax, and 8 feet at Sambro Isle, 12 miles south of that place.

property whereby certain bodies appear of a different colour, according to the quantity seen through. It depends generally on the less rapid absorption of the red ray as it penetrates a substance. A dichromatic solution was examined by placing it in a wedge-shaped glass trough, held in such a position that a slit in a window-shutter was seen traversing the varying thicknesses of the liquid. The diversely coloured line of light thus produced was analyzed by a prism, and the resulting spectrum was represented in a diagram by means of coloured chalks on black paper, the true position of the apparent colours being determined by the fixed lines of the spectrum. In this way the citrate and comenamate of iron, sulphate of indigo, litmus in various conditions, cochineal, and chromium, and cobalt salts, were examined and represented. Among the more notable results were the following:—A base, such as chromic oxide, produces very nearly the same spectral image with whatever acid it may be combined, although the salts may appear very different in colour to the unaided eye. Citrate of iron appears green, brown, or red, according to the quantity seen through. It transmits the red ray most easily, then the orange, then the green, which covers the space usually occupied by the yellow; it cut off entirely the more refrangible half of the spectrum. Neutral litmus appears blue or red, according to the strength or depth of the solution. Alkalies cause a great development of the blue ray; acids cause a like increase of the orange, while the minimum of luminosity is altered to a position much nearer the blue. Boracic acid causes a development of the violet. Alkaline litmus was exhibited so strong, that it appeared red, and slightly acid litmus so dilute that it looked bluish-purple; indeed, on account of the easy transmissibility of the orange ray through an acid solution, the apparent paradox was maintained that a large amount of alkaline litmus is of a purer red than acid litmus itself. Another kind of dichromatism was examined, dependent not on the actual quantity of coloured material, but on the relative proportion of the solvent. Diagrams of the changing appearances of sulphocyanide of iron, of chloride of copper, and of chloride of cobalt were exhibited.—*Athenæum.*

On Ozonometers.—Dr Lee made some remarks upon a pamphlet recently printed by Dr Herbert Barker of Bedford, on the relative value of the ozonometers of Dr Schönbein and Dr Moffat, based upon daily observations made for eighteen months at Bedford, and drew the attention of the audience to the following points:—1. Whether ozone observations have generally been conducted by them in their meteorological observations? 2. Whether they use Schönbein's or Moffat's test papers, or both? 3. Whether they have noticed the difference between those which the Bedford observations and those at Hartwell House Observatory indicate? 4. Whether they will without delay add the ozonometer to their staff of instruments, as so much interest and importance belongs to this mysterious agent, which is carrying on its, at present, incomprehensible effects on the atmosphere, in order that they may be recorded?—*Athenæum.*

The Law of the Squares—is it applicable or not to the Transmission of Signals in Submarine Circuits? By Mr E. O. W. Whitehouse.—Before proceeding to the consideration of this subject, the author wished to explain, with reference to his paper read on a previous day, that it was for the purpose of determining the force of either intermitting or alternating currents, whose duration was not sufficient to admit of the needle assuming a position of rest, that he proposed the use of the magneto-electrometer—an instrument rendering available the force of magnetic attraction instead of the deflection of the needle—as a means of measuring the amount of current circulating. This force was, he said, until we approach the point of magnetic saturation of the iron, strictly proportioned to the energy of the current under examination. The number of grains thus lifted on the arm of the lever, the author proposes to call the practical "value" of the current for telegraphic purposes. The most striking features of this instrument are—1*st*, the facility of determining the value of currents which do not admit of being tried by the galvanometer; 2*d*, the very great range which this instrument has (viz., from unity up to half a million), as well as the definiteness and accuracy of the results, even the extremes of the register being strictly comparable with each other; 3*d*, unlike the degrees upon the galvanometer, these grains of force are units of real "value" and of practical utility, as was shown by a telegraphic instrument in circuit being worked perfectly by a current of four grains. Referring to the proceedings of this section last year at Glasgow, the author quoted Professor W. Thomson's paper on this subject, where he stated "that a part of the theory communicated by himself to the Royal Society last May, and published in the Proceedings, shows that a wire of six times the length of the Varna and Balaklava wire, if of the same lateral dimensions, would give thirty-six times the retardation, and thirty-six times the slowness of action. If the distinctness of utterance and rapidity of action practicable with the Varna and Balaklava wire are only such as not to be inconvenient, it would be necessary to have a wire of six times the diameter, or better thirty-six wires of the same dimensions, or a larger number of small wires twisted together, under a gutta-percha covering, to give tolerably convenient action by a submarine cable of six times the length." The author then stated that circumstances had enabled him to make very recently a long series of experiments upon this point, the results of which he proposed to lay before the section, adding, that an opportunity still existed for repeating these experiments upon a portion of cable to which he could obtain access, and that he was ready to show them, before a committee of this section in London, if the important nature of the subject should seem to render such a course desirable. Although the subject of submarine telegraphy had many points of the highest importance requiring investigation, and to the consideration of which he had been devoting himself recently, Mr Whitehouse proposed to confine his remarks on this occasion to the one point indicated in the title, inasmuch as the decision of that one, either favourably or otherwise, would have, on the one hand, the effect of putting a very narrow limit to our progress in telegraphy, or, on the other, of leaving it the most ample scope. He drew a distinction between the mere transmission of a current across the Atlantic (the possibility of which he supposed everybody must admit), and the effectual working of a telegraph at a speed sufficient for "commercial success;" and we gathered from his remarks that there were those ready to embark in the undertaking as soon as the possibility of "commercial success" was demonstrated. The author then gave a description of the apparatus employed in his researches, of the manner in which the experiments were conducted, and, lastly, of the results obtained. The wires upon which the experiments were made were copper, of No. 16 gauge, very perfectly insulated with gutta-percha, spun into two cables, containing three wires of equal length (83 miles), covered with iron wires and coiled in a large tank in full contact with moist earth, but not submerged. The two cables were subsequently joined together, making a length of 166 miles of cable, containing three wires. In addition to this, in some of the latest experiments, he had also the advantage of another length of cable, giving, with the above, an aggregate of 1020 miles. The instruments, one of which was exhibited, seemed to be of great delicacy, capable of the utmost nicety of adjustment, and particularly free from sources of error. The records were all made automatically, by electro-chemical decomposition, on chemically-prepared paper. The observations of different distances recorded themselves upon the same slip of paper,—thus, 0·83 and 249 miles were imprinted upon one paper, 0·83, 498 miles upon another slip, 0·249, 498 upon another, and 0·535, 1020 upon another. Thus, by the juxtaposition of the several simultaneous records on each slip, as well as by the comparison of one slip with another, the author has been enabled to show most convincingly that the law of the squares is not the law which governs the transmission of signals in submarine circuits. Mr Whitehouse showed next, by reference to published experiments of Faraday and Wheatstone (*Philosophical Magazine*, July 1855), that the effect of the iron covering with which the cable was surrounded was, electrically speaking, identical with that which would have resulted from submerging the wire, and that the results of the experiments could not on that point be deemed otherwise than reliable. The author next addressed himself to the objections raised against conclusions drawn from experiments on "multiple" cables. Faraday had experimented, he said, upon wires laid in close juxtaposition, and with reliable results; but an appeal was made to direct experiment, and the amount of induction from wire to wire was weighed, and proved to be as one to ten thousand, and it was found impossible to vary the amount of retardation by any variation in the arrangement of the wires. Testimony, also, on this point was not wanting. The director of the Black Sea Telegraph, Lieut.-Col. Biddulph, was in England, and present at many of the experiments. He confirmed the author's view, adding, "that there was quite as much induction and embarrassment of instruments in this cable as he had met with in the Black Sea line." The author considers it, therefore, proved "that experiments upon such a cable, fairly and cautiously conducted, may be regarded as real practical tests, and the results obtained as a fair sample of what will ultimately be found to hold good practically in lines laid out *in extenso*. At the head of each column in the annexed table is stated the number of observations upon which the result given was computed,—every observation being rejected on which there could fall a suspicion of carelessness, inaccuracy, or uncertainty as to the precise conditions; and, on the other hand, every one which was retained being carefully measured to the hundredth part of a second. The table is subject to correction, for variation in the state of the battery employed, just as the barometrical observations are subject to correction for temperature. Of this variation as a source of error I am quite aware, but I am not yet in possession of facts enough to supply me with the exact amount of correction required. I prefer, therefore, to let the results stand without correction.

Amount of Retardation observed at various Distances. Voltaic Current. Time stated in parts of a Second.

Mean of 550 observations.	Mean of 110 observations.	Mean of 1840 observations.	Mean of 1960 observations.	Mean of 120 simultaneous observations.	
83 miles	166 miles	249 miles	498 miles	535 miles	1020 miles
·08	·14	·36	·79	·74	1·42

Now it needs no long examination of this table to find that we have the retardation following an increasing ratio, that increase being very little beyond the simple arithmetical ratio. I am quite prepared to admit the possibility of an amount of error having crept into these figures in spite of my precautions; indeed, I have on that account been anxious to

well known to all who have ever handled colours; and it is universally admitted that blue and yellow make green. Red, yellow, and blue being the primary colours among painters, green is regarded as a secondary colour, arising from the mixture of blue and yellow. Newton, however, found that the green of the spectrum was not the same thing as the mixture of two colours of the spectrum, for such a mixture could be separated by the prism, while the green of the spectrum resisted further decomposition. But still it was believed that yellow and blue would make a green, though not that of the spectrum. As far as I am aware, the first experiment on the subject is that of M. Plateau, who, before 1819, made a disc with alternate sectors of Prussian blue and gamboge, and observed that, when spinning, the resultant tint was not green, but a neutral grey, inclining sometimes to yellow or blue, but never to green. Professor J. D. Forbes, of Edinburgh, made similar experiments in 1849, with the same result. Professor Helmholtz, of Konigsberg, to whom we owe the most complete investigation on visible colour, has given the true explanation of this phenomenon. The result of mixing two coloured powders is not by any means the same as mixing the beams of light which flow from each separately. In the latter case we receive all the light which comes either from the one powder or the other. In the former, much of the light coming from one powder falls on a particle of the other, and we receive only that portion which has escaped absorption by one or other. Thus, the light coming from a mixture of blue and yellow powder, consists partly of light coming directly from blue particles or yellow particles, and partly of light acted on by both blue and yellow particles. This latter light is green, since the blue stops the red, yellow, and orange, and the yellow stops the blue and violet. I have made experiments on the mixture of blue and yellow *light*—by rapid rotation, by combined reflexion and transmission, by viewing them out of a focus, in stripes, at a great distance, by throwing the colours of the spectrum on a screen, and by receiving them into the eye directly; and I have arranged a portable apparatus by which any one may see the result of this or any other mixture of the colours of the spectrum. In all these cases blue and yellow do *not* make green. I have also made experiments on the mixture of coloured powders. Those which I used principally were "mineral blue" (from copper) and "chrome yellow." Other blue and yellow pigments gave curious results, but it was more difficult to make the mixtures, and the greens were less uniform in tint. The mixtures of these colours were made by weight, and were painted on discs of paper, which were afterwards treated in the manner described in my paper "On Colour as perceived by the Eye," in the *Transactions of the Royal Society of Edinburgh*, Vol. xxi., Part ii. The visible effect of the colour is estimated in terms of the standard-coloured papers:—vermilion (V), ultramarine (U), and emerald green (E). The accuracy of the results, and their significance, can be best understood by referring to the paper before mentioned. I shall denote mineral blue by B, and chrome yellow by Y; and $B_3\ Y_5$ means a mixture of three parts blue and five parts yellow.

Given Colour.			Standard Colours. V.	U.	E.		Co-efficient.
B_8	100	=	2	36	7	....	45
$B_7\ Y_1$	100	=	1	18	17	....	37
$B_6\ Y_2$	100	=	4	11	34	....	49
$B_5\ Y_3$	100	=	9	5	40	....	54
$B_4\ Y_4$	100	=	15	1	40	....	56
$B_3\ Y_5$	100	=	22	−2	44	....	64
$B_2\ Y_6$	100	=	35	−10	51	....	76
$B_1\ Y_7$	100	=	64	−19	64	....	109
Y_8	100	=	180	−27	124	....	277

—The columns V., U., E. give the proportions of the standard colours, which are equivalent to 100 of the given colour; and the sum of V., U., E. gives a coefficient which gives a general idea of the brightness. It will be seen that the first admixture of yellow *diminishes* the brightness of the blue. The negative values of U indicate that a mixture of V., U., and E. cannot be made equivalent to the given colour. The experiments from which these results were taken had the negative values transferred to the other side of the equation. They were all made by means of the colour-top, and were verified by repetition at different times. It may be necessary to remark, in conclusion, with reference to the mode of registering visible colours in terms of three arbitrary standard colours, that it proceeds upon that theory of three primary elements in the sensation of colour, which treats the investigation of the laws of visible colour as a branch of human physiology, incapable of being deduced from the laws of light itself, as set forth in physical optics. It takes advantage of the methods of optics to study vision itself,—and its appeal is not to physical principles, but to our consciousness of our own sensations.—*Athenæum.*

On the Unequal Sensibility of the Foramen Centrale *to Light of Different Colours.* By Prof. J. C. Maxwell.—When observing the spectrum formed by looking at a long vertical slit through a simple prism, I noticed an elongated dark spot running up and down in the blue, and following the motion of the eye as it moved *up and down* the spectrum, but refusing to pass out of the blue into the other colours. It was plain that the spot belonged both to the eye and to the blue part of the spectrum. The result to which I have come is, that the appearance is due to the yellow spot on the retina, commonly called the *Foramen Centrale* of Soemmering. The most convenient method of observing the spot is by presenting to the eye, in not too rapid succession, blue and yellow glasses, or, still better, allowing blue and yellow papers to revolve slowly before the eye. In this way the spot is seen to fade away in time, and to be renewed every time the yellow comes in to relieve the effect of the blue. By using a Nicol's prism along with this apparatus the brushes of Haidinger are well seen in connection with the spot, and the fact of the brushes being the spot analyzed by polarized light becomes evident. If we look steadily at an object behind a series of bright bars which move in front of it, we shall see a curious bending of the bars as they come up to the place of the yellow spot. The part which comes over the spot seems to start in advance of the rest of the bar, and this would seem to indicate a greater rapidity of sensation at the yellow spot than in the surrounding retina. But I find the experiment difficult, and I hope for better results from more accurate observers.—*Athenæum.*

Section C.—GEOLOGY.

On a Fossil Mammal (Stereognathus ooliticus) *from the Stonesfield Slate.* By Professor Owen.—Professor Owen exhibited, by favour of the Rev. J. P. B. Dennis, M.A., a portion of a lower jaw, with three molar teeth, of a small mammal, from the oolitic slate of Stonesfield, Oxfordshire, for which the name of *Stereognathus ooliticus* had been proposed; and after a minute description of the characters of the bone and teeth, he entered upon the question of its probable affinities. These could only be judged of by the peculiarities of certain molar teeth of the lower jaw of the unique fossil. Those teeth presented the singular complexity of six cusps or cones upon the grinding surface, in three longitudinal pairs, the crown of the tooth being quadrate, broadest transversely, but very short or *low.* The jaw-bone presents a corresponding shallowness and thickness. The cusps are subcompressed: the outermost and innermost of the three hinder ones are oblique, and converge towards the middle of the crown, being overlapped by the outermost and innermost of the three front cones. The three molar teeth occupy the extent of 4½ lines, or 1 centimetre: each tooth being 3 millimetres in fore and aft extent, and nearly 4 millimetres in transverse extent. After a comparison of these molars with the multicuspic teeth of the rat, the hedgehog, the shrews and Galeopitheci, the author showed that the proportions, numbers, and arrangement of the cusps in those Insectivora forbad a reference of the Stereognathus, on dental grounds, to that order. The same negative result followed a comparison of the fossil with the sexcuspid teeth of the young Manatee. The author finally proceeded to point out closer resemblances to the sexcuspid teeth of the oolitic mammal in the eocene Hyracothere, Microthere and Hyopotamus; but in these the resemblance was presented only by the teeth of the upper jaw. The lower molar teeth of the Choeropotamus, to which the author deemed those of the Hyracotherium would most closely approximate, when discovered, showed a rudiment of the intermediate cones between the normal pairs of cones. The proportional size and regularity of the form of the cones of the grinding teeth of the Stereognathus give a quite different character of the crown from that of the multicuspid molars of the Insectivora, and cause the sexcuspid crown of the oolitic mammal to resemble the pentecuspid and quadricuspid molars of the before-cited extinct Artiodactyle genera. Professor Owen concluded, therefore, that the Stereognathus was most probably a diminutive form of non-ruminant Artiodactyle, of omnivorous habits.—*Athenæum.*

On the Dichodon cuspidatus, *from the Upper Eocene of the Isle of Wight and Hordwell, Hants.* By Professor Owen.—Professor Owen communicated the results of examinations of additional specimens of jaws and teeth of the *Dichodon cuspidatus*, which he had received since his original Memoirs on that extinct animal in the "Quarterly Journal of the Geological Society," vol. iv., (June 1847). The first specimen described supplied the characters of the last true molar tooth of the lower jaw, which had not been previously known. This tooth has six lobes, the additional posterior pair being less than the normal ones, and more simple. The inner surface of the inner lobe has an accessory cusp at the back part of its base, but not at the fore part, as in the other lobes. The length of the last lower molar was nine lines, that of the first and second molars being each six lines. A specimen of the *Dichodon cuspidatus* from the Hordwell Sands, in the British Museum, supplied the characters of the permanent incisors, canine, and three anterior premolars of the upper jaw; all these teeth closely correspond in form with the corresponding deciduous teeth, but are of larger size. Finally, a portion of the lower jaw of an aged specimen of Dichodon, in the British Museum, showing the effects of attrition on the last molar tooth, was described, and the results of this additional evidence confirmed the conclusions of the author as to the generic distinction of the Dichodon.—*Athenæum.*

On the Magnesian Limestone having been produced by the Metamorphism of an ordinary Calcareous Deposit. By Mr H. C. Sorby.—The author first showed that, in some cases, ordinary calcareous limestone had been unquestionably changed into dolomite, and that the microscopical structure of the Peruvian limestone indicates that it was also originally non-magnesian. Various authors have proved that soluble magnesian salts can effect this change; and since the formation of rock salt and gypsum in the superjacent strata, by the evaporation of sea-water, would give rise to a strong solution of magnesian salts, the author contended that the same conditions that would account for the occurrence of those

author produced recent bivalve shells, in a closed condition, completely filled with recent sponges of the same species as the sponges of commerce. The loose specimens of the fossil sponges included in the Wiltshire flints were explained on the principle that, although sponges of the same species readily adhere to each other when placed in contact, those of different species never unite, however closely they may be pressed together. The author concluded his paper by applying the same principles to the siliceous deposits of the whole of the geological formations which were of aqueous origin.—*Athenæum.*

Report on Fossils from the Crimea. By Mr William H. Baily, Geological Survey of Great Britain.—The fossils which formed the subject of this communication belong, with one exception, to the Invertebrata, and were principally collected in the southern part of the Crimea, by Captain C. F. Cockburn, of the Royal Artillery. They comprise a series from the monastery of St George and gorge of Iphigenia, consisting of fossils from the Jurassic and oldest deposits; also others from the tertiaries resting immediately upon them; and from the volcanic or eruptive rocks which have disturbed and broken up some of these strata, together with a set of well-preserved newer tertiary mollusca from the Quarantine Harbour. The Museum of Practical Geology has also received from Major Cooke, of the Royal Engineers, a suite of somewhat similar forms of Steppe limestone fossils from the Redan and near the dockyard of Sevastopol, and some interesting Jurassic Brachiopoda from Balaklava. It possesses also from Lieutenant-Colonel Munro and Lieutenant-Colonel Charles Lygon Cocks, of the Coldstream Guards, other specimens of the steppe limestone containing fossils, obtained from the ground before Sevastopol, upon which the allied armies were encamped, and volcanic and mineral specimens from the sea-coast.

These instructive collections, including a series of fossils from the various strata of the Crimea, formerly presented by the Imperial School of Mines at St Petersburgh, enables us to add to the published lists of fossils from that country seventy-four species.

The geology of this peninsula having been described in detail by M. Du Bois de Montpereaux, M. Huot in the work of Demidoff, M. Hommaire de Hell, and by Sir R. I. Murchison and M. De Verneuil in the Geology of Russia and the Ural Mountains, a slight sketch of the formations represented in that country only is necessary before proceeding to the remarks upon the fossils.

The most ancient deposits of the Crimea are those at the base of the Jurassic formation, described as black schists, composed of hard, soft, and ferruginous beds, which are probably equivalent to the trias or New Red Sandstone appearing in the valley of Baidar and other localities, and on the coast where they are superimposed by the Lias. Overlying the schists of the Lias are the *Jurassic* rocks, which extend along the southern sea-coast from Balaklava to the vicinity of Theodosia or Kaffa, a length of about 100 miles. This mountain-chain of hard and crystalline limestones, pierced and broken into by volcanic eruptions of greenstone, porphyry, &c., is, with its associated strata, analogous to that of the Caucasus, and proceeds in a direction E.N.E. to S.S.W., its highest point being the Tchatir Dagh or Tent Mountain, of an elevation of 5135 feet. The Bay of Balaklava is inclosed on both sides by steep and rugged rocks of the Jurassic formation, composed of compact red and gray limestones, in which are clefts filled with a reddish clay. These limestones and clays contain numerous organic remains, the most abundant of which are corals, and Echinodermata.

At the foot of the chain towards the north, the lower division of the *cretaceous* series or "*Neocomien,*" may be well observed, its horizontal beds resting unconformably either upon the Jurassic limestones, or upon the shales at their base, the intermediate subdivision being absent. Upon these beds repose the *upper cretaceous*, composed of shales (probably equivalent to the *Gault*) *upper greensand, chalk marl, and white chalk.* On the eastern coast the Hippuritic and Sennonian subdivisions rest immediately on the disturbed Jurassic beds, the intermediate subdivisions being absent. The *cretaceous* series formation does not occupy much space in the Crimea, being inclosed between the *Nummulitic* deposits and the *Jurassic* limestone, taking the same direction, and extending from Kaffa to Cape Chersonese on the S.W. coast. The soft calcareous rock of Inkermann, from which the beautiful white stone used in constructing most of the public buildings of Sevastopol was obtained, is very easily worked, but becomes harder and more durable by exposure to the atmosphere. From comparison of its fossils, it appears to be identical with the upper chalk.

The *Lower Tertiary* or *Eocene* is represented by the nummulitic formation, which, like the cretaceous series, is elevated by the mountainous region of the coast, and disposed in long bands following its contour. This formation commences in the environs of Theodosia, continuing to the north, near to Karas-ubazar, Simferopol, and Baktchi Serai, terminating at the south-west coast near Sevastopol.

The *Upper Tertiary* formation includes the older and newer Caspian or steppe limestone, the former of which subdivisions, or older Caspian, occupies the northern and greater portion of the peninsula at Eupatoria, Sevastopol, &c., including the chief limestones round Kertch, and the deposits of the cliffs of Kamiesch, Boroun, and Taman. These limestones and sands, associated in some localities with volcanic ashes, tufa, &c., occur in various conditions as shelly and oolitic limestones of marine and fresh-water origin, being more or less fossiliferous. The Heracleotic Chersonesus is, as it were, a shred of the steppe limestone; the Bay of Sevastopol exhibiting a succession of formations from the most recent of these tertiaries through the nummulitic limestone and chalk. The *newer Caspian* occupies the still more northern extremity of the Crimea, extending to Perekop, Kherson, and the shores of the Sea of Azof. The environs of Kertch and Taman are the most favourable localities to observe its characters, and here the fossils are in good preservation. The existence of coal has been often rumoured; but on examination the supposed coal has proved to be lignite of very ordinary quality.

Deposits of hydrate and phosphate of iron have been met with near to Kertch, Taman, and other parts of the Crimea. A foundry was formerly established near Kertch, and the iron was worked by M. Gourieff. From an analysis by Hussein Effendi, of the Government School of Mines, it gave but 19·234 per cent.

After describing the new species, the following summary of fossils collected from each formation was read, viz.:—

LOWER SECONDARY—*Jurassic group.*

	Known species.	New species.	Total.
Amorphozoa	0	1	1
Zoophyta	10	0	10
Echinodermata	4 ?	?	9
Mollusca, Brachiopoda	7	4	11
Conchifera	6	2	8
Gasteropoda	1	1	2
Cephalopoda	15	0	15
	43	8	56

	Known species.	New species.	Total.
UPPER SECONDARY—*Cretaceous group.*			
Amorphozoa,	5		
Zoophyta,	11		
Echinodermata,	9		
Polyzoa,	8		
Brachiopoda,	14		
Conchifera,	49		
Gasteropoda,	9		
Cephalopoda,	19		
Total,	—		124
OLDER TERTIARY—*Nummulitic.*			
Foraminifera,	2		
Echinodermata,	3		
Conchifera,	8		
Gasteropoda,	10		
Total,	—		23
NEWER TERTIARY—" Falunian" (D'Orbigny).			
Amorphozoa,	0	2	
Conchifera,	27	30	
Gasteropoda,	19	34	
	46	66	112

Species before described,	236	Total number of species collected,	320
New species,	74		

Remarks on the Fossils.

On referring to the table of *Jurassic fossils*, it was shown that the most numerous classes represented in the Crimea from that formation are the *Zoophyta*, *Brachiopoda*, and *Cephalopoda*—the *Conchifera* and *Gasteropoda* being the fewest. In the lowest class, the *Amorphozoa*—a group of rare occurrence in this formation—a new form of sponge has been collected by Capt. Cockburn, from the red Jurassic limestone near the Monastery of St George. Of the *Zoophyta*, nearly all the specimens received have been identified with species found in the coralline and inferior oolite of this country. The *Echinodermata* are principally spines belonging to the genus Cidaris; with these are joints of crinoids (apiocrinites) from near Balaklava, and portions of stems of pentacrinites from the interior of the Crimea. Of the *Brachiopoda*, the characteristic Lias species, *Terebratula numismatis*, has been obtained from Woronzoff Road. Four are new species—two of those belonging to the genus Rhynchonella; others of the same genus have been identified with inferior oolite and marlstone species. In the Lias shales of the Woronzoff Road were found several specimens of a bivalve, identified with *Astarte complanata* (Roemer), together with a new form of Cardinea, allied to an inferior oolite species. The *Gasteropoda* are represented only by a large species of Natica from the Red limestone near the Monastery of St George, and a fragment of Nerinea, probably *N. grandis*, from the village Djanatai. The *Cephalopoda*, of which the ammonites belong mostly to the fimbriated group, have been described by M. D'Orbigny, together with one species of belemnites from Kobsel and Biasali.

In the list of cretaceous fossils are included those mentioned by M. Du Bois de Montperaux in his table of fossils from the *Neocomian* to the chalk found at Baktchi Serai; from the Neocomian of that locality he tabulates 65 species. The *Upper cretaceous*, including the *Upper greensand*, *Chalk marl*, and *Upper chalk*, are richest in Conchifera, of which there are 32 species. Many of these were collected by Capt. Cockburn from the upper chalk of Inkermann, several of them being identical with characteristic chalk fossils. Associated with these were found many speci-

by his showing them that it retained its colouring matter almost as perfectly as if it had been taken from a recent sepia. Of the latter genus a very beautiful example was shown to the meeting, which, like the Gaviæ of the present day, was covered with bony scutes or scales. In clearing this specimen Mr Moore was fortunate enough to make an incision into its stomach, in which, though so long a period had elapsed since it had taken its last meal, there was still to be seen there in perfect preservation a small fish of the genus Leptolepis—*Athenæum.*

Section D.—ZOOLOGY AND BOTANY.

Notes on Experiments in the Botanical Garden of the Royal Agricultural College. By Professor Buckman, of the Agricultural College, Cirencester.—In this paper the author first described the soil and situation of the locale occupied as his garden, which, from being situate on Forest Marble Clay, is of a somewhat sterile character. The experimental portion is divided into 200 plots, most of which are 2½ yards square, some double that size, and a few still larger, now engaged in experiments with various manures. The plots are employed at the present time with crops mostly experimental, in the following classes:—Grasses, 82; Papilionaceous feeding-plants, 25; crops for green food, 12; wheat, 6; garden vegetables, 5; turnips, experiments with manures, 14; economic plants, 13; flowering and ornamental plants, 40: total, 197. For the grasses many observations were given tending to show that several so-called species prove in cultivation to be varieties,—instances of which were given in the following genera:—Bromus, Festuca, and Agrostis. One case in particular of the three following forms of Festuca, *F. loliacea*, *F. pratensis*, and *F. elatior*, were shown to have been produced from the same seed by the gradual change of the first two into the latter. In the Papilionaceæ the author pointed out the production of the spring and winter varieties of Vetch from the *V. angustifolia.* In the genus Trifolium he made the following remarks on *T. pratense* and *T. medium.* The *T. pratense* occurs wild in all good and rich meadows and pastures; its place, however, in poor sandy soils is supplied by the *T. medium*, on which account the latter plant was some few years since introduced into agriculture to insure a crop when the former usually failed. The seedsmen used to supply it under its botanical name of *T. medium;* but it is a curious circumstance that all the samples of this seed now in the market show it to be but a variety of *T. pratense*, and hence, at present, the best-informed seedsmen no longer send it out under the original botanical designation of *T. medium*, but under that of *T. pratense perenne*—the fact being well established that we have two varieties of broad clover in cultivation, whilst the true *T. medium* has been entirely lost to agriculture; and the whole evidence with respect to this subject showed that it has not been lost from neglect, but that it has merged into *T. pratense;* and if so, it remains as a most interesting matter for experiment, especially when it is considered that no doubt has been entertained by botanists of their distinction as species. Many experiments of a like kind were described, and their practical utility clearly pointed out.—*Athenæum.*

Schleiden's Views of Embryogeny.—Professor Henfrey communicated the fact that Schleiden and his pupil Schacht have changed their opinions relative to the development of the Embryo in plants. In place of maintaining that the extremity of the pollen-tube formed the first cell of the embryo, they believe that the germinal vesicles exist in the embryo sac before fecundation in the form of protoplasmic corpuscles, which acquire their cellular coat after the fertilization by the agency of the pollen-tube.

The experiment of Dr Radlkofer of Munich seem to have been the means of convincing Schleiden of his error. Schacht has confirmed the views by his researches on the process of fertilization in *Gladiolus segetum.*

On Triticoidal Forms of Ægilops.—Professor Henslow exhibited a specimen of Ægilops, which had sprung up in his garden amidst a patch of *Æ. squarrosa*, which for three years in succession had been allowed to scatter its seeds over a portion of a bed appropriated to it. All the other plants had retained the usual characters of *Æ. squarrosa ;* but the one in question had become perfectly upright, and wheat-like (triticoidal) in appearance. The awns had lengthened, and the glumes were downy. The plant was barren. The triticoidal forms obtained from *Ægilops ovata*, and *Æ. triaristata*, are stated to be generally barren ; and it has been conjectured that all such must be hybrids. It has, on the other hand, been positively asserted that such triticoidal forms are occasionally fertile, and that genuine wheat has been extensively raised from them.

Dr Vogel on the Ajuh of Central Africa. Communicated by Professor Owen.—The translation of Dr Vogel's account of the animal which that enterprising traveller had seen in the River Benuė, or Chadda, in Central Africa, permits of no doubt being entertained as to the class, and even genus, of animal to which that brief and somewhat vague account refers. The combination of two crescentic nostrils, with a pair of fins attached "close behind the head," shows that it is a cetaceous animal; whilst its food, "chiefly of grass," proves it to belong to the herbivorous section of the order Cetacea of the Cuvierian system, answering to the order Sirenia of Illiger. That order now includes three genera : Manatus, Halicore, and Rytina ; the first of which is the only one in which the teeth are multicuspid and with two or more roots. It is, therefore, a species of Manatee that Dr Vogel makes known to us under the name of Ajuh. One species of Manatus has long been known as inhabiting certain rivers of Africa, especially those terminating on the west coast. This species is the *Manatus senegalensis* of Cuvier and other zoologists. A stuffed specimen from that coast is in the British Museum ; it was presented by Messrs Vorster and Co., African merchants. The back and sides of the body are of a very dark gray, approaching to black ; the belly is a light gray. The head is small in proportion to the body, and tapers to an obtuse muzzle ; the upper lip is cleft, and the mouth small. The nostrils, a pair of crescentic clefts, with the convexity upward and backward, are situated as described in the Ajuh : the eyes are, however, not situated *close* behind the nostrils, and they are distant 7½ inches from the end of the muzzle. This admeasurement is from an individual about 3 feet longer than the one of which the dimensions are given by Dr Vogel ; but the difference of relative position seems still too great to be accidental or probable in animals of the same species. The hard short bristles which fringe the mouth, the scattered hairs along the back, the nails terminating each of the three-jointed digits of the pectoral fin, the want of front or incisive teeth, the hard ivory-like texture of the bones, the fatness and vapid nature of the flesh, are all characters common to the Manatees. The number of nails appears to vary in individuals of the same species, as might be expected in parts almost rudimental in their development. and of no very great utility to the animal. Thus Cuvier notices in one individual of the American Manatee (*Manatus americanus*, Desm., *M. australis*, Tilesius) four flat rounded nails on the edge of the fin ; the fourth being very small. In a fœtus of this species there were but three nails on one fin, and four on the other. In a young Manatee, Cuvier noticed only two nails on each fin.* The three nails observed by Dr Vogel

* Ossemens Fossiles, ed. 1836, 8vo, tom. viii., p. 13.

on the fin of the Ajuh cannot, therefore, be depended on as a constant or specific character. The teeth of the known species of Manatee have the crown divided into two transverse ridges,—each ridge, in the upper molars, being at first trituberculate; but the intervals of the tubercles are so shallow that they are soon worn down, and a transverse ridge of dentine, bordered by enamel, is exposed. There is, also, an anterior and posterior low barrel ridge: the posterior one being most developed in the lower molars. The upper molars have each three diverging roots, one on the inner and two on the outer side. The lower molars have two fangs. Dr Vogel's description of the grinders, as "having six points and three roots each," would apply to the upper molars of the *M. senegalensis* before they had been much worn.* As to the number, "five," that doubtless refers to the number forming the series of teeth on each side of the jaw. I have not had the opportunity of examining the dentition of the known African Manatee. In the figure of the skull of the *M. senegalensis* given by Cuvier † six molars are shown on the right side of both upper and lower jaws, and the coronoid process of the mandible may hide a greater number. In the American Manatee I have ascertained that at least nine molars are developed on each side of both jaws,‡ but they are never simultaneously in place or use. The greatest number which I have found in that condition is seven,—the socket of a shed anterior molar being at one end of the series, and that containing an incomplete ninth molar at the opposite end. Professor Stannius has observed a small simple conical molar anterior to the normal two-ridged molars, and divided by a narrow interval from them, in a new-born American Manatee. The individual Ajuh, 5 feet in length, which appears to have been more especially the subject of Dr Vogel's account, was a half-grown animal, and the number of grinders (five), as well as their six-pointed crowns, doubtless relate to that circumstance. Fifteen feet is said to be the length to which adults of the *M. senegalensis* attain: the Ajuh becomes ten feet long. It may be a distinct and somewhat smaller species. The chief indication, however, of such specific distinction is the closer approximation of the eyes to the nostrils and to the end of the snout, as shown by the admeasurement given by Dr Vogel. The easiest procurable and transportable evidence of the Ajuh, and the best calculated to determine this point, would be the skull; but every part would be most acceptable; and, in the meanwhile, the species may be indicated and kept before the notice of naturalists by entering the Ajuh in the Zoological Catalogues as the *Manatus Vogelii*, or Vogel's Manatee.—*Athenæum.*

Notice of some New Genera and Species of British Zoophytes. By Mr J. Alder. Communicated by Professor Busk.—The paper contained descriptions of thirteen new species, found, by the author, on the coasts of Northumberland and Durham. They include two new genera, and another genus not before recorded as European. They are as follows:—Vorticlava,—a new genus allied to Clava, but differing in having the tentacles in two regular circles round the head, and dissimilar. The species *V. humilis* has five tentacles in the upper row, and ten in the lower.—*Eudendrium confectum*,—a small species encrusting old univalve shells, and having much the habit of a Hydractinia.—*E. capillare*,—a minute, slender-branched species, having the polypes and reproductive capsules on different branches.—*Sertularia tricuspidata*,—somewhat resembling *S. polyzonias*, but more nearly allied to a New Zealand species (*S. Johnstoni*, Gray). It has three toothed apertures to the cells.—*Sertu-*

* Cuvier figures a similar molar of the *M. americanus* in pl. 220, fig. 11.

† Loc. cit., fig. 4.

‡ Odontography, vol. i., p. 371, pl. 96, fig. 2.

The opinions of these two men, however, were at variance on a very important point, viz., the age at which the young fry assumed their migratory dress and took their departure from the river to the sea,—Mr Shaw making it two years, Mr Young only twelve or thirteen months.

These experiments, and the success which had attended artificial propagation in France, and the extent to which, in that country, it was beginning to be practised economically and for profit; the trials of Mr Garnett at Clitheroe, and of Mr Ashworth at Outerard in Ireland, attracted the attention of the fishermen of the Tay; and on the 19th July 1852, a meeting of the proprietors of that river was held at Perth to consider the subject generally. This meeting was numerously attended, and Mr Thomas Ashworth of Poynton laid before it and explained the operations which had been recently carried on by himself and his brother, Mr Edmund Ashworth, at their fisheries in Ireland, and recommended strongly that these should now be attempted for the Tay. The recommendation was acceded to, and the Earl of Mansfield, who was chairman of the meeting, at once gave permission to select from his estates any situation favourable for carrying on the experiments. This was the origin of the Stormontfield breeding-ponds, and an excellent account of their construction, and a detail of the operations conducted in them, was brought before the Natural History Section of the British Association at their meeting in Glasgow, which led to the support of the Association, and the appointment of the Committee which has reported this year to the meeting at Cheltenham.*

To bring the subject up to the period when the Committee appointed by the British Association was prepared to act, it will be necessary to mention the principal points and results of the experiments detailed by Mr Edmund Ashworth at Glasgow. These are extremely interesting in themselves, and are indispensable for the right understanding of the operations which were afterwards conducted and are now in operation.†

The situation for the ponds was selected at Stormontfield Mill, not far from the Palace of Scone. "A gentle slope from the lade which supplies the mill offered every facility for the equable flow of water through the boxes and pond. Three hundred boxes were laid down in twenty-five parallel rows, each box partly filled with clean gravel and pebbles, and protected at both ends with zinc-grating to exclude trout and insects. Filtering beds were formed at the head and foot of the rows, and a pond for the reception of the fry was constructed immediately below the hatching ground. On the 23d of November 1853, operations were commenced, and by the 23d of December, 300,000 ova were deposited in the boxes. The fish were taken from spawning-beds in the Tay."

The process of fecundation and of depositing the ova in the boxes was conducted by Mr Ramsbottom, who was engaged for the purpose, his practice and experience at Clitheroe and elsewhere giving confidence in his manipulations. "The ova were placed in the boxes as nearly similar to what they would be under the ordinary course of natural deposition as possible, with, however, this important advantage, that they were not liable to injury and destruction in such a variety of ways as in the bed of the river. The alluvial matter deposited in times of flood will often cover the ova too deep to admit of the extrication of the young fry, even if hatched.

* The Committee named to watch over the experiments in progress and those to be commenced in 1856, consisted of Sir W. Jardine, Bart.; the Rev. Dr Fleming, Prof. Nat. Hist., Free College, Edinburgh; and Mr Edmund Ashworth, Egerton Hall, Lancashire.

† "Remarks on Artificial Propagation of Salmon, and some Account of the Experiment at Stormontfield, near Perth, by Edmund Ashworth. Bolton: 1855." 8vo. Pp. 8.

The impetuosity of the streams when flooded will frequently sweep away whole spawning beds and their contents.* Whilst deposited in boxes, the ova are shielded from injury, and their vivification in large numbers is thus rendered a matter of certainty, and the young fish reared in safety. On the 31st of March 1854, the first ovum was observed to be hatched, and in April and May the greater portion had come to life, and were at large in the boxes; in June they were admitted into the pond, their average size being about an inch and a-half in length. From the period of their admission into the pond, the fry were fed daily with boiled liver rubbed small by the hand. Notwithstanding the severity of the winter, they continued in a healthy condition, and in the spring of the present year (1855) were found to have increased in size to the average of three and four inches in length. On the 2d of May 1855, a meeting of the Committee was held at the pond, to consider the expediency of detaining the fry for another year or allowing them to depart. A comparison with the undoubted smolts of the river then descending seawards with the fry in the ponds, led to the conclusion that the latter were not yet smolts, and ought to be detained. Seventeen days afterwards, viz., on the 19th May, a second meeting was held, in consequence of the great numbers of the fry having in the interim assumed the migratory dress. On inspection, it was found that a considerable portion were actual smolts, and the Committee came to the determination to allow them to depart. Accordingly, the sluice communicating with the Tay was opened, and every facility for egress afforded. Contrary to expectation, none of the fry manifested any inclination to leave the pond until the 24th of May, when the larger and more mature of the smolts, after having held themselves detached from the others for several days, went off in a body. A series of similar emigrations took place, until fully one half of the fry had left the pond and descended the sluice to the Tay. It has long been a subject of controversy whether the fry of the salmon assume the migratory dress in the second or third year of their existence. So favourable an opportunity of deciding the question as that afforded by the Stormontfield experiment was not to be overlooked. In order to test the matter in the fairest possible way, it was resolved to mark a portion of the smolts in such a manner that they might easily be detected when returning as grilse. A temporary tank, into which the fish must necessarily descend, was constructed at the junction of the sluice with the Tay; and as the shoals successively left the pond, about one in every hundred was marked by the abscission of the second dorsal fin. A greater number were marked on the 29th of May than on any other day, in all about 1200 or 1300. The result has proved highly satisfactory; within two months of the date of their liberation—viz., between 29th May and 31st July, 22 of the young fish so marked when in the state of smolts, on their way to the sea, have been, in their returning migration up the river, recaptured, and carefully examined. This fact may be considered as still further established by observing the increased weight according to date of the grilse caught and examined; those taken first, weighing 5 to 5½ lbs., then increasing progressively to 7 and 8 lbs., whilst the one captured 31st July, weighed no less than 9½ lbs. In all these fish the wound caused by marking was covered with skin, and in some a coating of scales had formed over the part. Although 22 only are mentioned, the taking of which rests on indubitable evidence, nearly as many more are reported from distant parts; the weights and sizes of these have not been forwarded.

* "These causes, in addition to the great destruction of ova, as well as young fry, by wild fowl, fish, and insects, all tend to limit the natural increase of the salmon."

"The experiment at Stormontfield has afforded satisfactory proof that a portion at least of the fry of the salmon assume the migratory dress and descend to the sea shortly after the close of the first year of their existence; and what is far more important in a practical point of view, it has also demonstrated the practicability of rearing salmon of marketable value within twenty months from the deposition of the ova. A very interesting question still remains to be solved. At what date will the fry now in the pond become smolts? Hitherto they have manifested no disposition to migrate, and if the silvery coat of the smolt be not assumed till the spring of 1856, a curious anomaly will present itself. Some of the fry as smolts will, for the first time, be descending seawards of the average weight of 2 oz.; some as grilse will be taking their second departure to the sea; and others still more advanced will even have completed their second migration, and return to the river as salmon 10 or 12 lbs. in weight. It is much to be desired that the experiment at Stormontfield could be continued for a year or two longer, till the links in the chain of evidence now wanting to complete the natural history of the salmon, should be obtained. All praise is due to Lord Mansfield for the liberal manner in which he has aided the carrying out the operations to this time, and from which he can reap little advantage beyond the satisfaction to an enlightened mind of promoting the interests of science and the welfare of the community.

"Since arriving in Glasgow, I have received a communication from my friend Mr Buist, in which he says, 'In my opinion you have kept your statements within the truth, as I have got satisfactory evidence of 22 marked grilse being taken, besides others which have been reported; and I have no doubt many have been thrown in the heap without being noticed by the careless fishermen. There is at present a mystery as regards the progress of the young salmon; there can be no doubt that all in our ponds are really and truly the offspring of salmon; no other fish, not even the seed of them, could by any possibility get into the ponds; now we see that about one half have gone off as smolts in their season as grilses. The other half remain as parrs, and the milt in the males is as much developed in proportion to the size of the fish, as their brethren of the same age, 7 to 10 lbs. weight, whilst these same parrs in the pond do not exceed 1 oz. in weight. This is an anomaly in nature which I fear cannot be cleared up at present. I hope, however, by proper attention, some light may be thrown upon it from our experiments next spring. The female parrs in the pond have their ova so undeveloped that the granulations can scarcely be discovered by a lens of some power. It is strange that both Young and Shaw's theories are likely to prove correct, though seemingly so contradictory, and the much disputed point settled, that parrs (such as ours at least) are truly the young of the salmon.'"

We may now consider ourselves at the close of the Glasgow meeting. The Committee which is now reporting to you prepared to act,—one-half of the fish hatched in the spring of 1854 being still in the Stormontfield ponds, and under the charge of their faithful guardian, Peter Marshall. These fish were still in the state of PARR. Mr Ashworth had arranged that a book should be kept at the ponds, in which every occurrence worthy of notice should be entered, and we shall allow that book to tell its own story:—"These parr continued, during the winter 1855-6, healthy, and in good condition, but did not appear to make much advance in size until the month of *April* 1856. They were then in good condition, but not much larger than those which had been allowed to leave the ponds the previous year."

As the migratory season approached, the fish were closely watched. Peter Marshall reports, 19th March, "that the parrs in the pond con-

the boxes with fresh impregnated spawn, and to take every care that this should be done with exactness. The taking of the fish for spawning was commenced on 22d November, and continued until 19th December 1855; in that time 183 boxes were filled, each being supposed to contain 2000 ova. On the 16th December last Mr E. Ashworth, on the part of the British Association Committee, accompanied by Mr Buist of Perth and Mr Ramsbottom met the fishermen at a ford near the junction of the Almond and the Tay, for the purpose of obtaining spawn. Our pond journal relates, "When we arrived at the river they had caught two female fish, and at the next cast of the net two other female fish were taken. At the third cast they captured a male fish in fine condition, from 24 to 28 lbs. weight. We had now full opportunity of seeing the whole process of spawning performed. The female fish, after being relieved of their ova, swam away quite lively, and each were marked by punching a hole in the tail."

The male fish proved to be one of the fish which had been caught by Mr Ramsbottom *in December* 1853, and marked at that time by the dead fin being cut off.*

On 18th February 1856 Peter Marshall reports "The spawn are all healthy, and have every appearance of coming to life."

On 3d March. "The appearance of the spawn still continues very healthy, but not yet quite ready for hatching."

These reports were continued, and the ova that were first deposited, viz., on 22d November 1855, came to life on the 3*d April* 1856; the others in succession. Those last deposited, viz., 19*th December*, were hatched on 11th April, showing a difference of only *eigh*t days in the hatching, although there were FOURTEEN between the different dates of deposition in the boxes.

Upon the dispersion or turning out of the last portion of the previous brood in the end of May, the rearing pond was emptied, thoroughly cleaned out and prepared for the reception of the young fish of this year, still in the spawning boxes, but now increasing in size. On the 1*st of July* last your Committee visited Perth, and in company with Mr Buist and Mr Walsh inspected the ponds. At this time a large proportion of the young fish had found their way to the rearing ponds. Some were still in the communicating race through which the water flowed gently, and a few still continued in the small pools of the spawning boxes. After the ova are hatched or come to life, the young are allowed to find their own way to the rearing pond; this they do gradually, and, with the exceptions stated, had nearly all reached it. They appeared quite healthy, were feeding upon flies and other insects, and when a small quantity of their artificial food (boiled liver grated) was thrown in, they rushed towards it in shoals. The reports of the keeper since the 1st of July have been equally satisfactory, "The young are as thriving as could be wished in every way."

This, then, is the state and condition of the experiment which your Com-

* Ova deposited in Stormontfield ponds in November and December 1855.

		Boxes.			Boxes.
1855.	November 22,	25	1855.	December 4,	5
	„ 23,	9		„ 5,	17
	„ 24,	1		„ 8,	15
	„ 26,	3		„ 15,	19
	„ 27,	9		„ 17,	24
	„ 28,	6		„ 19,	10
	„ 30,	2			
	December 1,	32		Total,	183
	„ 3,	6			

mittee consider they have under charge. Nothing farther can be done, until the time arrives next year when it is supposed a part, or the whole of the brood, may assume the migratory dress, and be ready to remove to the sea. We propose to take such measures as will allow us to watch this narrowly, and also, if the migratory dress be assumed, to mark a large number before turning out.

Note to the Report on the Stormontfield Ponds.

The importance of artificial impregnation, and the general question of changes and migration, is also being attended to elsewhere; and we trust that, as soon as the natural history, "the rise and progress," of the salmon shall have been completed, a similar series of experiments will be instituted to determine that of other migratory fishes which have not yet been bred or kept in confinement. Mr Shaw bred and reared the "*sea trout*"* of the Solway, and we have given a series of figures of this fish from the length of an inch to a weight of four and a half pounds; but the fish of the Tweed known as the "*bull trout*" has never been examined through its different stages, and, except those now in the Duke of Roxburgh's ponds at Floors, has never been bred in confinement.

Ponds similar in construction to those at Stormontfield were erected, in 1855, by the Duke of Roxburgh near Floors, and, upon writing to his Grace regarding them, every information has been kindly supplied by himself, and a detailed account, at his desire, has been drawn up by the superintendent of the Tweed River Police; and, as this bears so much upon our subject, it is thought that some extracts from it will not now be out of place.

"The pond is situate on a small rivulet called Stodrig Burn, and is about 60 yards from the Tweed, within the policies of Floors Castle, near Kelso. The breeding boxes or troughs I caused to be made similar to those at Stormontfield, and they consist of four, laid parallel, 18 feet long, subdivided into four compartments 4½ feet long, the only division between the troughs being a 1½-inch deal instead of the gravel walk, as at Stormontfield. The water, which is raised by a dam at the upper end is made to fall into a deep trough which adjoins the breeding-troughs, from which it is equally distributed, and, after flowing over the gravel, it falls into an aqueduct 18 inches wide, and which is carried round the margin of the receiving-pond, which is oval-shaped, and about 30 feet long by 15 wide, in which there are about 18 inches of water, and into it the aqueduct or canal discharges itself.

"The pond was constructed in the latter months of 1853, but, owing to circumstances, it was not stocked that season.

"On the 4th and 5th of March 1855 the produce of five fish (three of them grilses) was impregnated with the milt procured from two male fish, and deposited in the hatching-troughs. The spring was very cold, and the temperature of the water very low; however the ova appeared to thrive nicely, and on the 27th of April the young were formed and moving about, and, from their appearance, I expected they should have been hatched in the course of another week; but when I examined them on the 4th of May, I found, to my astonishment, that not a single ovum was in a healthy hatching state, but thousands of them had, in the course of the week, become opaque, and the backbone and eyes of the little creatures could be easily seen upon dividing the ovum with a penknife. The cause of this mishap it is impossible to trace, but there is much reason to believe that it was caused by a large quantity of lime being used as manure upon the lands through which the rivulet which supplies the ponds flows.

"On the 17th, 18th, and 19th of March this year I had a quantity of

* Illustrations of Scottish Salmonidæ.

ova dug from a shallow bank in the Tweed near Galashiels, part of it being the ova of the salmon, grilse, and bull trout, in about equal portions, and the whole being not less than 50,000. The ponds being in readiness, it was conveyed, on the 19th of March, to Kelso, in boxes filled with fine gravel or sand in a damp state, and was deposited in the boxes the same day, where it remained till the 11th of April, when they were first observed to be bursting the troughs. Upon examining the gravel in the boxes on the 2d of May, I found that all the fish were hatched, and only those remained which had become addled during the period of incubation. Since that time most of the fry have left the hatching-boxes, and fallen back into the aqueduct, from which most of them have passed into the receiving-pond, where they now remain. They have as yet received no artificial food, but they appear quite healthy, and are growing as well as could be desired. There is a great difference in the size and appearance of them; the largest are about 1½ inches long, while some of them are not over half the size, and the colour of some is much lighter than of others, which no doubt arises from the different kinds of ova that were placed there."

On the Oyster and Oyster-Beds of the British Shores. By T. C. Eyton, Esq., F.L.S., F.G.S., F.Z.S.—For the purposes of this report, I shall divide the subject into three sections—1*st*, That relating to the oyster-beds of England, and the laws respecting them. 2*dly*, An account of the different beds from my own observations and reports and information that have been sent to me; and, 3*dly*, an account of the natural history of the oyster, together with a short summary. The oyster-fisheries of England are of great antiquity. The luxurious Romans held the British oyster in great estimation, and they do not appear to have fallen off in that of the epicure to the present day.

Numerous Acts of Parliament have been passed at different times for the protection of the fisheries. The last, under which the present free months are appointed, was passed in the present reign (6th and 7th Vict., cap. 79), in consequence of a convention entered into between this kingdom and France. Section 45 enacts that the fisheries shall open on the 1st day of September, and shall close on the 30th day of April.

I have received reports from or visited the following oyster-beds:—

Loch Ryan in the mouth of the Clyde.

The whole of the beds of North Wales.

Loch Fyne, which is a bed of no commercial value.

The whole of the Isle of Man beds.

The Jersey, Guernsey, and Sark beds.

The Kentish and Essex beds.

From the observations contained in the above accounts my summary will be principally drawn.

The oysters whose spawn I am about to describe were taken in Loch Ryan on the 10th of July, and were forwarded to me in a box packed with wet grass; they were thirty-two in number, out of which only three proved in spawn. From a rough calculation, the number of animals contained in the spawn of one of these was about three millions, which I believe to be rather under than over the mark. The first I opened had spawn exuded, and lying between the folds of the mantle in a mass, it was of a purplish colour, and on examining it with a hand glass, I could perceive some motion, but on placing a small quantity on a glass plate underneath a half-inch power in the microscope, I could clearly perceive that what I took for ova, in the first instance, were living animals varying slightly in form. They were furnished with cilia, which were in constant and rapid motion, were semitransparent, and had two reddish elon-

nent by the natives whom he had Christianized, and whose fidelity to him during his perilous adventures had been rewarded by being instructed and reconducted to their native place. The map, constructed by Dr Livingston, of the vast unexplored region has been for some time in preparation by Mr Arrowsmith, for publication in the volumes of the Royal Geographical Society; and some of the information contained in the letters recently received will occasion improvements in that map,—the chief points of which have been fixed by astronomical observations, which the undaunted traveller was enabled to accomplish even under all the privations and dangers of his two remarkable journeys. Not endeavouring to detail the names of the African chiefs and places alluded to, but pointing out generally on the map the line of route pursued, Sir Roderick read those passages of the first letter which confirmed, by actual observation, a theory he had himself formed in the year 1852 of the probable physical condition of the interior of Africa, in ancient as well as in modern times, from the examination of a geological map of the Cape Colony by Mr Bain, and from the earlier discoveries of the Lake Njami by Dr Livingston and his former associate,—viz., that crests of hard and lofty rocks constitute both the eastern and western flanks of the continent, through which the rivers, escaping by deep fissures, have proceeded from a marshy, lacustrine, and broad central region of no great altitude. Of this comparatively flat central region, intersected by a net-work of rivers, Dr Livingston gives the clearest account,—some of the waters even flowing northwards into the Congo, and others southwards into the Zambesi. The chief geological and mineralogical characteristics of the eastern and western flanking crest-lands are given, with measurements of the chief altitudes as determined by the ebullition of water. The journey from St Paul di Loanda to Linyanti was facilitated for a time by the possession of two asses, given to the author by friends in the Portuguese settlement of Loanda,—these animals being insensible to the sting of the Tsetse, which destroys oxen and other animals.—In the second letter Dr Livingston, then within a few days' march of the Portuguese eastern station of Tette, gives a lively and graphic sketch of the remainder of the route he pursued in proceeding across the eastern hilly region; and his description of the scenery (as read to the Section) where the broad river Zambesi, after forming great rapids, is compressed into a narrow gorge and cascades over a lofty precipice, amidst the most luxuriant and extraordinary vegetation, afforded the liveliest gratification to the assembly. This rocky region is very salubrious, and in passing through it the traveller is no longer molested by the Tsetse, or destructive insect; and the author speculates on the probability of such *sanatoria* being extended vastly further to the north, and adds,—"At present there is the prospect of water carriage right up to the bottom of the eastern ridge; and if a quick passage can be effected thither during a healthy part of the season, there is, I presume, a prospect of residence in localities superior to those on the coast."—The third letter—most of which was read to the meeting—gives a general view and *resume* in relation to the ethnological distinctions, habits of the various tribes among whom he has lived, and with whose languages he is so well acquainted, assigning a manifest superiority in bravery and conduct to the hill people, and particularly the Caffre-Zuluh race. He also explains that the Bible has been nearly all translated into Sechuana, or the dialect of the Bechuanas, the most regularly developed of all the Negro languages. "Of its capabilities (he adds) you may judge, when I mention that the Pentateuch is fully expressed in considerably fewer words than in the Greek Septuagint, and in a very greatly less number than our verbose English." After a sketch of the zoology and natural history of the region, and a record of the prevalent diseases of the people, showing that certain maladies which civilized man cannot eradicate are often worn out and disappear naturally in South Africa, Dr Livingston, adverting to previous Portuguese explorers, modestly expresses his belief that he is the first European who has travelled over Southern Africa in those latitudes; and having accomplished thus much, he speaks of a visit to his native land, but only with the intention of returning to exercise his sacred calling. He concludes in these words:—"I feel thankful to God who has preserved my life, while so many who would have done more good have been cut off. But I am not so much elated as might have been expected, for the end of the geographical feat is but the beginning of the missionary enterprise. Geographers labouring to make men better acquainted with each other, soldiers fighting against oppression, and sailors rescuing captives in deadly climes, are all, as well as missionaries, aiding in hastening on a glorious consummation to all God's dealings to man. In the hope that I may yet be permitted to do some good to this poor, long trodden-down Africa, the gentlemen over whom you have the honour to preside will, I doubt not, all cordially join." In conclusion, Sir Roderick called attention to the great merits of Dr Livingston, who had justly been honoured with the adjudication of a Gold Medal of the Royal Geographical Society.—*Athenæum.*

SECTION G.—MECHANICAL SCIENCE.

On the Manufacture of Iron and Steel without Fuel. By Mr W. BESSAMER.—Mr Bessamer asserted that crude iron contains about 10 per cent. of carbon; that carbon cannot exist at white heat in the presence of oxygen, without uniting therewith and producing combustion, that such combustion would proceed with a rapidity dependent on the amount of surface of carbon exposed; lastly, that the temperature which the metal would acquire would also be dependent on the rapidity with which the oxygen and carbon were made to combine, and consequently that it was only necessary to bring the oxygen and carbon together in such a manner that a vast surface should be exposed to their mutual action in order to produce a temperature hitherto unattainable in our largest furnaces. With a view of testing practically this theory, he had constructed a cylindrical vessel of three feet in height, somewhat like an ordinary cupola furnace, the interior of which was lined with fire-bricks; and at about two inches from the bottom of it, inserted five tuyere pipes, the nozzles of which were framed of well-burnt fire-clay, the orifice of each tuyere pipe being about three-eighths of an inch in diameter. These were so put into the brick lining (from the outer side) as to admit of their removal and renewal in a few minutes when they were worn out. At one side of the vessel, about half way up from the bottom, there was a hole made for running in the crude metal, and on the opposite side there was a tap-hole stopped with loam, by means of which the iron was run out at the end of the process. The vessel should be placed so near to the discharge-hole of the blast furnace as to allow the iron to flow along a gutter into it. A small blast cylinder would be required, capable of compressing air to about 8lb. or 10lb. to the square inch. A communication having been made between it and the tuyeres before named, the converting vessel would be in a condition to commence work. It would, however, on the occasion of its being first used after re-lining with fire-bricks, be necessary to make a fire in the interior with a few baskets of coke, so as to dry the brickwork and heat up the vessel for the first operation, after which the fire would have to be all carefully raked out at the tapping-hole, which would again be made good with loam. The vessel would then be in readiness to commence work, and might be so continued without any use of fuel, until the brick lining in the course of time became worn away and a new lining was required. The tuyeres are situated nearly close to the bottom of the vessel; the fluid metal will therefore rise some eighteen inches or two feet above them. It is necessary, in order to prevent the metal from entering the tuyere-holes, to turn on the blast before allowing the fluid crude iron to run into the vessel from the blast furnace. This having been done, and the fluid iron run in, a rapid boiling up of the metal will be heard going on within the vessel, the metal being tossed violently about, and dashed from side to side, shaking the vessel by the force with which it moves from the throat of the converting vessel. Flame will then immediately issue, accompanied by a few bright sparks. This state of things will continue for about 15 or 20 minutes, during which time the oxygen in the atmospheric air combines with the carbon contained in the iron, producing carbonic acid gas, and at the same time evolving a powerful heat. Now, as this heat is generated in the interior of, and is diffused in innumerable fiery bubbles through, the whole fluid mass, the metal absorbs the greater part of it, and its temperature becomes immensely increased; and by the expiration of the 15 or 20 minutes before named, that part of the carbon which appears mechanically mixed and diffused through the crude iron has been entirely consumed. The temperature, however, is so high that the chemically combined carbon now begins to separate from the metal, as is at once indicated by an immense increase in the volume of flame rushing out of the throat of the vessel. The metal in the vessel now rises several inches above its natural level, and a light frothy slag makes its appearance, and is thrown out in large foam-like masses. This violent eruption of cinder generally lasts five or six minutes, when all further appearance of it ceases—a steady and powerful flame replacing the shower of sparks and cinder which always accompanies the boil. The rapid union of carbon and oxygen which thus takes place adds still further to the temperature of the metal, while the diminished quantity of carbon present allows a part of the oxygen to combine with the iron, which undergoes combustion, and is converted into an oxide. At the excessive temperature that the metal has now acquired, the oxide, as soon as formed, undergoes fusion, and furnishes a powerful solvent of those earthy bases that are associated with the iron. The violent ebullition which is going on mixes most intimately with scoriæ and metal, every part of which is thus brought into contact with the fluid, which will thus wash and cleanse the metal most thoroughly from the silica and other earthy bases which are combined with the crude iron, while the sulphur and other volatile matters which cling so tenaciously to iron at ordinary temperatures are drawn off, the sulphur combining with the oxygen, and forming sulphurous acid gas. The loss in weight of crude iron during its conversion into an ingot of malleable iron, was found, on a mean of four experiments, to be 12½ per cent., to which will have to be added the loss of metal in the finishing rolls. This will make the entire loss probably not less than 18 per cent., instead of 28 per cent., which is the loss on the present system. A large portion of this metal is, however, recoverable, by treating with carbonaceous gases the rich oxides thrown out of the furnace during the boil. These slags are found to contain innumerable small grains of metallic iron, which are mechanically held in suspension in the slags, and may be easily recovered, by opening the tap-hole of the converting vessel, and allowing the fluid malleable iron to flow into the iron ingot moulds placed there to receive it. The masses of iron thus formed will be perfectly free from any admixture of cinder, oxide, or other extraneous matters, and will be far more pure and in a sounder state of manufacture than a pile formed of ordinary puddle bars. And thus it will be seen that by a single process,

been arrived at by the use of a multiplicity of small furnaces. While the manufacturer has shown himself fully alive to these advantages, he has still been under the necessity of leaving the succeeding operations to be carried out on a scale wholly at variance with the principles he has found so advantageous in the smelting department. It is true, that hitherto no better method was known than the puddling process, in which from 400 lb. to 500 lb. weight of iron is all that can be operated upon at a time; and even this small quantity is divided into homœopathic doses of some 70 lb. or 80 lb., each of which is moulded and fashioned by human labour, and carefully watched and tended in the furnace, and removed therefrom one at a time, to be carefully manipulated and squeezed into form. When we consider the vast extent of the manufacture, and the gigantic scale on which the early stages of the process is conducted, it is astonishing that no effort should have been made to raise the after-processes somewhat nearer to a level commensurate with the preceding ones, and thus rescue the trade from the trammels which have so long surrounded it. Before concluding these remarks, I beg to call your attention to an important fact connected with the new process, which affords peculiar facilities for the manufacture of cast steel. At that stage of the process immediately following the boil, the whole of the crude iron has passed into the condition of cast steel of ordinary quality. By the continuation of the process the steel so produced gradually loses its small remaining portion of carbon, and passes successively from hard to soft steel, and from soft steel to steely iron, and eventually to very soft iron; hence, at a certain period of the process any quantity of metal may be obtained. There is one in particular, which, by way of distinction, I call semi-steel, being in hardness about midway between ordinary cast steel and soft malleable iron. This metal possesses the advantage of much greater tensile strength than soft iron. It is also more elastic, and does not readily take a permanent set, while it is much harder and is not worn or indented so easily as soft iron. At the same time it is not so brittle or hard to work as ordinary cast steel. These qualities render it eminently well adapted to purposes where lightness and strength are specially required, or where there is much wear, as in the case of railway cars, which from their softness of texture soon become destroyed. The cost of semi-steel will be a fraction less than iron, because the loss of metal that takes place by oxidation in the converting vessel is about two and a-half per cent. less than it is with iron; but as it is a little more difficult to roll, its cost per ton may be fairly considered to be the same as iron. But as its tensible strength is some thirty or forty per cent. greater than bar iron, it follows that for most purposes a much less weight of metal may be used; so that taken in that way the semi-steel will form a much cheaper metal than any that we are at present acquainted with. The facts which I have brought before the meeting are not mere laboratory experiments, but the result of working on a scale nearly twice as great as is pursued in our largest ironworks—the experimental apparatus doing 7 cwt. in thirty minutes, while the ordinary puddling furnace makes only 4½ cwt. in two hours, which is made into six separate balls, while the ingots or blooms are smooth, even prisms, ten inches square by thirty inches in length, weighing about equal to ten ordinary puddle balls.—*Athenæum.*

Explorations through the Valley of the Atrato to the Pacific in search of a Route for a Ship Canal. By Mr F. M. Kelley of New York.—Several surveying expeditions have been sent by Mr Kelley into this region, and much valuable information has resulted. But the chief result is a conviction of the feasibility of a ship canal through the isthmus. The most recent of Mr Kelley's explorers, Mr Kennish, proposes to enter the Atrato by the Cano Coquito. The greatest depth on the bar is about 4 feet at low water; the soundings gradually deepen, and become 30 feet within two miles, when the depth increases to 47 feet, and is nowhere less up to the Truando. The width varies from a quarter of a mile to two miles, and the removal of the bar would allow of the transit of the largest steamers. The confluence of the Truando is about 63 miles from the Gulf, and that river forms the channel of the proposed line for thirty-six miles. The line then follows the valley of the Nerqua through rock-cutting, and passes the summit by a tunnel of three and a quarter miles. It reaches the Pacific through the valley of a small stream, and debouches at Kelley's Inlet. In the valley of the Atrato, 300 miles long and seventy-five broad, and lying between the Antiochian mountains on the east and the Cordillera of the Andes on the west, rain falls almost daily, which accounts for the immense supply of water in that region. On the Pacific side of the Cordillera there is scarcely any rain for eight months of the year. The greater portion of the rain falling in the Atrato valley is caught above the confluence of the Truando. Fifteen large tributaries, and numerous smaller streams, fall into the Atrato, and contribute to the immense lagoons, which form natural reservoirs and a superabundant store of water throughout the year. There are various cogent reasons for selecting the confluence of the Truando as the best point from whence the passage from the Atrato to the Pacific may be effected. In the first place, there is no point of junction with the Atrato by western tributaries so near the level of high water on the Pacific as that of the Truando. It happens to be 9 feet above the Pacific at high water, and it is therefore of sufficient elevation to prevent the Pacific at high water from flowing through the proposed cut into the Atrato, while it is not so high as to cause the current from the Atrato to the Pacific at *low* water to pass through the cut too rapidly. In fact the elevation of the Truando confluence just preserves a preponderating balance on the side of the Atrato. The Atrato, at the junction of the Salaqui, is only 1 foot above the level of the Pacific at high water; but the dividing ridge is 1063 feet high, and 30 miles wide, according to a survey of that route by Mr Kennish and Mr Nelson. Should any of the rivers at the mouth of the Atrato be selected, without reference to the height and width of the dividing ridge, it may be observed that the maximum tidal wave in the Pacific being 25 feet, and that on the Atlantic only 2 feet, the Pacific at high tide would flow into the Atlantic with a current equal to a head of 11½ feet, and at low water in the Pacific the Atlantic would flow into it with a similar current. In the inlet of the Gulf of Micuel, recently called Darien Harbour, the action of the tide is so strong that H.B.M. steamship Virago, commanded by Captain Prevost, dragged both anchors ahead, and was only brought up by paying out nearly all her cable. The heights of the tides and the levels of the two oceans have been well established by the recent observations of Colonel Tolten in Navy Bay, on the Atlantic, and in a deep bend of the Bay of Panama, on the Pacific. On the Atlantic a consecutive series of thirty-two observations were taken in the months of August and September during the season of calms. On the Pacific two sets of observations were made,—the first during May and June, when fifty-four consecutive tides were observed in a season of calms, and the second in November and December, when fifty-two consecutive tides were observed in a season of light winds. These observations make the mean level of the Pacific from 0·14 to 0·75 higher than the mean level of the Atlantic; but this is probably owing only to local circumstances, and it may be assumed that there is no difference in the mean levels of the two oceans. The conclusions arrived at by the successive independent surveys carried out at the expense of Mr Kelley may be summed up as follows:—1*st*, That the oceans can be united through the Atrato and Truando by a canal, without a lock or any other impediment; 2*d*, That while the distance between the oceans by this route is only 131 miles, half that distance is provided by nature with a passage for the largest ships; 3*d*, The remaining distance requires the removal of bars, excavations, and cuttings presenting no unusual difficulties; 4*th*, Harbours requiring but little improvement to render them excellent exist at the termini.—*Athenæum.*

Botanical Society of Edinburgh.

Thursday, June 12, 1856.—Professor Balfour, V.P., in the Chair.

1. *Elucidation of some Plants mentioned in Dr Francis Hamilton's Account of the Kingdom of Nepal.* By Lieut.-Col. Madden.

2. *On the Duration of the Life of Plants.* By Professor Fleming.

The phrases ordinarily employed to express the duration of life in plants are Annuals, Biennials, and Perennials. Viewing the subject, however, in reference to function rather than seasons, divisions much more consistent with the phenomena must be resorted to. Thus, in the case of annuals, it may happen in an unfavourable season that the plant may outlive the winter, flourish during a portion of the following season, and thus become a biennial. But in many cases those plants termed biennials merely extend themselves during the first season, and in the following flower, ripen their seeds, and perish. But in both cases the plant dies after having once executed the function of reproduction. Those plants have their vitality completely exhausted by the seed-producing process, and, in consequence of this functional character, they constitute a very distinct group, to which the somewhat ambiguous term Monocarpous has been applied by Decandolle and Lindley. It suggests the idea of the plant producing only one carpel or seed-vessel. As defined by Lindley, however, it may be conveniently employed. He says,—" Monocarpous, bearing fruit but once, and dying after fructification, as wheat. Some live but one year, and are called annuals; the term of the existence of others is prolonged to two years,—these are biennials; others live for many years before they flower, but die immediately afterwards, as the *Agave americana.*"

In proof that it is the production of the seed which consumes the vitality of the plant, it will be found that by destroying the flower-buds the life of the plant will be prolonged until new flower-buds be produced, or those already existing, but in an imperfect state, become developed. Thus, I have kept the common oat, *Avena sativa*, for four seasons by cutting off the flowering stem. The annual bean may be easily converted into a biennial. The tree mallow, *Lavatera arborea*, usually considered a biennial, in one case outlived the greater part of the second winter with me, but perished by the severity of the frost in the spring of 1855, having a stem such as I now exhibit, displaying spurious annual rings of growth, about eighteen in number, marking intermittent action, irrespective of the dead or winter season, and well calculated to give a salutary warning to the vegetable palæontologist.

The circumstance of monocarpous plants having their life prolonged by being prevented from flowering, and the production of new parts for flowering purposes, give no countenance to the assertion of Knight in his paper "On the Reproduction of Buds" (*Phil. Trans.*, 1805, p. 262). "Nature appears to have denied to annual and biennial plants (at least

4. Where the whole plant dies after maturing the seed, and forming from the stem a tuber, as in the potato. Here we have an aggregation of flower buds destined to produce individuals with the annual or monocarpous character.

These groups of rhizocarpous plants do not seem to have occupied, to any extent, the consideration of botanists, although, in a physiological point of view, of great interest. The field, indeed, may be regarded as in a considerable degree unoccupied by our botanical writers.

The last great group, in reference to the term of life, denominated Perennial, or, in the phrase of Lindley, Caulocarpous, are those "whose stem endures many years, constantly bearing flowers and fruits, as trees and shrubs." In this group the efforts of life are of two kinds—the production of buds of extension and those of fruit. The fruit, flower, or seed buds resemble in some degree in their function an annual or monocarpous plant. Death follows the reproductive process. It is otherwise with the extension buds. Both, however, are greatly under the influence of external circumstances. An abundant supply of nourishment makes a tree generate extension buds almost exclusively, whereas a scanty supply of food promotes the reproductive efforts, and fruit buds predominate, a process the reverse of that which prevails in the animal kingdom, where it has long been alleged, "sine Cerere et Libero friget Venus" (*Horace.*)

By many vegetable physiologists it has been supposed that the life of a tree is confined to its buds; that the stem is a sort of dead soil, or rather support; and farther, that the bud, when it evolves in spring, acts like a seed, sending downwards certain vessels to act as roots, and another set upwards, for extension of the individual and the formation of new buds for development in the following season. In this view of the matter, the tree, with the exception of the buds, is an aggregation of dead cells.

The authors who have adopted this notion have been chiefly influenced by considering the power which buds possess of developing themselves in certain circumstances, even when detached from the stem, as in the act of budding, and even by the more ordinary process of extension by slips. To this view of vegetable life there have ever appeared to me to be grave objections, which, to save the time of the Society, I shall state very briefly.

1. I shall not here dwell on the fact that by particular processes the leaves, stem, and roots can be made to produce buds, or the parts supposed only subservient to vitality can exercise living functions from vital centres, nor on the action of poisons.

2. When a tree is grafted—say a cultivated apple on a crab stock—the buds of the graft may extend into a lofty tree, and yet its downward roots, although becoming continuous, never embracing the stock and reaching the soil. The stock remains the same in its bark, wood, and pith, and, after many years, if it produces buds and suckers, these invariably retain the characters of their crab original. The practice of dwarfing fruit trees would prove a failure if the buds contained the whole life of a tree. A slow-growing stock is selected, on which is inserted a fast-growing graft, or one inclined to generate extension rather than fruit buds. If the buds of the graft annually sent down their roots to the ground, the influence of the stock should cease by the second year, an event which does not occur.

3. The difference between summer and winter felled wood is equally hostile to the notion that the life of a tree is limited in winter to its buds. The cells of the newer layers of wood are storehouses of nourishment: the sap, when beginning its ascent, is nearly pure water; as it ascends it becomes more and more loaded with the contents of the cells through which it has travelled, and the buds are thus supplied with nourishment by the living agency of the former year, which made the bud and provided for its de-

velopment. Hence the comparative lightness of timber felled after the bud has evolved its leaves.

The stem of a tree is the common support of all the organs, the receptacle of the peculiar juices, and the storehouse of nourishment. The buds evolve simultaneously or successively according to a law of a symmetry and co-operation, as among the composite zoophytes, giving to the individuals of a species their characteristic expression.

I have to apologize for the desultory character of these brief remarks. I have not met with any satisfactory grouping of all the phenomena to which I have referred in any of the treatises on Botany which I have been able to consult; and if I can induce any one to cultivate the field which I have so indistinctly pointed out, who has more time and better opportunities than I can command, the portion of your time which I have occupied will not have been misspent.

3. *Inquiry into the signs of current Electricity in Plants.* By H. F. BAXTER, Esq.

(This paper appeared in the number of this Journal for July last.)

4. *Notice of some Additions to the Hepaticæ of the neighbourhood of Edinburgh.* By JOHN LOWE, Esq.

5. *Records of Localities for Rare Plants.* By Professor BALFOUR.

6. *Continuation of Account of the Contents of the Museum of the Botanic Garden.* By Professor BALFOUR.

7. *Notice of the Fibrous Plants of India.* By Professor BALFOUR.

Thursday, July 10, 1856.—Professor BALFOUR, V.P., in the Chair.

In taking the Chair, Professor Balfour stated that the painful duty devolved upon him of recording the death of the President, Colonel Madden—an event which took place suddenly and unexpectedly, from rupture of the aorta, soon after last meeting of the Society. "We all, I am sure (he said) deeply deplore the loss of one who took a warm interest in our proceedings, and with whom we have had much pleasant intercourse. For my own part I cannot easily give expression to the sad feelings with which I contemplate this bereavement. He had been a constant visitor at the Garden during the summer while engaged in preparing his elaborate paper on the Indian plants in Dr Buchanan Hamilton's harbarium; and I had looked forward to the pleasure of spending many a happy day with him in the prosecution of botanical science. His amiable deportment and gentlemanly manner endeared him to all of us, and we all rejoiced to see one who had spent a large portion of his life in the active service of the East India Company now devoting his time and leisure to the prosecution of science. During his residence in India he was a careful observer, and made many interesting remarks on the flora of the country. He sent home the seeds of many valuable plants which have flowered in Glasnevin and in other gardens. When he came to settle in Edinburgh, he joined the Royal and Botanical Societies, in both of which he became a very active member. He was elected a councillor of the Royal Society, and took a marked interest in its proceedings. He particularly took charge of the scientific additions which it was agreed to make to its library. To the Transactions of the Botanical Society he contributed an excellent paper on the occurrence of Palms and Bamboos high on the Himalaya, and it is to be hoped that the paper which was read from him at our last meeting will be in such a state as to allow of its publication. Most sincerely, I am sure, do the Society condole with his afflicted widow.

Such events call on us to be ready, seeing we know not what a day may bring forth."

"I have also to report the death of Mr William Gourlie, the local Secretary of the Society in Glasgow, who was connected with our Society from its commencement, and who aided it much by his exertions. He was a zealous naturalist, and had made a large and valuable collection of plants, which it is hoped will not be lost to science. From his mercantile position in Glasgow, he was able to render important service to the Society and to botanists on many occasions, and he was always ready and willing to do everything in his power for the promotion of science. During my residence in Glasgow as Professor of Botany, I was much indebted to him, and many specimens now in the Museum here I owe to his kindness. He set an example of zeal to the mercantile men of the western metropolis, and his labours promised to be instrumental in infusing a taste for science among the community of Glasgow. When the meeting of the British Association took place in Glasgow in September last, he acted as chief local Secretary. The labour which he underwent, not merely during the meeting, but for months before, was extraordinary. He spared no pains to render the meeting creditable to Glasgow, and the arrangements which he made called for commendation from all. He was publicly thanked by the Duke of Argyll for his services. About the time of the meeting symptoms of disease of the bones in the face appeared, and the malady went on insidiously and unobserved for many months, till at length it appeared as a fungous growth. He endured at first great suffering, which he bore with much fortitude and resignation; and after a protracted illness he sunk in the course of last week. He has been taken away in the midst of his usefulness, and at the very time when he seemed to be gaining the highest eminence in his native city. The place which he occupied will not be easily supplied. Let us hope that his enthusiastic love of science, and his noble exertions in the cause of Botany, will be the means of stimulating his townsmen to follow his steps; and that, while they are prosecuting their commercial speculations, they will not think it beneath their notice to devote some of their time to science, which was to him in his season of recreation a source of high enjoyment, and which secured for him many friends in all parts of the world. Though dead, may he yet speak to them."

1. *A Brief Account of the General Botanical Features of a Hill District in Western India, with the results of a series of Observations in connection with Vegetable Climatology.* By JOHN KENNETH WILSON, Esq., Bombay.

2. *List of the Botanical Society's British Desiderata, being Plants required for the Distributions during* 1856–7.

3. *On an Abnormality in the Flowers of Salix Andersoniana.* By JOHN LOWE, Esq.

The author referred to Mr Leefe's Observations on Metamorphoses of the pistil of *Salix Caprea* (*Trans. Bot. Soc.*, vol. i.), and called attention to some observations by himself on *Salix Andersoniana*, which seemed further to illustrate the morphological changes of the reproductive organs. The gradual change of stamens into ovaries was pointed out by an extensive series of examples, which also served to show the particular parts of the leaf which give origin to the different parts of the essential organs. The anther gradually merging into the carpel, shows that it is derived from the lamina; the pollen appeared to be merely a gemmiferous condition of the lamina; and Mr Lowe believed that the glands of Salix represent the corolla. By regarding the scale as the calyx, we should have the various whorls of the flower complete.

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[illegible]dification of th[illegible]pellary Leaf, especially with reference to the Lome[illegible] By W. Nichol, Esq.

[illegible] Trip to A[illegible]h 60 Pupils, in July 1856. By Pro[illegible] Balfour.

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SCIENTI[illegible]INTELLIGENCE.

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[illegible] Composition [illegible] Muscles in the Animal Series. By MM. V[illegible]CIENNES and Fremy.

[illegible] lately publish[illegible] us on the composition of eggs, show [illegible]rative study of [illegible]cts related in organization, running [illegible]different classes [illegible] animal kingdom, is always a source of [illegible] alike to zoolog[illegible] chemistry. Taking up the eggs of the [illegible]ups of animals, [illegible]ointed out fundamental differences in [illegible]which zoology sh[illegible]ereafter regard, and besides, we gave [illegible]haracteristics of [illegible] class of organic substances, designated [illegible] the name of Vit[illegible]bstances, which chemistry and physio- [illegible]confound with th[illegible]minous substances.

[illegible]g still our labour[illegible]hich enables us to handle questions [illegible]provinces both of [illegible]y and chemistry,—we have proposed [illegible] to extend to th[illegible]lar fibre the mode of research which [illegible]stowed on eggs, [illegible] to endeavour to exhibit, by a compa- [illegible], the differences [illegible] muscles in chemical composition. A [illegible]mination of the wh[illegible]nimal series should then give us toler- [illegible] notions of the n[illegible] of the proximate principles found in [illegible]ar fibre, as well [illegible]he analytical processes by which they [illegible]lated.

[illegible] our joint research, [illegible]ave established several important facts [illegible]brought out in this [illegible]rst communication on the subject. [illegible]scular fibre of the ver[illegible]rate animals, which we first examined, [illegible]ted with the great[illegible]are by anatomical processes from the [illegible]eurotic or tendinou[illegible]es, from the nervous cords, the prin- [illegible]vessels, and also from [illegible]e fat which it contains in considerable [illegible] The proximate princi[illegible] which first appears in the analysis of [illegible]s of the Vertebrata is [illegible]atin, the discovery of which, as is well [illegible] due to M. Chevreul. Then come inosic acid and creatinin, [illegible] been described with [illegible] much discrimination and care by M. [illegible] In this part of our re[illegible]ches, we can only confirm the labours [illegible] known chemists ju[illegible]ned. We will mention, however, that [illegible]appears to us more [illegible]dant in the animal economy than is [illegible] supposed; we hav[illegible]rtained its presence in the [illegible] most all th[illegible] [illegible] found in a fr[illegible]

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stance which gives acidity to the muscles of all the Vertebrata; we thought it of interest to isolate this principle and to analyze it. The result of our researches in this direction is, that if in some cases, the acidity of the muscles is due to lactic acid, that which makes the muscular fibre strongly acid is ordinarily a phosphate of potash, having, according to our analysis, the formula, KO 2HO PO^5. We obtained this salt in a crystallized condition by treating the muscles with weak alcohol and evaporating the liquor to a syrupy consistence.

While determining the proportion of this salt in the muscles of different animals, we observed evidence of some connection with the formation of the osseous system; that is, we always found it largely in animals in which the bones are very much developed, and very slightly in the Articulata and Mollusca. The part which this salt takes in the formation of bones is now clear; for we have directly ascertained that in reacting on carbonate of lime, the phosphate of potash from the muscles forms the basic phosphate of lime, which is so considerable a part of the bony substance. This phosphate of potash is not, perhaps, without effect in the production of a phosphuretted fatty matter that exists in the muscles, which will be mentioned farther on; we think, however, that under these circumstances, it deserves the attention of physiologists. The muscles of the vertebrated animals are impregnated with a considerable quantity of fatty bodies made up of varying proportions of olein, margarin, and stearin. Besides these neutral fatty bodies, another is always found, which differs from the substances properly called fat by a number of peculiarities, and presents some analogy to the cerebral fat. We have made a tolerably complete examination of this interesting substance. It was extracted easily by treating the muscles with weak alcohol, which dissolves it without altering the other fatty bodies. This liquid, when evaporated, gives a viscous amber-coloured substance, which partly dissolves in water; treated with sulphuric acid, it decomposes like a soap, giving sulphate of soda and an acid heavier than water. This acid contains both azote and phosphorus; analyzed, it afforded exactly the composition which one of us obtained from the cerebral fat, called oleophosphoric acid.

The phosphuretted fat which exists in the muscles, is therefore identical with that which is found so plentifully in the brain, and is produced, like the latter, by the combination of soda and oleophosphoric acid. This substance can now be said to be found in every part of the animal organization. We have established that its proportion in the muscular tissue increases with the age of the animal, and it is as various as the different species of the vertebrate animals. Fishes, such as the whiting, the dab, the flounder, have only a very small proportion, while species having a compact body, with a strong taste, generally difficult to digest, like the mackerel, herring, trout, and, most of all, salmon, have a large quantity. It is this phosphuretted substance which, by decomposing incompletely through the action of heat, gives to broiled fish its characteristic smell.

While studying this substance in the muscles of fish, we have been naturally led to examine the red matter which colours the muscles of salmon, that which, in trout and some other fish, produces the "*saumonage.*" This remarkable change of colour is partly dependent on the phenomenon of reproduction. The salmon, for instance, is red-skinned all the year, but its muscles become perceptibly paler at the time of spawning. This discoloration is still more distinct in trout, for when they spawn the skin becomes quite white. While the spawning does not occur at the same time, the female "salmons" itself a deeper red, and keeps this colour longer than the male; and often in the same stream there are taken white trout and salmon trout. This shows, too, that the salmon trout is not the mongrel of the trout and salmon; besides, the fecundation of one

tinin: these proximate principles are replaced by a crystalline material, which is obtained as plentifully from oysters as from the cuttle fish, and may be called a characteristic of the muscles of these animals. It is much more soluble in boiling water than in cold, insoluble in alcohol and ether, combines with neither acids nor bases, and resists the action of nitric acid. When submitted to the action of heat, it gives all the products which result from the decomposition of organic azotized substances, and with sulphuric acid, affords both the sulphite and the sulphate of ammonia. The presence of sulphur in the crystalline matter of the molluscs has been confirmed by the analyses, which resulted thus:—

C = ...	19·5
H = ...	5·9
N = ...	10·5
S = ...	24·0
O = ...	40·0
	100·0

These analytical data, with the other characteristics, show that the substance from molluscs is identical with a very remarkable material discovered by Gmelin in the bile of the vertebrated animals, which he calls *taurine.*

To give the last degree of certainty to this interesting fact, we asked M. de Senarmont to determine the crystalline form of the substance obtained from the molluscs; and his crystallographic determination is a further confirmation of the identity of taurine from the bile, and that from the muscles of oysters and cuttle fish. The presence in the muscles of molluscs of a substance containing 25 per cent. of sulphur, which till now has been found only in the bile, is an important physiological fact; and it seems to us probable, that by directing attention to taurine, the ideas which have hitherto been expressed as to the function of this interesting substance may be modified. Taurine, in the distinctness of its crystalline forms, may be compared to urea, and it presents, both chemically and physiologically, some analogy to that base of animal origin. Both have been artificially produced. M. Strecker has shown that isethionate of ammonia, when heated, produces taurine. It has always been supposed that this substance was a result of the decomposition of sulphuric acid in the bile, and it has been looked upon as an original substance in the body. We think that the results published in this article are likely to modify these opinions, showing that taurine does not originate in the liver, and that it is much more abundant in the animal organization than was generally supposed. These are the chief facts which we present.

Although in this first essay we have examined only a few of the proximate principles of muscles, and have analyzed but a small part of the different groups of the animal series, yet the results confirm a general fact of great importance, set forth in our essay on eggs: namely, that analytical chemistry, while corroborating to some extent the principles which from the first have been used in zoological classification, establishes as a new criterion of distinction, the existence of different substances in animals that are fundamentally different in organization.—(*Silliman's Journal, translated from the Journal de Pharmacie for December* 1855.)

On the Nature of the Involuntary Muscular Fibres. By Professor Ellis.—The following is a summary of the conclusions which the author has arrived at on the main subject of his inquiry:—

In both kinds of muscles, voluntary and involuntary, there is an interweaving of the fibres with the formation of meshes.

The fibres in both kinds are long, slender, rounded cords of uniform width, except at the ends, where they are fixed by tendinous tissue, and in both the size of the fibres in the same bundle varies greatly.

In neither voluntary nor involuntary muscle is the fibre of the nature of a cell, but in both is composed of minute threads or fibrils. Its surface-appearance in both kinds of muscle allows of the supposition that in both it is constructed in a similar way, namely, of small particles or "sarcous elements," and that a difference in the arrangement of these elements gives a *dotted* appearance to the involuntary and a *transverse striation* to the voluntary fibres.

The length of the fibres varies in both cases with the organ or part examined, and the connection with tendon always takes place after the same manner, whether the fibre is dotted or striated.

On the addition of acetic acid, fusiform or rod-shaped corpuscles make their appearance in all muscular tissue; these bodies, which appear to belong to the sheath of the fibre, approach nearest in their characters to the corpuscles belonging to the yellow or elastic fibres which pervade various other tissues: and, from the apparent identity in nature of these corpuscles in the different textures in which they are found, and especially in voluntary, as compared with involuntary muscle, it is scarcely conceivable that in the latter case exclusively they should be the nuclei of oblong cells constituting the proper muscular tissue.

The paper concludes with a statement of the mode of procedure which the author has found most suitable for examining the tissue which forms the subject of his inquiry.—*Proceedings of the Royal Society of London*, June 1856.

On the Electricity of Muscles.—Professor Matteucci comes to the following conclusion in regard to the electric currents exhibited by muscles at rest:—

a. The electro-motive power of a cut muscle is independent of the size of its transverse section.

b. The electro-motive power increases with the length of the muscle.

c. The electro-motive property of the muscles of living or recently killed animals is greater in mammals and birds than in fish and amphibia. The *duration* of this force, which in all cases decreases most rapidly in the first moments after death, is greater in fish and amphibia than in the higher orders of animals.

d. The nerves have no direct influence on the electro-motive force of muscles. In general, all causes which exert an influence on the physical structure and chemical composition of muscles, so as to modify, in ways unknown, their irritability or contractility, act equally on their electro-motive power.—*Proceedings of the Royal Society of London*, June 1856.

Fossil Apes.—M. Fontan has recently discovered, in the south of France, a new fossil ape, allied to the Chimpanzee or Ourang-outang, to which the name of *Dryopithecus Fontani* has been given. It is supposed to have been frugivorous, and to have inhabited trees. There are thus six fossil apes in Europe:—two in Britain, *Macacus eocenus* and *Macacus pliocenus* of Owen; three in France, *Pliopithecus antiquus*, *Dryopithecus Fontani*, and *Semnopithecus monspessulanus* of Lartet, which latter is probably the same as the *Pithecus maritimus* of M. de Christol; and lastly, *Mezopithecus pentelicus* of Wagner, or *Semnopithecus pentelicus* of Lartet, the ape of Pikermi in Greece.

A new Species of Turkey from Mexico.—Mr Gould exhibited a specimen of turkey which he had obtained from Mexico, and which differed materially from the wild turkey of the United States. At the same time this turkey so closely resembled the domesticated turkey of Europe, that he believed naturalists were wrong in attributing its origin to the

United States species. The present specimen was therefore a new species, and he proposed to call it *Meleagris mexicana*, which, if his theory was correct, must henceforth be the designation of the common turkey.—*Silliman's Journal*, July 1856.

BOTANY.

Value of Meteorological Observation as regards the Distribution of Plants.—Much stress is laid upon the value of meteorological observations, but there is no method of tabulating these that offers a prospect of their being applied to the solution of any one general question in the distribution of species. Certain plants will not survive temperatures above or below a given number of degrees; or, in other words, certain sums of temperatures are necessary to the fulfilment of their functions: this all the world knows; but the tabulation of these temperatures has hitherto led to no general laws, for not every family of plants, nor every genus, nor even every species, but often every variety or race, must have its own sum of degrees to insure its continued existence. Nor is this all: the sum of degrees must extend annually over a certain definite period of the year, and must be accompanied with so many favourable conditions of soil, light, moisture, and purity of air, that the mere question of temperature becomes a very subordinate element, however accurately ascertained. So far, then, as meteorological observations are concerned, we must consider that, however accurate they be, they have hitherto admitted of no exact practical application with reference to the distribution of species, nor have they even indicated a theoretical approximation to it.

Next with regard to the limitation of species, genera, and families, within certain areas; this again is subject to no appreciable laws; plants are no doubt governed in their diffusion by conditions of climate and soil, and are dependent for their diffusion on their own powers of endurance, on the time that has elapsed since they first existed as species, on the elements, on the motions of animals, and on geological changes; but we not only know nothing in any case of the time elapsed, and next to nothing of the geological changes they may have survived, but all our attempts have failed to regulate their distribution in elevation or latitude or longitude, by climate, or soil, or other external conditions. Species, Genera, and Orders stop, we see not why, and often reappear where we least expect them. Under this head, too, must be noticed the fact that there is none of that recognisable relation between structure and function, or structure and external conditions, in the vegetable kingdom that there is in the animal, and which often enables us to account for a fact in the distribution of an animal by another in that of a plant. We see the limit of some animal's distribution coinciding with that of the plant it lives upon or under, or that nourishes a third animal it preys upon; but we never see the plant stopped by or for the animal. There are comparatively few evidences of plants being structurally better suited to one situation than to another, with the exception of a few conspicuous classes, as water-plants, epiphytes, parasites, &c.; and hence our power of accounting by physical causes for the facts of Botanical Geography is extremely limited.—*J. D. Hooker, in Journal of Botany*, August 1856.

Progressive Development.—The main facts of Fossil Botany, though few, are well established, and their significance in relation to the question of progressive development is, we think, quite clear. They are—

That *Lycopodiaceæ* existed, and are amongst the earliest known land-plants in the Carboniferous period.

That they were accompanied by many genera and species of Ferns.

That *Coniferæ* are the only other Natural Order, of whose existence, at the same period, there are any very strong indications.

tal experiments of Lindley, who tested the powers of resisting decay possessed by various Natural Orders, show that Ferns, *Coniferæ*, *Lycopodiaceæ*, and *Cycadeæ*, are the most imperishable under water ; which, taken with the fact that the formation of coal is due, in part at least, to a local and not to a promiscuous assemblage of plants, representing the vegetation of the period, reduces the force of the very weak argument, founded on the absence of certain Orders, to a shadow.—*J. D. Hooker, in Journal of Botany*, August 1856.

Notice of the Vegetation of Pichincha. By Dr WILLIAM JAMESON, of Quito, in a Letter to Sir William Jardine, Bart.

The two peaks of Pichincha have been repeatedly visited by me, chiefly with the intention of collecting those plants that approximate to what may be called the extreme limit of vegetable life. On the volcanic soil at the brink of the crater, the only plants that reach that point are *Culcitium rufescens* and *nivale*, *Eudema nubigena* and *Cerastium imbricatum*. My last visit was on the 5th March of the present year (1856). At 12 A.M. the thermometer placed *outside* the wall of the crater indicated 39° ; whereas the same instrument transferred a yard or two *inside* rose to 47°. The warmer current ascending from within, and intermingling with the colder air on the outside, produced a dense cloud of mist which completely intercepted our view.

The following is a list of the plants that occur on Pichincha, commencing at the summit, and descending to about a thousand feet. The numbers refer to the collection transmitted on a former occasion, and still n progress :—

Compositæ (11 species).
 Werneria rigida, 146.
 Aster rupestre, 49.
 Aster ——, 17.
 Baccharis ——, 52, 285.
 Conyza ——, 149.
 Culcitium ——, 161, 173, 595.
 Chuquiraga insiqnis, 401.
 Baccharis thyoides.
Cruciferæ (5 species).
 Draba aretoides.
 —— alyssoides.
 —— ——, 583.
 Eudema nubigena.
 Arabis ——, 292.
Umbelliferæ, (5 species).
 Apium ——, 298.
 Bolax ——, 552.
 —— ——, 530.
 —— ——, 569.
Amaryllidaceæ.
 Alstrœmeria glaucescens. H. et Bonpl.
Orchidaceæ.
 Altensteinia? 578. (If this should really be an orchid, it is the only example of a plant belonging to that family reaching an elevation of 16,000 feet. Oncidium nubigenum and Epidendrum frigidum grow respectively at 14,000 and 13,000 feet of elevation.)
Saxifragaceæ.
 Saxifraga andicola, 3.
Valerianaceæ.
 Valeriana plantaginea, 581.
 —— —— 136.
Malvaceæ.
 Sida Pichinchensis.
Gentianaceæ.
 Gentiana ——, 82.
 —— ——, 514.
 —— sedifolia.
 Swertia asclepiadea.
Gramineæ.
 17, 47, 48, 56, 159.
Juncaceæ.
 150.
Leguminosæ.
 Astragalus ——, 262.
 Lupinus ——, 594, 220.
Caryophyllaceæ.
 Cerastium ——, 139, 497.
 Arenaria ——, 140, 96.
Ranunculaceæ.
 Ranunculus ——, 582.
Grossulariaceæ.
 Ribes frigidum, 504.
Geraniaceæ.
 Geranium, 496, 270.
Gesneraceæ.
 —— ——, 510.
Ericaceæ.
 Gaultheria, 84.
Rosaceæ.
 Alchemilla? 141.
Lycopodiaceæ.
 Lycopodium ——, 289.
Filices.
 Acrostichum ——, 458.
 Asplenium ——, 211.
 Polypodium? 205.
 —— —— 203.
Musci.
 Several, including 2 species of Andræa. Bartramia, 511. Encalypta vulgaris, identical with the plant found on the Scottish mountains.

Hairs in Oleaceæ and Jasminaceæ.—The hairs on the epidermis of Olea have a sort of stellate head, composed of from twenty to thirty cellules, raised on a stalk formed of one of the epidermal cells, and elongated and contracted at the point, where it leaves the cuticle. The free portion of the hair is covered with the cuticle. In the Ash sessile radiating bodies are seen on the epidermis, which seem to be analogous to the hairs of Olea. Similar bodies are seen in Jasminum. Prillieux has also noticed these hairs in species of Fontanesia, Forsythia, Syringa, Picconia, Osmanthus, Phillyrea, Ligustrum, Chionanthus, &c. The number of cellules forming the sessile or stipitate head are frequently four, eight, twelve, sixteen, twenty-four, or thirty. These hairs arise at first as a simple epidermal cell, which divides into two, then into four, and so on.

Similar hairs, only with a larger stalk, often composed of several cells, are seen in *Pinguicula vulgaris*. Hairs like those of *Jasminum grandiflorum* and Lilac are noticed in Callitriche.

Stellate scales and hairs are thus not considered as formed by several cells united, but by the division of one cell, either sessile or stalked, into several cellules.—*Annales des Sc. Nat.*, 4th ser., v. 5.

Temperature of Flower of Victoria regia.—M. R. Caspary has made experiments on the flower of this plant, and has arrived at the following conclusions :—A short time before its opening, the flower bud exhibits an elevation of temperature, especially in the stamens. About an hour after its expansion, the temperature of the flower falls to the extent of from 0·9 to 2·9 degrees of Fahrenheit. After this the heat rises to a maximum, exceeding that of the air, from 14·06 to 24·9 degrees Fahrenheit, and that of the water 1·24 to 10·44 degrees Fahrenheit. This increase of temperature is independent of any change in the heat of the air or of the water. This independent maximum, as it is called, is succeeded by a second period of floral heat, which Caspary calls dependent, inasmuch as it is under the influence of the atmospheric temperature, attaining, like it, the minimum at sunrise, and the maximum a little after mid-day. This second period has two minima and two maxima. The elevation of temperature occurs in the anthers, the filaments, the staminodia, the petals, and the ovules. The greatest heat is exhibited by the anthers; the maximum exceeding that of the water by 6·5 to 13·39 degrees, and that of the air by 19·48 to 29·9 degrees (the latter was observed on 2d November 1855 at 10 A.M.) The filaments are always cooler than the anthers. In the embryos the temperature is not so elevated as in the anthers, and the maximum is only 1·1 to 5·2 degrees above the water, and 4·5 to 18·9 degrees above the air. In the petals and staminodia the increase of temperature is still smaller than in the embryos, the maximum being 2·7 degrees above the temperature of the water, and 6·4 degrees above that of the air. The increase of temperature is different in different flowers, and in the anthers it sometimes attains 61·83 degrees, in the embryos 60·7 degrees. These phenomena are attributed to the absorption of oxygen and evolution of carbonic acid.—*L'Institut*, 28 Mai 1856.

Effect of Salt Water on Seeds.—(1.) Seeds of common cress (*Lepidium sativum*) have germinated well after 42 days' immersion in salt water; they give out a surprising quantity of slime, so as to cohere in a mass. (2.) Radishes have germinated (but not so well) after the same period. (3.) Cabbage seed; after 14 days' immersion only one seed out of many came up; this is rather strange, considering that the cabbage is a sea-side plant; in the ice-cold salt water, however, several have come up after 30 days' immersion. (4.) Lettuce seed has grown well after 42 days. (5.) Of onion seed only a few have germinated after the same period. (6.) Carrot and (7.) Celery seed, well after 42 days. (8.) *Borago officinalis*;

(9.) *Capsicum*, (10.) *Cucurbita ovifera*, have germinated well after 28 days' immersion ; the two latter rather tender kinds were also tried in the ice-cold water, and germinated after 30 days' immersion. (11.) Savory, or Satureja, has grown after 28 days. (12.) *Linum usitatissimum* ; only one seed out of the mass of seeds (which gave out much slime) came up after 28 days, and the same thing happened after 14 days ; and only three seeds came up after the first 7 days' immersion, yet the seed was very good. (13.) Rhubarb, (14.) Beet, (15.) Orach or Atriplex, (16.) Oats, (17.) Barley, (18.) *Phalaris canariensis*, all germinated well after 28 days; likewise these six latter after 30 days in the ice-cold water. (19.) Beans, and (20.) Furze or Ulex ; of these, a few survived with difficulty 14 days ; the beans were all killed by 30 days in the ice-cold water. (21.) Peas germinated after 7 days, but were all dead after 14 days' immersion out of doors, and likewise after 30 days in the ice-cold water. (22.) *Trifolium incarnatum* is the only plant of which every seed was killed by 7 days' immersion ; nor did it withstand 30 days in the ice-cold salt water. (23.) Kidney beans have been tried only in the latter water, and all were dead after the 30 days.—*Experiments by Darwin, Gardeners' Chronicle*, May 1855.

The oblique direction of the Ligneous Fibre, and the Twist of the Trunks of Trees occasioned thereby. By Professor Braun.

The twist of the wood of many trees is a phenomenon well known to wood-cutters, shingle-makers, carpenters, and others, but almost entirely neglected by botanists. The distinguished geologist, the late Leopold Von Buch, appears to have first directed the attention of scientific men to it; and Decandolle, in his *Organographie* (1827), was the first botanist who spoke of it. Professor Braun, in the Proceedings of the Berlin Academy of Sciences, gives the result of a great many observations made on this subject by himself and others in Germany, France, Spain, and America.

Most trees show this obliquity of the woody fibre more or less. In certain species the twist is almost uniformly in the same direction ; in others both directions occur with about equal frequency, while in not a few no twist is distinctly observable. Sometimes the same directions prevail in the majority of the species of a genus, or even of a whole family; in other cases opposite directions occur in the same genus or family ; and it is curious to remark that, in some instances, nearly allied species of Europe and America twist in opposite directions. In a few instances the fibre of a young tree is twisted in one direction, that of the old tree in the opposite direction.

In speaking of the direction, it is necessary to come to an understanding, first of all, as to what we mean by *right* or *left*, a distinction attended with more difficulty than would appear possible. Professor Braun follows Decandolle and others in viewing the twist or coil objectively, imagining himself in the centre of the coil.

The twist of the fibre may be discerned in splitting the wood, or in its cracks when the bark is stripped off, or in the course of the fissures made by lightning. Very often the bark itself, at the angles or superficial lines of the trunk, indicates the direction of the wood within very distinctly.*

No manifest twist has been observed in the species of *Fagus*, *Juglans*, and *Carya*, either in Europe or America, nor in *Ulmus*, *Ailanthus*, *Fraxinus*, *Acer dasycarpum*, *Gleditschia* or *Robinia*, though the latter exhibits a very slight twist to the left. The woody fibre twists to the right in *Pinus Strobus*, *Ostrya virginica*, the chestnut of Europe, the

* We have remarked this twist very evidently in some old fir trees in Braemar, the bark of which had been stripped off so as to leave the wood exposed to the weather.—[*Ed. Phil. Jour.*]

And if the whole number be thus reduced to seven, or perhaps eight, it will be found that the four largest of them have a close parallel among Loganiaceæ, as may be seen by the following comparative statement:—

			Rubiaceæ.	Loganiaceæ.
Ovules several in each cell.	Seeds winged	Flowers numerous on globular receptacles . .	Naucleæ.	. . . .
		Flowers distinct	Cinchoneæ.	Antonieæ.
	Seeds not winged .	Fruit capsular	Hedyotideæ.	Euloganieæ.
		Fruit succulent, indehiscent	Gardenieæ.	Fagræeæ.
Ovules solitary or rarely two collateral.	Fruit succulent		Coffeeæ.	Gærtnerieæ.
	Fruit dry	Stipules interpetiolar, not foliaceous	Spermacoceæ	. . . .
		Stipules similar to the leaves, forming a whorl with them	Stellatæ.	. . . .

The nearest approach to Spermacoceæ among free Monopetalæ must be sought for among Verbenaceæ, although I am not aware of any of them having a sufficiently marked tendency to stipular appendages and regular flowers to be referred to Loganiaceæ, and I know of no genera whatever with free ovaries representing either Naucleæ or Stellatæ. The following table will best show the double arrangement of the known genera of Loganiaceæ, according to the nature of the fruit, or according to the æstivation of the corolla:—

	Æstivation contorted.	Æstivation valvate.	Æstivation imbricate.
Antonieæ.		Antonia. Usteria. Norrisia.	Gelsemium.
Euloganieæ.	Geniostoma.	Spigelia. Mitreola. Mitrasacme.	Polypremum. Logania. Gomphostigma. Nuxia. Chilianthus. Buddleia.
Fagræeæ.	Desfontainea. Fagræa. Potalia. Anthocleista.	Strychnos. Brehmia. ? Labordea.	Nicodemia.
Gærtnerieæ.		Gardneria. Pagamæa. Gærtnera.	

Use of Plants in the Economy of Nature.—That the office of plants in the economy of the world is not so much to purify the air for animals as to supply them with nourishment, may be argued—

1*st*, From the nature of the operation in which oxygen gas is liberated by vegetables. Plants take carbonic acid, water, &c., from the air, and decompose them, giving back to the atmosphere a part of the oxygen, while they transform the rest of the materials into vegetable fabric, or into vegetable products (mostly the prepared materials of vegetable fabric). The raw materials used contain more oxygen than the vegetable matter produced from them does. The surplus oxygen has to be eliminated, and is therefore given off in a free state, which appears to be the essential thing here;—the formation of vegetable fabric, or of organic matter, by which alone the plant can grow, form its parts, and continue to exist; or the evolution of the oxygen gas necessarily separated in the process, and which has to be got rid of.

2*d*, From considering the kind and the degree of the dependence of the animal creation upon these two results of vegetation, namely, the vegetable matter produced and the oxygen gas liberated. Now upon the first, as is well known, the dependence of the animal creation is entire and absolute ; upon the second, only remote and contingent. For vegetable matter so produced furnishes the whole food and fabric of animals. Without it animal life could not have existed at all ; and were its production now to be suspended, all the herbivorous, and then the carnivorous races, would perish almost at once. On the other hand, the amount of the dependence of animal life upon the disengagement of oxygen gas by plants may be estimated by supposing existing vegetation to cease evolving free oxygen, or (which would come to the same thing) by supposing some new operation in the organic world to absorb this element as fast as it is given to the air by plants. How soon would the diminution of the oxygen of the air be felt, even by the higher classes of animals? Making the needful calculations, M. Dumas has answered this question by assuming that the unbalanced action of the whole animal kingdom for a century would not consume more than 1-8000th part by weight of the oxygen of the atmosphere, " a quantity altogether inappreciable to the most delicate means of investigation we possess at the present day, and which certainly would have no influence on the life of animals ;"—that, as respects the higher races of animals, " it would require no less than 10,000 years before all the men on the face of the globe could produce an effect which should be sensible to *Volta's eudiometer*, even supposing vegetable life to be extinct during the whole of this time ;"—so vast is the original stock of this important element of the atmosphere.

Surely, then, we ought not to call this remotely needful action upon the air the essential office of vegetables in the economy of the world, nor view as a subordinate or concomitant end that operation of organizing matters which provides the whole animal creation with sustenance, and the failure of which for a single year would depopulate the earth. Nor should we call that the essential office of vegetation, which certainly was not essential (as the other was) to the existence of an abundant animal life before and during the epoch of the coal formation, and which (however propitious) has not been proved to be necessary even to the existence of man.

Of course there is no question here of this as a function of vegetation, and of the reciprocal action of the two kinds of organized beings upon the air, as maintaining the balance of its elements ; but even here it is not always considered that, as Sir Boyle Roche once said, " the reciprocity is all on one side ;" that though the animal kingdom could not exist at all without the vegetable, yet the vegetable kingdom might very well exist and flourish without the animal. In other words, the vegetable creation is a provision for the animal,—immediately and continually essential, in one respect ; remotely and contingently needful, possibly essential to its well-being, but not to its being,—in the other.—*Dr Asa Gray, in Silliman's Journal*, May 1856.

Ægilops triticoides.—Dr Regel of St Petersburg and M. Godron maintain that *Ægilops triticoides* is a hybrid between wheat and *Ægilops ovata*,—the pollen of the wheat having been applied to the latter. A hybrid between two genera, always, according to Regel, bears the generic type of the plant which furnished the pollen. The hybrid then between Ægilops and wheat is a true *Triticum ;* its glumes and paleæ are not, as in the Ægilops, concave, but they are carinate. Regel says that the pollen of *Ægilops triticoides* (the hybrid) is sterile.—*Berthold Seemann, in Gardeners' Chronicle*, 30th Aug. 1856.

CHEMISTRY.

Ozone.—Mr Scoutetten states that he has made a certain number of experiments which seem to prove that the ozone of the atmosphere is formed—1. By the electrization of the oxygen secreted by plants; 2. By the electrization of the oxygen which escapes from water; 3. By the electrization of oxygen disengaged during chemical action; 4. By electrical phenomena reacting on the oxygen of the air. He adds that a series of varied and repeated experiments appear to show—1. That plants as well as water furnish constantly to the atmosphere ozone during the day; 2. That this phenomenon ceases during night; 3. That it is suspended during the day by withdrawing water or plants from the action of direct light, as by putting them in the diffused light of a room, or covering them with a piece of linen or a sheet of paper; 4. That ozone is not produced when boiled distilled water is used; that the same thing takes place when plants are introduced into a bell-jar filled with this boiled water, or when ordinary boiled water is used with a layer of oil on the surface to prevent absorption of atmospheric air; 5. That the formation of ozone takes place when the water and plants are inclosed in a glass globe suspended at a distance from the earth by a thread. He remarks that ozone is nascent oxygen, and that it is to properties which oxygen acquires by positive electrization that we must attribute the combinations it forms, and which cannot be accomplished by pure oxygen. Ozone is formed in the atmosphere by continuous invisible electrical currents, as well as by successions of sparks, more or less powerful. M. Wolf, of Berne, attributes many diseases to the effects of atmospheric ozone. By observations made at Berne in 1855 he endeavours to show a remarkable correspondence between the variations in the quantity of ozone in the atmosphere, and the changes in the intensity of an epidemic dysentery at Berne in the months of August and September.—*L'Institut*, 28 Mai 1856.

M. Ch. Brame confirms these observations as to ozone being given out by plants under the influence of the sun, and as to its existence in rain-water. He attributes in a great measure to ozone the formation of the nitrate of ammonia met with in rain-water.—*L'Institut*, 6 Août 1856.

Professor W. B. Rogers has also made observations on ozone in the atmosphere.

In making his observations, Professor Rogers uses the prepared paper and scale of colours of Schönbein's Ozonometer, which, although imperfect as a means of comparison, is the best for practical use yet devised. The slip of paper is suspended out of doors in a box open only at the bottom, so as to be shielded from the rain and snow, and from strong light, at the same time that it is freely exposed to the air. Usually, it is allowed to remain in this position for twelve hours, when it is removed for observation, and a fresh slip substituted; but when there are indications of a great prevalence of ozone, the test is examined, and renewed at shorter intervals.

On comparing the recorded observations for the past six weeks, Professor Rogers has been struck with what seems to be a fixed relation between the direction of the aerial current and the amount of ozone prevalent at the time. As long as the wind continued to come from eastern or southern points, he found the ozone to be nearly or quite absent; but whenever the current has changed to west or north-west, the test-paper unfailingly indicated its presence in considerable force. The rapidity and amount of this effect has always been greatest when the wind has hauled suddenly to west and north, and has blown violently, but it has continued to manifest itself, although with slow abatement, as long as the current held from this quarter.

To illustrate this effect, Professor Rogers referred to examples within the present month (February). Thus, on the 11th, the wind being light from west by south and south-west, there was no indication of ozone, and

PHYSICAL GEOGRAPHY.

On the Inland Sea of Central Africa. By M. Erhardt.

Vague reports have long since been heard by the missionaries in Eastern Africa of lakes; of mountains, isolated and in masses; and of a country whose slope and drainage was towards the interior. At Mombas few opportunities offered themselves of meeting with travelled natives; but it was quite otherwise both at Fuga and at Tanga. At both of these places the missionaries stayed many months, and made acquaintance with caravan-leaders, Arabs, Suáhelis, ivory-merchants, and slave-dealers, whose reports corrected and corroborated what had been told to them before. There are three main sets of routes from the coast to the interior, all of which pass over a flat country, and finally lead to an immense lake of fresh water. Mr Erhardt calls this the "Sea of Uniamesi," from the country that affords the greatest extent of its eastern shores. But the Waniamesi, the inhabitants of that country, call it "Ukerewe:" elsewhere it is called "Niandja," and its southernmost extremity "Niassa."

The routes are as follow, and all of them run westerly:—1st. That of the ivory-traders from Tanga, who, threading various isolated masses of hills, of which Kilmandjaro and Doenyo Engai are snow-capped, passes through the level pastoral country of Masai to a place called Burgenei. This route—taking the average of four journeys, the particulars of which are given—occupies fifty-five days, the rate of travel being about seven hours a-day. His informants travelled eight days further from Burgenei, through a tract peopled densely with Waniamesi, and then came suddenly upon the lake. The Masai are fierce and pastoral; the Waniamesi kind-hearted and agricultural. 2d. That from Mboa Maji to Ujigi, a town of Uniamesi. This is of equal length to the first route, and is travelled leisurely by numerous caravans, with horses, donkeys, &c., for slaves, ivory, and copper ore. The country passed over is perfectly level, with the exception only of a mass of hills, the Ngu, which has to be crossed about a quarter of the way from the coast. 3d. Those from Kiloa or Kirimba, to the ferries Gnombo and Mdenga. They are travelled by Portuguese slave-dealers as well as by Arabs.

In tracing the contour of the lake, he begins from the south. He speaks of people who come up from its shores two days' journey to the southwards of the ferry Mdgena (which is stated to be due west of Wuibu) in order to cross the lake, for they know nothing of its southern termination. From Mdenga to Gnombo is five days—two hard days further to Sigono, a "heel." Here the shore of the lake makes a great *heel*, and turns to the westward of north for seven days, when a wild elephant-country is reached. The shore now runs due west for six days to the Waniamesi. Among them, for twelve days further, the shores run due E. and W.; and in another twelve days further, a tribe, the Wafipa, is reached, in whose country is a small salt-water stream, of which much notice is taken, and which is spoken of as running westwards from the Wafipa to the Wapogo.

A traveller from Ujigi, going due south along the shores of the lake, reached the salt river in the Wapogo country in seven days: here, he says, the sea made "quite a round bend." This great bend is confirmed by fishermen of the lake. From Ujigi northwards to the great river of the Wadusi was sailed by an Arab, but detailed itineraries are wanting. A considerable portion of its southern and western shores is traced out on similar evidence. Ujigi is the starting-point for large row-boats to cross the lake to the opposite shore: in five days' rowing they reach a mountainous island, Kavogo. Twenty-five more days takes them to the opposite shore, where they buy copper. The above-mentioned Arab sailed across the sea in twelve or fifteen days, and was nine days in returning.

The lake appears to be remarkable for its low, sandy, and reedy shores, except only at its southern extremity, where it runs along the base of a steep range of hills. Its waves run very high, and an entirely calm day is rare. Its water is sweet and good, and abounds with fish. There are very few islands visible anywhere from the coast, and the above-mentioned Arab, who twice crossed it, saw none. A large part of its shores teems with a population "like an ant-hill." Its northern extremity is unknown, but it may be at the foot of a range of mountains which stretch westward to the north of Burgenei. The river of the Wadusi, on the northern part of its east coast, is an enormous river, but very sluggish.—*Church Missionary Intelligencer*, August 1856.

MISCELLANEOUS.

African Tribes.—The "Ackbar," an Algerian newspaper, presents this interesting fact in the following paragraph, under the date of January last:—

A considerable sensation was created on the 6th at Algiers by the arrival there of a deputation of four Arabs belonging to a tribe inhabiting the Great Desert, and known under the name of Tooaregs.* Since the conquest of the country bordering on the Great Sahara has been effected by the French troops, it has become a matter of interest to the French government to establish a friendly intercourse with the tribes inhabiting the desert itself, a space measuring upwards of 400 leagues from north to south—that is, from Onargia, the last oasis occupied by the French, to Timbuctoo. The tribe above mentioned is divided into eight different branches—the Azguer, bordering on the regency of Tunis; the Hoggar, inhabiting the mountainous range of that name; the Ahir, lying south of R'at; the Ennebigh, or Lemden, in the vicinity of Timbuctoo; and the Kelooel, the Boodal, the Kelgures, and the Itissa tribes, occupying the country between the black population of the Soodan, and the far whiter races inhabiting the north of Africa. The Tooaregs are very nearly white. They inhabit tents made of tanned hides, and live chiefly on the produce of the chase, their camels, and a kind of fleeceless sheep called *deman*, of which they possess immense flocks. In the south they cultivate rice and maize; those of the north have but lately turned their attention to agriculture. The men wear two long gowns, a white and a blue, of Soodan manufacture, a kind of woollen or silk caftan reaching to the ground, and wide trousers, closing at the ankles, with a gaudy trimming all round. They wear no stockings, but red leather sandals of good workmanship. On their heads they wear a red skull-cap, covered with a kind of turban, from which a blue veil descends as far as their mouths; a kind of cravat, beginning from the occiput, covers the lower part of their faces, thus quite hidden from view; while their women, on the contrary, wear no kind of veil, and enjoy the greatest liberty. Their weapons consist of a long poniard, called *deraia*, and a double-edged sabre, a lance, a musket, and a shield made out of an elephant's ear. The deputation above mentioned was received in a most friendly manner by the Governor-General of Algiers, their own behaviour being respectful and dignified in the extreme.—*Church Missionary Gleaner*, June 1856.

On the Action of Urari and Strychnia on the Animal Economy. By Professor ALBERT KÖLLIKER of Wurzburg.

The communication which I now offer to the Royal Society contains a brief statement of the results of a series of experiments which I lately made on the action of the urari poison and of strychnia on the animal economy.

* Frequently spelt "Tuarics."

I. Urari.

The urari is the well-known poison from Guiana, also called Curare and Woorara. That which I employed in my experiments I owe to the liberality of my friend Professor Christison of Edinburgh. The following are the conclusions at which I arrived respecting its operation:—

1. The urari causes death very rapidly when injected into the blood or inserted into a wound; when introduced by way of the mucous membrane of the intestinal canal its effects are slow, and require a large dose for their production, especially in mammalia. When applied to the skin of frogs it is altogether inoperative.

2. Frogs poisoned with very small doses of urari may gradually recover, even after it has produced complete paralysis of the nerves. Mammalia may also be restored, even after large doses, provided respiration is maintained artificially.

3. The urari, *acting through the blood, destroys the excitability of the motor nerves.* In frogs under its operation the terminal branches of these nerves within the muscles lose their excitability in a few minutes, whilst their trunks become affected an hour or two later. If, after the nervous extremities have become paralysed, the heart of the animal be excised so as to prevent the nerves from receiving any further share of the poison, the nervous trunks may retain their excitability for three or four hours.

4. The brain is less affected by the urari than the nerves in the muscles; still when, by ligature of the two aortic arches, in frogs, the poisoning is confined to the anterior half of the body, the voluntary movements of the limbs speedily cease, whilst automatic movements, of doubtful nature, and probably proceeding from the medulla oblongata, may be still observed for half an hour or an hour after the poison has begun to operate.

5. The spinal cord is considerably less affected than the brain by this poison; and by local limitation of the poisoning (as in No. 4), it is found that the cord retains its *reflex activity* from half an hour to an hour and a half, and the excitability of its white substance or its conducting power from two or three hours after the poison has taken effect. It is worthy of remark that in such cases the impaired reflex activity of the spinal cord may be revived by strychnia directly applied to it.

6. The *sensory nerves*, as shown also by locally limited poisoning, retain their functional activity as long at any rate as reflex actions can be excited; and when the depressed reflex activity has been revived by means of strychnia, these nerves are found not to have been in the slightest degree injured, so that it seems doubtful whether the urari in any way affects them.

7. *The nerves of the involuntary muscles and of the glands* are also paralysed by the action of urari, at least I find this to be true in the following cases, viz.:—

a. The pneumogastric, as regards its influence on the heart.

b. The sympathetic (its cervical portion), in its relation to the iris.

c. The nerves of the posterior lymph-hearts of the frog.

d. The nerves of the vessels in the web of the frog's foot.

e. The splanchnic nerves of the rabbit, as affecting the peristaltic motions.

f. The nerves governing the secretion of the submaxillary gland in dogs.

8. *The voluntary muscles* remain perfectly excitable, but show a greater tendency than usual to merely local contractions. In general the cadaveric rigidity of these muscles appears to set in later than usual.

9. *The plain or non-striated muscles* also remain long irritable after poisoning by urari.

10. The heart, in amphibia, is little affected by urari. Its pulsation

cord, produce the tetanic contractions as reflex movements; and, secondly, *through the brain*, which is not affected at all by strychnia, and preserves its powers of volition and sensation. Accordingly, animals poisoned with strychnia try to move in the ordinary way, but every attempt brings on a tetanic fit, so that it is plain that the spinal cord may also be excited by the brain to its peculiar actions.

6. If the tetanus produced by strychnia has been strong, the *muscles are less irritable*, and pass much sooner into the state of *cadaveric rigidity*, which is very strongly marked, and seems to last longer than it generally does. The same early onset of rigidity may be observed in animals killed by tetanus excited by electricity.—*Proc. Royal Soc. Lond.*

Detection of Strychnia.—Dr Herapath states that by means of the optical properties of iodo-strychnia, he is able to recognise the 10,000th part of a grain of strychnia in pure solution.

In order to operate in this experiment he uses dilute spirit of wine (1 of spirit to 3 of water) as the solvent medium, and employs the smallest quantity of the mixture of iodine as the re-agent, and after applying heat for a short time sets it in repose. On spontaneous evaporation or cooling, the optical crystals deposit themselves, and may be recognised by the polarizing microscope.—*Proceed. Royal Soc. Lond.*, June 1856.

Since the publication of our April number science and art have lost some old and well-tried members:—

William Yarrell, F.L.S., &c.—Early on Monday morning, the 1st of September, died, at Great Yarmouth, William Yarrell. About three years ago some premonitory symptoms of indisposition had shown themselves. They made little impression, however, on either the natural cheerfulness of disposition or the active intellect of our departed friend and naturalist. However, on the 3d of August last, as he was returning from the church, a slight giddiness seized him, and he felt himself for a moment unable to proceed. After a short pause he reached home without assistance. The attack, however, was so far then thrown off that, although he felt himself constrained to decline invitations of pleasure, his attendance to matters of business was uninterrupted. A few days before his death he appeared at the Council of the Linnean Society with his usual cheerfulness and clearness of head.

The following Saturday he accompanied a friend (himself an invalid) to Yarmouth, enjoyed (as was his wont) his voyage, and went to bed on Sunday with the anticipation of a more than ordinary share of good and refreshing sleep—his appetite good, his spirits good, his strength unimpaired. He was seized, however, soon afterwards, with a difficulty of breathing, upon which he got up and unlocked the door, in order that assistance, if required, might be obtained without difficulty. On returning to bed the symptoms increased, and he assented to the suggestion that a medical man should be called in. This was done promptly, but without effect. About half-past twelve on the Monday morning he expired calmly, and without pain.

A telegraphic message being transmitted to his friend and executor Mr Van Voorst, the removal of his remains to London, and thence to Bayford in Hertfordshire, was effected. Here he was the last buried of twelve brothers and sisters, a father, and a mother.

In September 1854 he transferred to the album of a relative the lines from Wordsworth,—

> "First and last,
> The earliest summoned and the longest spared,
> Are here deposited."

Adding that this was what he wished to be his epitaph.

The immediate cause of death seems to have been disease of the heart, the previous symptoms of paralysis being but indirectly connected with it. No autopsy, however, was made.

Street, St James', where his father (in partnership with his uncle) was a news-agent. His son continued the business, a removal to the corner of Little Ryder Street being one of the few events in his quiet and simple life. For many years the house was familiar to all naturalists, and to visitors of every rank from the country, not to mention foreigners, to whom the reputation of one of the soundest living zoologists was well known, and who never visited it without being struck by the kind and communicative manners of its hospitable inmate.

A few months of his life were spent as a clerk in the banking-house of Messrs Herries, Farquhar, and Company. Before, however, he was eighteen he had decided upon joining his cousin in a more independent mode of life—independent, but of a remarkably even tenor, more so even than that of scientific men in general, so proverbial for the uneventful character of their lives. As a young man he was fond of shooting and angling, in both of which he excelled. A Londoner by birth and residence, and a Londoner in many respects by education, he was, as long as the rod and the gun were the chief pursuits which attracted him to the open downs of Cambridgeshire or the undulating fields of Herts (Royston, the residence of Mr Wortham, and Bishop-Stortford, of Mr Nash),—a sportsman amongst sportsmen, but never that exceptionable or equivocal personage denominated a sporting character. Some of his friends were such; but Mr Yarrell, though skilful enough to have done so, never made a practice of backing his own skill by heavy wagers. His tastes were, upon the whole, those that the *rus in urbe* well suited—better, perhaps, than the unmixed country. They were those of Isaac Walton—citizen and angler, rather than those of the full and perfect yeoman.

His first publication was "Notices of the occurrence of some rare British Birds he observed during the years 1823, 1824, and 1825," published in the Zoological Journal for March 1825. In 1827, the "Observations on the Tracheæ of Birds," &c. were published in the Linnean Society's Transactions; and in the same year, in those of the Royal Society, one "On the change in the plumage of some Hen Pheasants." This gave him, to say the least, a *locus standi* for a Fellowship. His name, however, was withdrawn, doubtless on the strength of certain misgivings as to his chance of election. His connection with trade was against him. Under the new and more liberal *regime* of the last ten years, every facility for entrance was offered him. He looked, however, to advancing years, and declined the honour that many friends, not without the influence sufficient to ensure his election, would willingly have pressed upon him.

His *last* work was a paper "On the influence of the Sexual Organ in modifying External Character," in the Journal of Proceedings of the Linnean Society for the present year.

Between these two extremes (to say nothing about his contributions to serial literature), his two *opera magna* were—(1.) "The History of British Fishes;" and (2.) "The History of British Birds,"—works which it is enough to name. The introduction to his publisher, Mr Van Voorst, was made by their common friend, the librarian to the Duke of Bedford, Mr Martin, perhaps the most intimate of Mr Yarrell's old companions, and one whose death (a few months previous to his own) he deeply felt.

We have said that the habits of Mr Yarrell, angler and ornithologist as he was, were eminently those of a Londoner. And so they were. He loved society; he loved glees (and sung them well); and at one time of his life was a frequent attendant at the theatres.

It is not, then, only as a loss to zoology that he is regretted. Strong social instincts, geniality of temper, warmth of heart (exhibited in an extreme fondness for children), made him loved; even as his simple and straightforward independence of character made him respected. His advice, too, was always valued—freely asked and freely given; for his mind was observant, active, practical, and wholly unclouded by fancies or prejudices; his knowledge varied and accurate. Indeed, he was essentially a reliable man; knowing what he knew well, and caring to undertake nothing that he was likely to fail in. For this a strong will and perseverance is needed, and that he had. It was strong enough, too, to keep a warm but somewhat irritable temper in thorough control; for Mr Yarrell, knowing what was due to himself, knew also what was due to others. He helped many not only by his advice but by his purse, ever valuing money for its uses only, never for its own sake; moderate (as a man of business) in his aims, though attentive to what he undertook; hating waste, yet never ambitious of accumulation.

His purely intellectual character is seen in his works. The part which the author himself always took most credit for was the geographical distribution of the several species of Birds. He always considered that, in treating it as he had done, he smuggled in a certain amount of geography in the garb of ornithology. For the high qualities of accuracy, terseness of description, and felicity of illustration, they speak for themselves.

Dr Buckland, late professor of geology in the University of Oxford, died at Clapham, 14th August 1856, aged 72.—*Sir Richard Westmacott, R.A.*, a veteran sculptor, a bold and powerful draughtsman, and an able lecturer, died in London, in the 82d year of his age.—*Sir John Ross, K.C.B.*, our earliest modern Arctic navigator, as well as one of our latest, for he was chosen to command Lady Franklin's private expedition a few years since, has died at the age of 79.

We have also to record the death of Professor Bojer, the well-known botanist of the Mauritius, at the age of 56. This sad event took place on the 4th of June last. Wenceslaus Bojer was born at Prague, in Bohemia. Under the auspices of the Emperor of Austria, he visited, in early life, Madagascar and the eastern shores of Africa, where he made valuable collections of plants for the Vienna Herbarium. In 1820 he visited Mauritius, and subsequently undertook a second voyage to Madagascar and the African shores. In 1837 he published his *Hortus Mauritianus*, or Account of the Flora of the Mauritius. At the time of his death he was engaged in drawing up an illustrated monograph of the genus Mangifera, which, it is hoped, will be in such a state as to admit of its publication. He was instrumental, along with others, in founding a Natural History Society in the Mauritius. About a year before his death he was appointed Professor of Natural Philosophy in the Royal College there.

PUBLICATIONS RECEIVED.

Quarterly Journal of the Chemical Society. July 1856.

Journal of the Asiatic Society of Bengal, Nos. I. and II., for 1856.

Proceedings of the Geographical Society of London for May and June 1856.

L'Institut from June to 27th August 1856.

Sir David Brewster on the Stereoscope.

Mallet on the Physical Conditions involved in the Construction of Artillery.

New York Meteorological Observations. Compiled by Dr F. B. Hough. 1855.

Annual Report of the Trustees of the New York State Library. 1856.

Williams' Prize Essay on the Prevention of the Smoke Nuisance.

Adolf Zeizing, das Normalverhaltniss der Chemischen und Morphologischen Proportionen. Leipzig, 1856.

Journal of the Indian Archipelago and Eastern Asia for October, November, and December, 1856.

Admiral Beechey's Address at the Anniversary Meeting of the Royal

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