THE POPULAR SCIENCE REVIEW.

A QUARTERLY MISCELLANY OF ENTERTAINING AND INSTRUCTIVE ARTICLES ON SCIENTIFIC SUBJECTS.

EDITED BY HENRY LAWSON, M.D.

VOLUME XII.

LONDON:
ROBERT HARDWICKE, 192 PICCADILLY;
AND ALL BOOKSELLERS.
1873.

THE

POPULAR SCIENCE REVIEW.

A QUARTERLY MISCELLANY OF ENTERTAINING AND INSTRUCTIVE ARTICLES ON SCIENTIFIC SUBJECTS.

EDITED BY HENRY LAWSON, M.D.

VOLUME XII.

LONDON:
ROBERT HARDWICKE, 192 PICCADILLY;
AND ALL BOOKSELLERS.
1873.

LONDON: PRINTED BY
SPOTTISWOODE AND CO., NEW-STREET SQUARE
AND PARLIAMENT STREET

CONTENTS OF VOL. XII.

Fig. 1. (*Bessemer*)

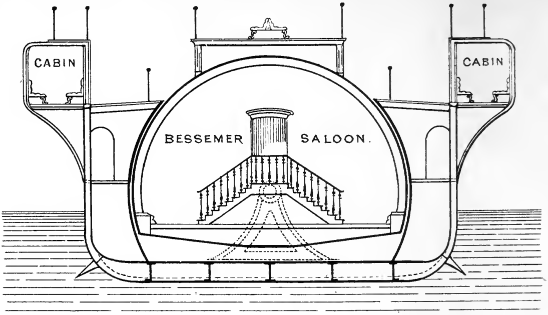


Fig. 2. (*Dicey*)

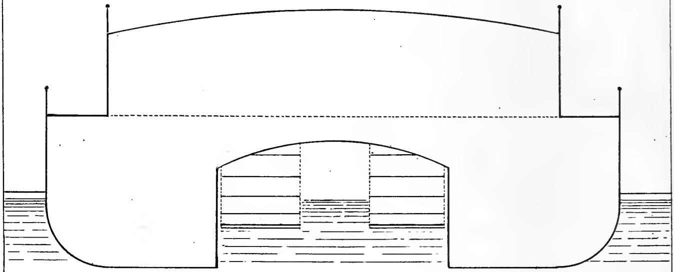
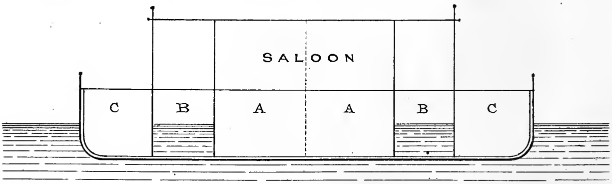


Fig. 3. (*Mackie*)



A.....*Main Hull, Engines &c.*
B.....*Waterways*
C.....*Outer Hull, Cargo &c.*

W. West & Co. Lith.

Transverse Sections of Vessels for the Channel passage.

POPULAR SCIENCE REVIEW.

STEAMSHIPS FOR THE CHANNEL PASSAGE.

By C. W. MERRIFIELD, F.R.S.

[PLATE XCII.]

Errata in the last Number

Page 343, lines 37 and 38, *for* shower masses of pink through the walls of its
read show as masses of pink through the walls of the

Popular Science Review, October

capital is quite out of proportion to any probable traffic return. It is easy enough to talk in general terms of absorbing the whole of the continental passenger traffic, increased by a safe and comfortable means of transit; but in the first place it is not possible to secure all or nearly all of it at renumerative rates, and secondly the whole annual number of passengers is very limited. We in England are apt to talk as if the channel passage were of even greater importance to Europe than to ourselves. The fact is the reverse. It is a primary matter to us, a secondary affair to France and Belgium, and a thing of very small concern to anybody else. It is the English who have most to gain by it; and on England, therefore, in some shape or other, the charge will ultimately fall. In so far as they depend upon passenger traffic across the channel, large engineering works cannot be renumerative. It is true that a company may be promoted, and that it may make the fortune

Fig. 1. (*Bessemer*)

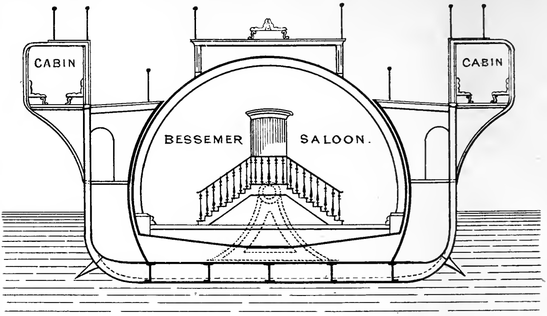


Fig. 2. (*Dicey*)

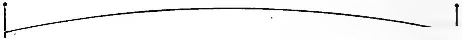
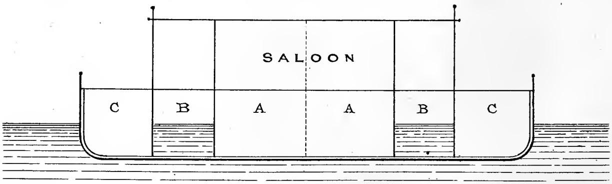


Fig. 3. (*Mackie.*)



A. .... *Main Hull, Engines &c*
B. .... *Waterways*
C. .... *Outer Hull, Cargo &c*

W. West & Co. Lith.rs

Transverse Sections of Vessels for the Channel passage.

POPULAR SCIENCE REVIEW.

STEAMSHIPS FOR THE CHANNEL PASSAGE.

By C. W. MERRIFIELD, F.R.S.

[PLATE XCII.]

THE ambitious schemes for the formation of harbours on one or both sides of the channel, and the still more extravagant proposals for tunnels and bridges, can hardly be considered as being of any immediate public interest. An estimate of the profit and loss account is sufficient to settle this part of the question to the satisfaction of any but an enthusiastic inventor or an interested promoter. Not that it would be at all safe to assert that such things will never be done, or that they may not be useful when done. Bigger bubbles than these, and blown with less soap, too, have been looked upon before now as solid investments by confiding capitalists. In all these schemes the dead-weight charge of interest on an enormous capital is quite out of proportion to any probable traffic return. It is easy enough to talk in general terms of absorbing the whole of the continental passenger traffic, increased by a safe and comfortable means of transit; but in the first place it is not possible to secure all or nearly all of it at renumerative rates, and secondly the whole annual number of passengers is very limited. We in England are apt to talk as if the channel passage were of even greater importance to Europe than to ourselves. The fact is the reverse. It is a primary matter to us, a secondary affair to France and Belgium, and a thing of very small concern to anybody else. It is the English who have most to gain by it; and on England, therefore, in some shape or other, the charge will ultimately fall. In so far as they depend upon passenger traffic across the channel, large engineering works cannot be renumerative. It is true that a company may be promoted, and that it may make the fortune of the engineer and of some of the early directors; and it is also true that if the works succeed in their material intention—of which there is, perhaps, almost an even chance—the shareholders will enjoy the satisfaction of having conferred upon their country a benefit as enduring as their structures. Their patriotism will be its own reward.

More reasonable projects are those which have in view the use of the existing harbours, either as they now are, or with such improvements as the local authorities could be induced to make without large contributions from the companies; and which propose to substitute large, safe, and comfortable vessels, with special provisions for preventing or alleviating sea-sickness, for the present mail steamers—passenger steamers it would be absurd to call them. I make this remark advisedly. The boats are admirably suited to the mail service, and to the light goods traffic, especially in fruit and fish, which take up so much of their available deck space. But a fishing lugger, with its hold cleared for a sailing party, or a tug chartered for a cheap trip, usually carries its passengers with less discomfort than the best means which English enterprise has furnished for the most important sea-ferry in Europe. I know of nothing more disgusting than the main cabin of these channel steamers on a wet night, unless it be the ladies' cabin; and it is a marvel to me how a nation which prides itself on the care with which it protects women from all coarse contact, can submit to see gentlewomen exposed to crowding and filth in the midst of which decency is scarcely possible, and delicacy is out of the question.

Apart from the discomforts of overcrowding, small boats have much more motion than large ones; and it is a general result of experience that, under like conditions in other respects, the sea-sickness varies inversely as the size of the ship, being very severe in small vessels and scarcely felt in very large ships. The ailment itself appears to be of a rather complex character, both in its causes and its effects, and the exact relation of each separate cause and effect does not appear to have as yet been completely disentangled from the others. That its ultimate cause is solely and entirely the motion of the ship, there is no doubt at all; but physiologists are by no means agreed as to the chain of operation, or the intermediate detail which separates the primary cause from its final result. Some attach more importance to the changes of mechanical pressure induced by the varying motion; others to the optical effect reacting on the stomach through the brain. My own opinion is that with unseasoned travellers either of these causes is alone sufficient to produce the sickness, and that they are generally in simultaneous operation; but that the mechanical is the leading one. We know that there *is* mechanical cause. When a man is standing or sitting, the weight of his intestines is taken by the pelvic bones, and through the reaction of these there is but little upward pressure against the stomach, diaphragm, and liver, which are supported by the scaffolding of the spine and ribs. When this reaction is prevented by the ship sinking from under one's feet, the elasticity of the intestines is no longer controlled by gravity, and they are free to press upwards against the stomach and other organs. Elsewhere than at sea, we know that this relief of weight does produce uneasiness. A qualm is felt in the descent from a swing, and in jumping feet foremost from great heights, while no such feeling is experienced in a high dive taken head foremost. The alternation of this pressure is quite a sufficient cause of irritation to produce sickness. A very remarkable confirmation of this view is afforded by the fact that sea-sickness in women occasionally presents different and far more serious symptoms than it is usual to meet with in the case of men.

Whether the optical effect be alone sufficient to produce sea-sickness in an ordinary person may be open to doubt; but there is no denying that it very much enhances whatever effects may be due to the mechanical causes, especially the distressing giddiness which is a frequent symptom. Giddiness is not solely due to optical causes. I have seen a child make itself sick by turning round and round with its eyes shut. I draw from this the further inference that the amount of motion necessary is not very great, if it be sufficiently long continued.

The upward and downward motion on board a ship is due not only to the upward and downward movements of the ship as a whole, but also to the rocking, whether rolling or pitching; just as in a see-saw the ends of the plank move up and down, although the plank, as a whole, has no vertical motion, seeing that it turns on a fixed pivot. There is no such fixed pivot in a ship: every point of it moves; but at the extreme ends and sides this see-sawing is added to the unsteadiness of the middle part of the ship, which accordingly seems to be comparatively still.

The uneasiness of a ship is greatly enhanced by the continually varying mixture of heaving, rolling, and pitching, which prevents our adapting ourselves to the motion in the same way that a little muscular action, combined with the selection of a suitable attitude, enables us to meet a simple oscillation like that of a swing. Any mechanism which simplifies the motion will therefore probably tend to reduce sea-sickness.

One point, which is common to all the improved designs of ships for the channel passage, is large size. The harbours on the French coast impose considerable restrictions upon this, especially as regards draught of water. At or near low water, six or seven feet is all that can be depended upon, and this only in still weather. With large boats, accordingly, any idea of a service at fixed hours, irrespective of tide, must be abandoned, and there will also be certain rough days in which small mail steamers can enter the harbours when the larger boats cannot do so with safety. There can be no question, however, that no real improvement can be effected without larger boats. Three or four years ago the Society of Arts offered a prize for a model of good arrangements for deck passengers aboard vessels of the same size as those now in use. Of more than twenty models submitted for adjudication, only three or four complied with the conditions laid down as to size, and these three or four showed no real improvement. Under these circumstances no prize could, of course, be awarded; but it was quite evident to the writer (who was one of the committee), that the limitation as to dimensions rendered a good deck arrangement impracticable. The only really improved designs postulated increased dimensions.

Of the schemes which have been laid before the public, while there are several which aim at reducing the amount of motion, and of consequent sea-sickness, by due proportion and dimension, there is only one which takes special and direct means of securing that the passengers shall not partake of the motion of the ship. That scheme is Mr. Henry Bessemer's.

Most of our readers must have noticed the way in which a ship's compass, and the cabin barometer, are suspended—in a sort of universal joint, commonly called jimbals. The idea of suspending a cabin in this way is no novelty; but there were several practical difficulties in the way of carrying it out on a large scale. The double pivoting makes rather an insecure connection between the large moving weight and the structure of the ship. There are also difficulties about getting in and out of such a cabin. Moreover, there is no really fixed point in a ship at sea, and the motion of the point of suspension reacts upon the suspended mass, which thus acquires an oscillation of its own. Oscillations have a regular rhythmical period, like a musical note, and every freely suspended body has its own note, or periodic time. If it happens that the periodic time of the suspended cabin coincides, absolutely or approximately, with that of the point of suspension, there may be an accumulated roll far in excess of that of the ship itself. A freely suspended cabin, therefore, would not answer the intended purpose.

The point of Mr. Bessemer's invention consists in the steadying of the cabin being controlled by hand instead of acting automatically. A man sits at a lever, by which he commands hydraulic machinery which adjusts the position of the cabin relatively to the ship. He has a spirit-level in front of him, by which he keeps the level, just as the helmsman keeps his course by means of the compass. This retention of controlling power appears to me to be the chief point of the invention. It is by no means the only point in the actual design, about which there are many features, constituting in their entirety a very bold and original as well as an ingenious design.

The steam-ships which are to carry this swinging cabin have been designed by Mr. E. J. Reed, C.B. The following description is taken from information furnished by the designers :—

"These steam-ships are double-ended, and are propelled by four large paddle-wheels, two at each side. The ends are kept low for the purpose of reducing the motions produced by the action of the wind and of the sea, and the middle portion is made sufficiently high to enable them to steam at a high speed against the worst seas they will have to meet. A rudder is fitted at each end, with means for locking, so that the ship will be able to steam in either direction, and will not require to be turned round in harbour.

"Each steamer will be 350 ft. long, 45 ft. wide along the deck beam, and 65 feet wide across the paddle-boxes. She will draw 7 ft. 6 in. of water, the same as the present steamers, and will be propelled at a speed of twenty miles per hour, by two pairs of engines of the collective power of 4,600 horses. The centres of the two pairs of paddle-wheels will be 106 ft. apart.

"The great peculiarity, however, of these ships is that each will contain a large saloon, designed by Mr. Bessemer, suspended in the middle of the ship in such a way that it can be moved about a longitudinal axis parallel to the keel. The motion of this saloon, which would be set up when the vessel rolled if left free to move, will be governed by a hydraulic apparatus, and will be completely under the control of one man, whose duty it will be to keep the floor of the saloon, under all circumstances, in a line with a spirit-level.

"The passenger accommodation will consist of the Bessemer saloon, which is 70 ft. long, 35 ft. wide, and 20 ft. high; a fixed saloon at one end between decks, 52 ft. long; and a line of fixed cabins on each side of the ship, between the paddle-boxes. This line of fixed cabins will occupy a total length of 150 ft., and include a refreshment-cabin, smoking-cabin, lavatories, and small deck-cabins. The luggage will be stowed in the hold at the opposite end of the ship to the passenger-saloons. The Bessemer saloon will form by far the finest cabin that has ever been fitted in a ship. Its great size and height will enable it to be completely ventilated, unlike the ordinary cabin between decks, which is so unpleasant that ladies and delicate persons endure the worst weather on deck rather than accept shelter in it.

"But one of the greatest advantages of this saloon is that, whatever motion the ship may take from the waves—and this, from the adaptation of her form to passivity among channel waves, will be slight—the saloon will be practically free from it. It is in the middle of the ship, as regards length and breadth; and the axis of rotation is at a height where there is least motion; so that, as regards its position, it is one in which the vertical and lateral motions, produced in every part of the ship by the pitching and rolling, will be so small as to be inappreciable. The cabin will also have no sensible pitching motion, for the form of the vessel is such as to make it impossible for the sea of the Strait of Dover to raise the ends very considerably; and even the small effect produced at the ends of the ship will be reduced by one-seventh at the extremities of the cabin. The rolling motion of the ship on the intended service cannot be very great, from the resistance of her paddle-wheels, her size, form, and speed; but, such as it is, it will not be communicated to the cabin, for the perfect action of Mr. Bessemer's hydraulic apparatus is an established certainty, and not a matter of speculation, and it will always insure the floor being kept level.

"The governing principle of this suspended saloon consists of a set of powerful hydraulic apparatus connected with the underside of the flooring, and so arranged that, as the vessel rolls to either side, the pressure or resistance afforded by the water is instantly brought into play and utilised in checking the motion.

"The floor, beneath the saloon, is composed of riveted iron beams, with smaller rafters attached to them. This floor, at its ends and at two intermediate points of its length, rests on steel axles, of about the diameter of the driving axle of a locomotive. The supporting frames are securely fixed to the double bottom of the vessel.

"This floor is capable of a motion like the beam of a pumping-engine; and if as much dead weight be placed below the beams of the floor as will counterbalance the upper part of the structure, the saloon will be in a state of equilibrium and capable of motion on its axis. In this condition it is liable to be put in motion by the movement of passengers or by the force of the wind blowing against the upper part. But the hydraulic power here applied prevents any such erratic motion, and affords means of retaining the saloon in a vertical position at the will of the man operating the apparatus, notwithstanding that the vessel in which it rests is moving beneath it.

"In order to effect this end, a toothed sector of large diameter is secured to the main central axis of the structure, and beneath it is a strong bed-plate firmly attached to the floor of the ship. On this bed-plate are two hydraulic cylinders, to which a double-ended ram is fitted, the central part of the ram being provided with teeth, which gear into the sector. Therefore when the ship is in a state of rest, the sliding in and out of the rams will cause the saloon to move on its own axis with a gentle but powerful motion. These movements, however, are controlled by a pair of delicately-balanced equilibrium valves.

"Hence it will be seen, that when the ship is rolling at sea, this power of acting on the saloon enables the steersman to retain the saloon constantly in a perfectly vertical position, while the floor of the ship is rising and falling beneath it. The essential point of this arrangement is that the hydraulic apparatus has not to put the saloon in motion, but simply to prevent it acquiring any motion. Moreover, the *vis inertiæ* of a structure like the saloon, which will weigh some seventy or eighty tons, will greatly assist in resisting the initial tendency to motion.

"In other respects Mr. Bessemer's saloon offers undoubted advantages. Resting, as it will, on four axial supports bedded on an elastic packing of large area, it will be completely insulated, and will not be susceptible of the violent tremulous motion imparted by the engines and paddles. Again, the heavy shocks of the sea against the sides of the ship, so objectionable in cabins built against the framing of the vessel, will be wholly unfelt, as there will be a space of five feet between the saloon and the sides of the ship, from which, in fact, it will be totally disconnected."

Fig. 1 of Plate XCII. is a section of the ship taken right through the saloon. The strong black line shows the moving part.

It will be observed that the attempt to neutralise the motion of the vessel by that of the saloon addresses itself to the rolling only. It does not affect either the translatory part of a ship's oscillation, or the pitching. I agree with the promoters in thinking that, in such large vessels as they propose to use, and with the saloon in the middle of the ship, the pitching will be small in amount, and slow; and that, taken alone, it will not be sufficient to cause sea-sickness. There is, however, another kind of motion affecting the ship, which requires fuller consideration.

In the regular heaving of the sea, after the wind has blown sufficiently long to cause regular waves or swell, each particle of water describes a circle in a vertical plane. At the surface, the diameter of these circles is the whole height of the wave, from valley to crest. The circles rapidly diminish in size as their depth below the surface increases. Taking into account this diminution, as well as the effect of the ship's breadth, it is certain that the ship will not follow this circular motion at all to the same extent as a cork floating on the surface. In moderately heavy weather, it is probable that, in such a ship as that which Mr. Reed has designed for Mr. Bessemer, any fixed point would describe a vertical circle of five or six feet in diameter in rough weather, quite independently of any rotatory or rocking motion. The model exhibited at Denmark Hill simply oscillated on a fixed centre, and therefore the experiment did not go to this point, as it might have done if it had been mounted on a crank or eccentric. It does not, therefore, tell us how far this remains as a real cause of uneasiness, especially when combined with a small amount of pitching, after the rocking or rolling is got rid of. While, therefore, I am unable to look forward to the absolute prevention of sea-sickness with the full confidence expressed by the promoters, I have not the slightest doubt that the remedy will be all but absolute, and that the residual motion will only affect extremely sensitive persons in exceptionally rough weather. Even for these, it will be nothing like what they undergo at present. The invention of springs has not entirely cured the shaking of a carriage; but I believe that the comparison of the motion in the Bessemer saloon with that in the present boats, in a rough sea, will be much the same in degree as that between a well hung carriage and a waggon or tumbril on a rough road.

The mode of propulsion, by two pairs of paddles, one working in the wash of the other, is not very favourable to economy of fuel. There is practically, however, no help for it; and as the voyage is a short one, this question is of secondary consequence. The great length and breadth of these vessels will make it somewhat more difficult for them to enter the French harbours than for smaller boats; and therefore there will, I think, be a few rough days in the year when smaller vessels will have to perform the mail service. With this reservation, I have no doubt as to their being perfectly safe—in fact, all the safer on account of their large size. An accident to the saloon, or to the machinery which moves it, would simply have the effect of setting it fast, and the worst that could happen from this cause would be, that the passengers would not get the relief desired, but would simply be as in the saloon of an ordinary ship, only with much better ventilation.

Another plan, remarkable for its divergence from the ordinary form of ships, is the double steam-ship proposed by Captain

Dicey. A sketch * of this type of ship is given (in section) in Fig. 2.

Imagine that an ordinary ship, 45 feet broad, and 350 feet long, is sawn right down the middle, longitudinally; that the two halves are separated by an interval of 30 feet; that a flat side is then fitted on the inner side of each half ship, and that they are then bridged together by a strong platform, which connects them rigidly. There is thus a clear waterway, or rectangular canal, 30 feet wide, along the whole length of the ship, right down the middle, open at both ends and at the bottom, but covered at the top by the lower deck of the saloons. Propulsion is effected by a pair of ordinary paddle-wheels placed in this canal, right amidships—one paddle being close to each flat side, with a clear waterway ten or twelve feet wide between them.

I can quite bear out the promoters' claim for this design in respect of easy and gentle motion in a rough sea. It is now more than twenty years since I first assisted at experiments with models of twin boats, and I have recently had the advantage of sailing in a schooner yacht of this build. I know that these ships are remarkably steady, and so far as concerns the mere question of immunity from sea-sickness, I think that they are only second to Mr. Bessemer's plan. If sea-sickness were the only difficulty of the channel passage, I should desire nothing better than Captain Dicey's ship to go across in.

The objections are, that these vessels are unhandy, and steer badly, and that their form is ill adapted for speed. These are very serious faults, and render them unsafe vessels for the channel service. Our mail steamers frequently find it no easy matter to enter Calais harbour, or to cross Boulogne bar in safety, and they sometimes have to give up the attempt. Now every one who has experience of twin boats with flat sides, is aware that they cannot be depended on for steering in a heavy sea. Their flat sides make them answer the helm very sluggishly, and at the same time give double effect to the tendency of the waves to turn them against their helm. This is a bad quality in the open sea; it might be a fatal quality in attempting to enter or leave a gutway in a cross sea—like Boulogne harbour in a south-wester. The danger is enhanced by defective propulsion.

A twin ship has nearly twice as much wetted surface as an ordinary vessel of the same displacement. As a large part of

* This sketch must not be considered authentic, except as regards its general shape, nor as being correct in its dimensions. The writer has not had access to accurate plans, but has only seen a model; and as he was unable to speak favourably of the project, he did not think it right to apply to the promoters for information about details. The sketch is quite sufficient as an illustration to this paper.

the resistance of a ship is due to friction, this is one obstacle. In the next place, every vessel carries before it a wave of displacement and a frictional wave. These diverge from each bow, whether one side of the bow be flat or not. A flat bow certainly diminishes the wave of displacement, but it does not annihilate it, and it scarcely diminishes the frictional wave at all. From these two causes there is a heaping of the waves in the channel, which forms a great source of extra resistance. In sailing vessels of this form the extra resistance is compensated for by the extra sail-carrying power of this type, but there is no such compensation in a steam-vessel. Then, again, the mode of propulsion is so bad—I should have said the worst possible, were it not that one of the directors of the Dicey Company has proposed to substitute a water-jet propeller for the paddles. There can scarcely be a worse position for a paddle-wheel than half-way along a rectangular channel. The propulsion is affected by the reaction of the water, whose backward velocity relatively to the ship is greater after it leaves the paddle-float than before it meets it; otherwise there would be no propulsion. Now the sectional area of a stream of water is inversely proportional to the velocity—for the quantity of water that passes any section of it is constant—and if the section is uniform, there must be a difference of level, or eddy-disturbance, or waves, either of which take up part of the work which ought to be expended upon propulsion. This occurs to some extent with outside paddles; but it is very much enhanced when the paddle is placed in a confined channel—not to mention the increased frictional resistance of the paddle race. I believe I am within the mark in predicting that, for the same speed, Captain Dicey's boat will require twice the engine power of that designed by Mr. Reed and Mr. Bessemer. It is not probable to my mind, that with such a ship, and such a propeller, a speed of twenty or twenty-one miles could be reached at all, no matter what the engine power might be.

Besides the danger from want of steering power, there is great danger of the paddle being carried away or disabled by a great wave, the effect of which would be guarded from dissipating itself laterally by the sides and roof of the canal in which the paddle works.

As regards the connection of the two hulls by means of the platform, I do not think that this presents any mechanical or practical difficulty, except that it will require a great weight of iron, and that this will have to be met by increased draught of water. This is itself an evil where tidal ports have to be entered; and it also takes up engine power.

In short, I have come to the belief that Captain Dicey's twin ship will be easy, but that it will not be fast, economical, or safe.

Another proposal, which has been much before the public, is that of Mr. S. J. Mackie, C.E. This is a double-ended and flat-bottomed boat, 400 feet long, 90 feet broad, and drawing 6 feet 6 inches of water. A section of it is given in Fig. 3. B and B′ are rectangular waterways going right fore and aft, differing from that in Captain Dicey's plan by having a bottom as well as a top and sides, and in there being two of them, instead of one central canal. Mr. Mackie's mode of propulsion is by two or three pairs of paddle-wheels working in the rectangular waterways. He claims, as the advantage of his design, great steadiness at sea, ample and well-distributed space for the accommodation of passengers, great longitudinal and transverse strength, and the absence of any projections which could receive injury from waves or piers. He also expects to attain high speed. I believe his vessel would realise all that he claims, except speed, but that no steam power whatever could give her speed with such propellers. A paddle-wheel working in a closed tube would do more churning than propulsion; and as to placing two or more paddle-wheels behind the first, I think they are more likely to impede it than to do any useful work of their own. I have the highest personal respect for Mr. Mackie, and I have come to this judgment regarding his scheme with much regret; but I am sure he would be the last person to wish that I should suppress my opinion, advisedly formed.

At the annual general meeting of the Institution of Naval Architects in March, 1871, Mr. Michael Scott, C.E., brought forward a plan for controlling the motion of vessels for the channel passage, by the judicious use of water ballast. He proposed that the vessels should leave and enter the ports in light trim; but that, as soon as they got into deep water, their displacement should be altered by the admission of sea-water into closed compartments, in such measure as to make the ship's behaviour as easy as possible. This plan may seem rather bold, on the face of it; but there is very little doubt that it could be successfully worked, with a little attention and experience. The quantity of water required could all be pumped out in a few minutes, on approaching the harbour. It must be confessed that it is rather an artificial way of meeting the difficulty, and that it falls under the suspicion of being "too clever by half." Still the plan is theoretically right, apart from the somewhat ticklish character of the adjustment. I do not think I should have recourse to such a plan, for myself, until the more direct method of Mr. Bessemer had been found to fail; but, failing that, it may be worth reverting to.

At the same meeting, Mr. Evan Leigh, of Manchester, brought forward a proposal for a channel steam-ship, which may be said to bear a rough likeness to Mr. Mackie's proposal.

There was the same double channel port and starboard, in each of which worked a paddle-wheel; only the channel, instead of being closed at the bottom and open from end to end, was segmental in profile, and open at the bottom. The paddle-wheels were moreover arranged as drums instead of open wheels. This plan is just as inefficient in respect of propulsion as either Captain Dicey's or Mr. Mackie's, and Mr. Leigh has moreover encumbered it with a ridiculous plan for harbours, and with bad steering apparatus. The device is not worth much on its own account, and these appendages are quite enough to prevent its floating, either mechanically or commercially.

Mr. John West, of Liverpool, has published plans* of a "Channel Ferryboat," 345 ft. long and 43 ft. beam; breadth over all 68 ft., and draught 6 ft. 6 in. The propellers are two pairs of paddle-wheels, external, as in Mr. Bessemer's ship; but the guards extend the full breadth of the paddles throughout the whole midship length, as in American river steamers, and, as in those, are utilised for cabins and smoke-boxes. The boilers, however, are inboard, instead of on the guards. Apart from the Bessemer saloon, the plan only differs in detail from that designed by Mr. Reed for Mr. Bessemer.

I have had before me a large number of schemes, of the most varied character, but the greater part of them hopelessly and irretrievably bad. Very few inventors will take the trouble either of acquiring the knowledge requisite to form an exact idea of the problem which they have undertaken to solve, or of ascertaining what steps have already been taken towards its solution. Hence we get schemes which never could be likely to work; schemes which have already been tried, and found to fail; schemes brought forward as new, which are already in common use. From among this chaos I have endeavoured to select those which are of the most immediate practical interest, and to lay before my readers, frankly and impartially, what I conceive to be the advantages and disadvantages of these.

My readers may now reasonably turn round and say, "What does the writer mean to indicate as the best ship for the purpose?" My answer is :—

1. For mail service, in very rough weather, a small full-powered vessel, which will make everybody sick whose inside has not been well salted.

2. As a mere preventative of sea-sickness, without special mechanism, the longest and broadest boat possible.

3. With reference to safe work, in entering and leaving port,

* See "The Engineer" for August 30, 1872.

in ordinary rough weather,* as well as to reasonable ease and comfort at sea, a boat 350 ft. long and 45 ft. broad or thereabouts, and drawing not more than 8 ft. of water.

4. As to the easiest thing likely to be obtained in our days —the Bessemer saloon steamer.

I give this to my readers as the best judgment which I can form on a subject which I have studied with great care. Whether right or wrong, it is to that extent worthy of attention, and it is wholly unprejudiced; as I have neither interest nor share in, nor retainer for, any one of the schemes which have been brought forward.

* Boulogne harbour is 70 mètres or 225 feet wide, and Calais harbour 100 mètres or 330 feet wide. The entrances of both are mere canals open to seaward.

ON EXPLOSIONS OF FIRE-DAMP IN COAL MINES; THEIR CAUSES AND MODE OF PREVENTION.

By A. H. GREEN, M.A., F.G.S.

WHEN the old Hebrew poet wished to fix upon a class of men who were exposed more than their fellows to danger, and who had to face nature under her most terrible aspects, he selected, with admirable fitness for his day, those "that go down to the sea in ships and occupy their business in great waters:" should a Tennyson or a Browning wish now-adays to handle a similar theme, he would find illustrations still more apt in the perils of those who pass their lives in the chambers and galleries of deep mines. And coal-miners are exposed to a larger amount of risk than any others of the craft; for, while they share with the rest of the mining population perils from falls of rock overhead, from sudden rushes of water, from accidents in shafts, and other similar sources of danger, they have in addition, always hanging over their heads, a hazard peculiarly their own, in the possibility of a sudden outburst of the gas known popularly as fire-damp, to be followed, should any one of a series of delicate precautions go wrong, by an explosion, which will first burn and shatter whatever comes in its way, and then leave behind it a deadly vapour that stifles out any life that the previous fire and havoc may have spared.

We propose to attempt a short description of this ever-present source of danger to the coal-miner, and of the methods which have been suggested for guarding against it; to point out where these methods have succeeded, and where they have failed; and to add a few hints as to how failure may have been caused, and how it may be avoided for the future.

It may be as well first to give our readers a few figures, showing the number of lives lost every year in Great Britain by explosions of fire-damp. The table below is taken from the Reports of the Colliery Inspectors.

TABLE SHOWING THE LOSS OF LIFE IN BRITISH COLLIERIES FROM 1864 TO 1871.

	1864	1865	1866*	1867	1868	1869	1870	1871
Estimated number of men employed	307,542	315,451	320,663	333,116	346,820	345,446	350,894	370,881
Lives lost by explosions	94	168	651	286	154	257	185	269
Total lives lost	867	984	1,484	1,190	1,011	1,116	991	1,075

These results are far from reassuring. The percentage of lives lost from accidents of all kinds seems to be slightly increasing every year, and last year amounted to very nearly three in every thousand: the proportion lost by the cause of accident we are now specially considering varies very much from year to year, but last year it was almost exactly one quarter of the whole.

Fire-damp, the source of such a large part of the accidents incidental to coal-mining, is a mixture of carburetted hydrogen, nitrogen, and carbonic acid gases. Of these carburetted hydrogen is by far the largest ingredient, and, as the cause of explosions, the one we are more specially concerned with; it is a compound of carbon and hydrogen (CH_4), and in a pure state burns with a faint bluish-yellow flame: it becomes explosive when mixed with air, the violence of the detonation depending on the proportions of the mixture: if the amount of gas be not more than $\frac{1}{15}$th of the whole, the mixture burns without explosion, though the presence of the gas is distinctly indicated by changes, well known to miners, produced in the flame of a candle or lamp held in it. The maximum of explosiveness is reached when the proportion of gas is from $\frac{1}{01}$th to $\frac{1}{9}$th: if a light be brought into such a mixture, the whole flashes into flame with fearful violence, and the unlucky miner whom it comes across is either scorched to a cinder or blown to pieces, or perhaps suffers both fates: when the gas is present to the extent of $\frac{1}{4}$th, or a larger proportion, the mixture again burns without explosion: so large a proportion of gas, however, makes an atmosphere in which breathing is carried on with difficulty, and when the proportion of gas reaches $\frac{1}{3}$rd, respiration becomes impossible.

The products of the explosion are steam and carbonic acid, the latter a heavy gas, the presence of a small quantity of which in air is immediately fatal to life. This floods slowly the passages of the mine, and effectually stifles out any life that may have escaped the flame and concussion of the explosion.

* This was the year of the Oaks explosion, in which 361 men were killed; in the same year explosions occurred at Talk-on-the-Hill and Dukinfield, causing respectively 91 and 38 deaths.

Carbonic acid is known among the colliers as "black-damp," or "after-damp."

We must also note that carburetted hydrogen is very light, not much more than one-half as heavy as common air, and in spite of the general property of gases to diffuse themselves uniformly without reference to their relative density, it tends, in virtue of its low specific gravity, to accumulate in the higher parts of a mine, in bell-shaped hollows in the roof, and in the stagnant atmosphere of the "goaf," or abandoned workings.

Such then are the deadly qualities of this subtle enemy, which exists often in enormous quantity, pent up in the body of the coal itself. How it came there is a question to which it is not easy to give a definite answer. The same gas, however, is produced by the decomposition of dead plants in marshy places, and we must content ourselves with the vague statement that carburetted hydrogen has been generated by chemical reaction out of the vegetable matter of which coal is made up.

But whatever be the exact cause of its presence, there it is, locked up in a highly condensed state, and ready to burst forth the moment the pressure which holds it back is removed by the operation of cutting into the coal.

In some beds the gas seems to be uniformly disseminated through the whole body of the seam, and in these cases it is most striking to stand in front of a newly bared face of coal, and hear it rushing out, like bees out of a hive, as the colliers say, with an incessant sputtering and hissing, while small bits of coal keep flying off with a sharp cracking sound, as the imprisoned gas bursts the cells in which it is confined. Gas of this sort is comparatively harmless, as it gives warning of its presence, and can be dealt with and subdued by methods to be described further on. Far more serious are these cases when a single blow of a pick taps an enormous reservoir of pent up gas, and an outburst follows, with a roar like that produced by the escape of high-pressure steam, so suddenly and in such quantity, that it overpowers all the ordinary precautions, and nothing can be done but to leave it till it has exhausted itself or considerably abated. Such discharges are known as "blowers;" they occur very generally in the neighbourhood of faults or dislocations, and it seems likely that the gas finds its way up the rent in the strata, from great depths, where it exists in a still higher state of compression than in the coal itself. Outbursts of this nature sometimes force their way through the floor of the mine, in which they tear long rents, as if the solid rock were so much parchment.* Some of these

* See "Transactions of the Midland Institute of Mining Engineers," vol. ii. pp. 155, 189.

sudden discharges blow themselves off in a short time: others go on for years without showing any signs of abatement, and the gas from them has been collected, and used in those parts of the mine where present custom looks upon it as safe to employ naked lights.

The reader will now realise the danger which the collier stands always face to face with: gas to some extent is almost always present, and should it be mixed with air in the proper proportions and come in contact with a naked light, an explosion more or less severe immediately follows.

The methods of coping with this difficulty may be grouped under two main heads. One will include the processes of ventilation, by which the gas is diluted with common air to such an extent as to render it harmless: the other will take in all the contrivances for shielding those lights which must be used, so as to prevent their coming in contact with any explosive compound that ventilation may have failed to remove.

First of ventilation—absolutely necessary in every case to supply breathing air to the miner, and doubly needful where the earth is ever pouring out a deadly gas, which lurks in each sheltered spot, and can only be driven out by sweeping every nook and corner by something like a hurricane of pure air.

Every well-ordered coal mine is now supplied with at least two separate shafts, the size of which depends on its area, 12 to 15 feet clear diameter within the brickwork being not too large if the workings are very extensive. Down one of these, known as the "downcast" shaft, pure air is constantly passing, and is conducted through the workings, driving before it the contaminated atmosphere, and in the end forcing it up the other shaft, which serves for an outlet, and is called the "upcast" shaft. The air taken in goes by the name of the "intake" current, and the foul compound discharged from the upcast is called the "returns." It was at one time customary to carry all the air in one body through the windings and turnings of the workings, but by this method the current became too much contaminated, and its velocity too much reduced before it reached the end of its long journey, to allow of its producing any useful result in the parts of the mine most distant from the downcast shaft: accordingly the intake air is now "split" into separate currents, varying in number according to the size of the mine, before it begins to run its course; each of these ventilates a separate district, and in the end all unite and are discharged through the upcast.

The passage of the air through the workings is regulated by barriers known as "stoppings;" by doors, often double like a canal lock, which allow the miner to pass through, but keep back the air current; or in some cases simply by hanging heavy cloths across an opening through which it is wished to prevent the passage of the air. Sometimes, when the ventilating current has to cross one of the main roads which it would be inconvenient to interrupt by doors, the air is carried across in a distinct passage over the roof of the gallery.

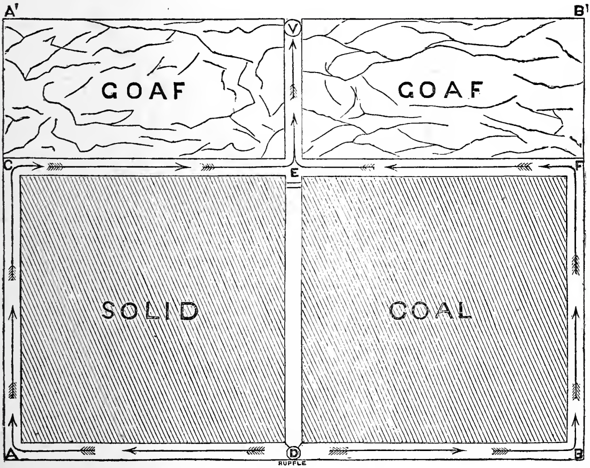
Thus there is constantly going on a process which does for the mine exactly what the functions of breathing and the circulation of the blood do for the human body; and we must next see by what means the circulation is kept going in the case of the mine.

The methods usually employed are twofold: sometimes a large fan, turned by machinery, is placed at the top of the upcast shaft, to create an upward draught; sometimes a furnace is kept burning in that shaft, which rarifies the air, causes it to rise, and sucks a corresponding quantity to fill its place down the downcast.

The disadvantage of a furnace is that the returns may be so charged with fire-damp as to explode on coming in contact with the flame. To obviate this the foul air is carried through a gallery, known as a "dumb drift," which opens into the upcast some way above the furnace: even this precaution, however, is thought to have been ineffectual in some very fiery mines, and good authorities have given it as their opinion that there are cases where no precaution can render a furnace safe, and that a fan ought then to be employed. One great drawback to the use of a fan is, that the instant any accident happens to it, or the machinery which turns it, ventilation is at once stopped; whereas with a furnace, especially if it be placed at the bottom of the upcast shaft, and that shaft be deep, a long time will elapse before the heated column of air can cool down to the same temperature as the rest of the mine, and ventilation, to a certain extent, will go on after the furnace has gone out, should either accident or carelessness cause that to happen. Hence, when fans are used, it is very desirable to have at least two, so that if one be disabled the other may immediately take its place.

One or two other points connected with ventilation call for notice. Beds of coal very rarely lie perfectly flat; in most cases they are inclined, or "dip" at various angles to the horizon. Now, the small specific gravity of fire-damp tends to make it flow of itself towards the highest, or "rise" parts of the mine, and the tendency should be taken advantage of to facilitate the escape of the gas. Hence it is desirable to put the upcast shaft as far to the rise as can be done. Further we have noticed the tendency of gas to accumulate in abandoned workings or "goafs," from which falls of the roof are liable to force it out into the mine, or from which sudden decrease in the pressure of the surrounding air allows it to escape. This makes the "goaf" a constant source of danger, which should be entered or traversed as little as possible, and, as far as may be, cut off from communication with workings in progress. Putting these facts together, it is clear that the safest combination is to have the "goaf" *in the rear and to the rise* of the workings; and that, *cæteris paribus*, the safest way of getting the coal is that known as "long wall," by which all the mineral is extracted at the first working; and that the "pillar and stall" method,

Fig. 1.



by which portions are left to support the roof, and afterwards got out by a second working, is liable to objection, because it involves the carrying on of operations in the middle of a mass of abandoned workings, loaded with fiery gas. It is also clear that several advantages will be gained by placing the downcast shaft on the extreme dip of the mine, and making it the shaft by which the mineral is raised to the surface. For by this means the intake air drives the light fire-damp in the direction in which it naturally tends to move, and the coal may be run down to the shaft bottom by its own gravity.

Fig. 1 shows a plan of what may be called a coal mine under its simplest form, in which all these advantages have been secured. D is the downcast, V the upcast shaft, and the bed of coal rises from D to V. The first thing done on beginning to work the mine is to drive out roads, D A, D B, as nearly level as possible, to the right and left of D up to the boundaries of the royalty; the roads A A′, D V, B B′, are then driven at right angles to A B, up to the boundary on the rise side: the boundary on the dip side is A B. The extraction of coal now begins, and the mineral is sliced off in long faces parallel to A′ B′, starting at the rise boundary, and working backwards to the dip. In this way the "goaf" is always behind and to the rise of the workings, and is traversed only by the air course E V, which may be bricked and completely isolated from the fiery district on either side. The intake air is split into two courses, which travel along D A C, D B F, sweep the faces C E, F E, and pass along E V to the upcast. The coal as it is extracted is drawn along the levels C E, F E, and run down the incline E D to the drawing shaft D.

Very simple indeed this looks on paper, but unluckily in practice innumerable obstacles come in the way, when we attempt to carry out such a plan. First natural obstacles occur. The rise of the coal is not constantly in the same direction, and the seam is often traversed by lines of fracture, known as "faults" or "troubles," by which the bed has been broken across, and the part on one side raised or depressed relatively to the part on the other side. Commercial considerations give rise to still more serious difficulties. The subdivision of property often makes it difficult to obtain a tract of coal anything like as symmetrical as that in the sketch. The time taken in driving the preliminary roads or "straight work" would in a large colliery be very considerable; and adventurers do not like to see their money lying idle so long, and are tempted to obtain quicker returns by beginning to raise coal as near to the shaft as is safe. The position of the drawing shaft is mainly determined by the consideration that it must be as near as possible to the canal or railway that is to carry the coal to market, and it may well happen that this is not on the dip of the mine. Unless the mine be very large indeed, it will be impossible to obtain from a single face an output large enough to make the undertaking pay. These and other obstacles, too numerous to mention here, prevent us in practice from ever obtaining all the advantages possessed by the plan shown in Fig. 1, and corresponding compromises have to be made; but the general principles there illustrated are such as guide the engineer in the laying out of a colliery.

The precautions already described would render a mine, in which gas exuded uniformly and slowly from the coal, absolutely safe; but they do not alone suffice where the outbursts known as "blowers" are liable to occur, because the discharge of gas from these is so sudden and so enormous as to overpower the most plentiful and perfect ventilation. In nearly all coals there is a risk, and in some a certainty, of meeting with these blowers, and for perfect security we must find some means of removing the danger arising from them. This is done by employing what are known as "safety-lamps," that is, lamps which may be carried into an explosive mixture of carburetted hydrogen and air without firing the compound. The principle on which they depend was discovered independently about the same time by Sir H. Davy and George Stephenson, and is as follows:—It was found that if a lamp or candle be enclosed in an envelope of fine wire gauze, containing not less than 600 holes to the square inch, any explosions which take place within the envelope cannot be communicated to the gas outside, and that the flame cannot pass through the gauze except under pressure.* In Davy's original lamp the light is simply enclosed in a cylinder of this gauze, but this arrangement has a somewhat feeble illuminating power. Modifications have been made by the introduction of glass, which give a better light; and other contrivances have been proposed for increasing the draught, and thus obtaining a similar result. The principal forms of safety-lamp are well described in the "Rudimentary Treatise on Coal and Coal Mining," by Mr. Warrington Smyth (Lockwood & Co., 1872).

Unluckily, when perfect ventilation and an efficient safety-lamp have been provided, the colliery manager's cares are not at an end. The working collier is proverbially reckless, and nothing can prevent him from opening his lamp, if he can, to get a better light for his work, to light his pipe, or even sometimes from foolhardiness. Lamps are locked before being given into the men's hands, and then the men carry keys. Lamps are constructed which go out directly they are opened, and then the men take down lucifers and light them again. Lamps have been devised which are locked with a plug of lead, on which a device is punched, and which cannot be opened without breaking the plug; and some such troublesome precaution, it seems, must be adopted, if tampering with the lamp is to be put an end to. The latest contrivance is a lamp which is closed by a steel spring, and can only be opened by the action of a very powerful magnet on the spring. The magnet is kept in the custody of the head manager, and as it is obliged to be a far more powerful one than the colliers are likely to be able to obtain, this plan, if it succeed in other respects, seems likely to be effective.

* For an explanation of the physical reason of these facts, see Tyndall's "Heat as a Mode of Motion," p. 240.

A probable cause of accidents which we can only hint at here is the spontaneous combustion of the waste coal left in the goaf; and it is also highly likely that some explosions have been caused by blasting in fiery pits.

It is further to be noted, that even the most perfect safety-lamp requires occasionally the utmost caution in using it. In a fiery atmosphere the combustion and explosion of gas within the lamp sometimes raises the gauze to a red-heat, and in this way sets light to the explosive mixture outside. It has also been repeatedly proved by experiment that no lamp is safe in a strong current of air. The velocity necessary to cause an explosion varies with different forms of lamp, but all that have been yet devised blow up sooner or later, if the force of the draught in which they are placed is gradually increased.*

Science has therefore still something further to do for the collier in the matter of lighting him at his work; and the most promising quarter, perhaps, to which the would-be inventor can turn his attention is the electric light. If this could be produced cheaply and in a portable form, we should have in it all the conditions of perfect safety; for the light may be completely cut off from the explosive atmosphere by surrounding it with a glass globe, and a cage of a few iron bars would guard against any risk of fracture to the glass. Even now it seems that this source of light might be usefully employed in these exceptional cases, like the first opening out of a colliery after an explosion, when much of the work has to be done in the dark. A beam of parallel rays sent down the shaft by an electric lamp at the top would have intensity enough to allow of its being reflected by mirrors into the workings, and would make the task of beginning to open out a wrecked colliery easier and more expeditious. And as soon as a cheap galvanic battery is invented, there seems to be no reason why we should not light our collieries with a brilliancy undreamed of now, and at the same time get rid of all risk of explosion.

We have not yet said anything about the means of detecting the presence of fire-damp, and since it is as true in a mine as elsewhere that to be forewarned is to be forearmed, this part of our subject must not be passed over. It has been noticed that many serious explosions have been preceded by rapid falls of the barometer, and it is not hard to imagine how sudden diminution of atmospheric pressure might well affect so light and easily moved a gas as carburetted hydrogen. Every colliery ought therefore to be furnished with a good barometer, and its readings constantly noted; and whenever a rapid fall takes

* Among the latest of these experiments are some made at the Barnsley Gas Works. See "Mining Journal," 1867, p. 530.

place, extra precautions should be used. Also, when a safety-lamp is carried where firedamp is present, the flame elongates and takes a pale bluish hue, till the gas is present in quantity enough to cause explosion within the gauze. These indications enable a trained eye to estimate to a very fair degree of approximation the proportion of gas present. The observation of them partakes somewhat of the nature of playing with fire, and requires a cool head and steady hand, and a knowledge, which can be acquired only by practice, how far it is safe to go, and when it becomes necessary to withdraw or extinguish the light. A very beautiful and ingenious indicator has been invented by Mr. Ansell, the general principle of which is as follows:—A vessel full of air is separated from the impure atmosphere of the mine by a porous diaphragm. In virtue of the law of the diffusion of gases, air passes out and carburetted hydrogen passes in through the diaphragam; but the latter, on account of its low specific gravity, is transferred in larger quantity than the former. Consequently the pressure within the chamber is increased, and either by the expansion of the elastic walls of the vessel itself, or by the raising of a column of mercury, an electric circuit is completed, and a telegraphic bell set ringing. If such instruments are placed at different points in the mine, and connected by wires with bells at some central station, the presence of gas in dangerous quantity at any place is immediately pointed out, and the necessary orders may be at once issued. In another form of the instrument, intended to be carried about, the gas passes by diffusion into a sensitive aneroid chamber, and moves an index in the same way as in the common aneroid barometer. Beautiful as these contrivances are, it is a question whether their construction is not too delicate to stand the rough life of a coal mine; but fair and ample trial ought certainly to be made of them. Their competency to detect the presence of gas has been proved by actual experiment, and the time may come—the average intelligence of the collier having been raised by education—when it will be possible to employ them as the inventor has suggested.

And now comes the question, How is it that though science has worked so earnestly, and as it would seem so successfully, to put into the miner's hands the means by which he may protect himself from the dangers that beset him on all sides, the tale of lives lost year by year shows no signs of a decrease? To anyone who has studied the Reports of the Colliery Inspectors, the answer comes in no uncertain tone. The facts there collected show, without the possibility of a mistake, that a very large portion of the accidents ought never to have occurred, since they have been caused either by the incompetence of the managers or the foolhardiness of the men.

On the first head, though there is still much to complain of, considerable improvement has taken place of late, and the establishment of such schools as the College of Physical Science at Newcastle, and the provisions of the Mines Regulation Act of last Session, will doubtless produce before long a still larger advance. But much yet remains to be done before those entrusted with the immediate superintendence of our mines can compare with the men holding similar positions in Germany. Of the recklessness of the men, one or two instances may be given to show that they are not accused without reason. In 1866 occurred the most disastrous colliery explosion yet on record—that of the Oaks Colliery, by which more than three hundred men were in a moment laid lifeless; but even this warning had no effect, for only a few weeks afterwards some colliers in an adjoining colliery, working the same fiery seam, were summoned before the magistrate for using lucifer-matches in the pit to light their pipes with. It is indeed seldom possible to bring home to anyone the guilt of having caused an explosion, for those most at fault are usually the first victims; but the constant occurrence of lamp-keys and lucifers on the persons of the killed tells a story which cannot well be misread. Totally untrained to reflection, and living face to face with danger till they have lost almost the sense of fear, these men deliberately risk their own lives, and those of some hundreds of their fellow-workmen, rather than forego the luxury of smoking for an hour or two. Another fact brings out this characteristic very forcibly. We have already shown that in many cases it is necessary, however perfect the ventilation may be, to use safety-lamps, because sudden outbursts of gas may any minute occur which will overpower the best ventilation in the world: in a word, that here as elsewhere it is good to have two strings to your bow. But while fully admitting the truth of this, many really intelligent managers are averse to the use of safety-lamps because the men cannot be brought to see the force of the old adage, and will insist on trusting to lamps alone, and neglect the ventilation.

Two things it seems to us can alone remedy this disastrous state of things. The rising generation of colliers must have impressed upon them some sense of moral responsibility, and they must be taught so much science as will enable them to understand how accidents are caused. Ministers of all religious denominations show a most praiseworthy activity after any colliery disaster, but they seem to dwell mainly on the uncertainty of life, and the necessity for being prepared for death at any moment. Such warnings are not specially applicable to miners; they might, for instance, be addressed with considerable propriety to anyone who nowadays has occasion to travel often by railway. It might have gone some way towards preventing the disaster altogether if it had been forcibly insisted on beforehand, that a sin, whose magnitude can scarcely be estimated, is committed every time a colliery proprietor employs an incompetent manager from short-sighted economy, or a collier lights a pipe in a fiery pit.

The second remedy is by no means difficult of attainment. Many of the larger collieries have already attached to them, by the generosity of their proprietors, excellent schools, and the example thus set will doubtless be extensively followed. If clear and simple lectures, illustrated by experiments, were given in these schools from time to time on the *rationale* of colliery disasters, the rising generation of colliers would grow up with quite enough of scientific knowledge to cure them of the recklessness which disgraced their forefathers.

That there is the mental grit in colliers which makes all that has been here suggested for their improvement possible, and a great deal more besides, no one who knows them well will for a moment deny, but they have not yet been shown how to turn it to account. With all their faults they are a hearty, shrewd race, and among them the writer has spent many a pleasant and profitable hour.

HOW TO MAKE A GEOLOGICAL MAP.

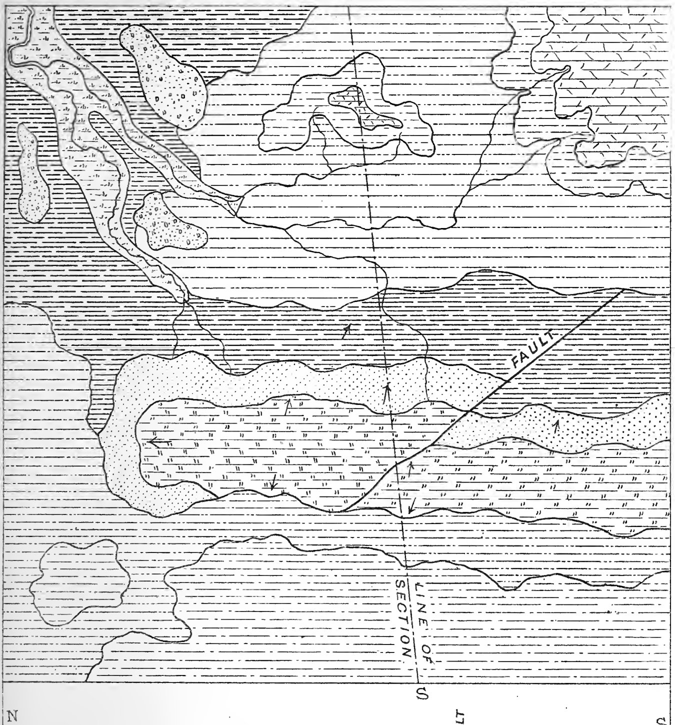
By HORACE B. WOODWARD, F.G.S.,

Of the Geological Survey of England and Wales.

[PLATE XCIII.]

AMONG the numerous efforts to popularise Geology, we are not aware that much has been done to explain the mystery of geological maps. We say mystery, because by many they are looked upon as a sort of scientific myth; they are rarely understood by any but the geologist proper, and certainly are but little known and appreciated by our agricultural and "practical" population. Of course to make the best use of our geological maps a considerable knowledge of the science is necessary; and if this were the case, we should not hear so often of fruitless efforts to find coal. The notions that black shales are an indication of coal, and that "where God has sent iron-ore, He has also sent coal to smelt it," have not died out, anymore than has that relic of superstition, the Divining-rod, which in the West of England has still a few credulous practisers. But the meaning of geological maps may be understood without any very deep knowledge of geology. It is frequently remarked that such a map "looks very pretty with all those colours, but how do you find it out?" To say a few words about the construction of geological maps, and what they mean, may therefore be of some interest; and in doing so, we may at the same time draw attention to a few of the practical bearings of geology.

In our own country we are well provided with geological maps, from the small atlas edition to our Government Survey Map, which, however, is not yet completed; and if it were, the map of England and Wales would measure about 36 ft. in length by 25 in breadth! It was about two hundred years ago (1673) when the first suggestion for a geological map of England was made by Dr. Martin Lister. Geology was then little known except as a mineralogical science, and fossils were either "freaks of nature," or the results of some "plastic virtue" in the earth. It is therefore interesting to consider



H.B. Woodward. W. West & Co lith.

Diagram to explain Geological Maps & their Economic uses.

that at this early period the practical value of a map, showing the areas occupied by each rock at the surface, was surmised. The first really practical map of the geology of England and Wales was that of William Smith, which was completed in 1815, after a labour of more than twenty years. This now forms the basis of the Greenough Geological Map, published by the Geological Society of London. The geological survey of the United Kingdom, which was commenced about the year 1832 by Sir Henry De la Beche, formed a new era in the history of geological maps. Of small maps of England, Scotland, and Ireland, we have those of Phillips, Murchison, Ramsay, Griffith, Jukes, and Geikie, but we need say no more about these. They pretend to no great minuteness or accuracy of detail, and are merely intended to give a general idea of the rocks exposed at the surface, so that practically speaking they will admit of but little improvement. Our Geological Survey Map, however, is on the scale of one inch to the mile; a few sheets are published on the scale of six inches to a mile, and here we find that detail which it would be impossible to show on a smaller map, and which it is often hard enough to show on the one-inch scale. It is these which are intended to serve as practical guides to the miner and the quarryman, the architect and the engineer, and the agriculturalist. It is to be feared, however, that these do not avail themselves of the maps to any very large extent; certainly very few of our agricultural population ever heard of a geological map; and to judge from their general reception of the geological surveyor who is found wandering about in a mysterious way over their lands, they acknowledge but little respect for the science. "What be doin' of?" a small farmer would say. "Oh, making a map of the different rocks and soils," one would reply. "Rocks and soils! I thought you was after the rabbits. You can't come trespassing over these fields like that. Who be ye doin' it for?" "It's a Government survey; I am at liberty to go anywhere," would be the usual reply. "Goverment survey, indeed," says the farmer; "Goverment be always a doin' summut queer." While on this subject we may mention that returning one evening from field-work, we sat resting a few moments on a gate and laid our map-book on the adjoining post. Being absorbed in reflections not geological—for it is a relief to think of other things after a hard day's work in the field, where all one's attention is required—we arose and walked home to our humble village apartments, leaving our maps behind us. We soon discovered the loss, as we disencumbered ourselves of hammer, compass and clinometer, and at once hurried back to the scene of our recent reverie. No maps were there; it grew dark, and we returned home sad and discomfited. There was nothing for it but to advertise; so we wrote out several large bills describing the maps, and offering a reward for their return, which we placed in the village shops. Two days passed in suspense; then, on the evening of the third, a farmer came in with them. He had found the map-case on the gate-post, and had put it into his pocket and taken it home; but here he did not stop; he gave it to his little child to amuse itself with! Happily the maps were all right, unharmed, and we were thankful; though a sort of thrill ran through us as we thought of our maps, with three months' work upon them, as a plaything in the unscrupulous hands of a child! So much for agricultural appreciation. Let us now turn our attention more seriously to the subject of geological maps.

It is well known how our British rocks are mostly of the "stratified" kind—rocks deposited under water—such as slate and clay, limestone and marl, sandstone, sand, and conglomerate, intercalated one with another, and occurring at all horizons in the earth's crust, generally harder or more compact the older they are. It is also well known how these rocks are arranged in a certain regular series, characterised by peculiar mineral characters, and more particularly by assemblages of fossils which are more and more closely allied to the forms of life now in existence, the newer the rocks in which they are embedded. Thus we have the table of British strata, such as the old red sandstone, the lias, and the chalk; the oldest rocks known being the Laurentian, the newest including the alluvial deposits of our present streams. This order of superposition is never inverted, except by local and extremely rare disturbance, when the rocks may be folded or bent over so as to bring the older above the newer. We have also in England, though they occupy a comparatively small area, many "unstratified" rocks, the result of old igneous eruptions, and metamorphic rocks which in bygone times have lost their original stratified character through the agency of heat. These rocks include the toadstone of Derbyshire, and the granites of Cornwall.

The arrangement of our stratified rocks has been aptly compared to layers of cloth of various colours and irregular shapes overlying and overlapping one another; some squeezed or rucked up with even layers deposited upon them, but yet arranged in a definite order comparable to that order of succession into which all stratified rocks may be determined. Each layer may be taken to represent a series of limestones and clays, or sandstones and conglomerates, or slates. Some layers—the lowest ones, perhaps—may be rucked up into mounds higher than all the rest, and yet they are clearly the oldest, because they may be traced in places underneath those at a lower level. Indeed we find, as a rule, that the older the rocks the more wild, rugged, and mountainous is the nature of the ground they occupy, for these rocks have of course uudergone more induration and elevation from heat and pressure than the rocks formed subsequently to them; and they have often been elevated to form land for long periods, while newer deposits were forming around them, and which, indeed, were made up to a large extent from their destruction. Some of our rucked layers of cloth should have the summits of their folds cut off to represent denudation or wearing away which took place before the layers above were deposited. This is called an unconformity, an indication of a lapse of time. Then, when we have our pile of cloths thus arranged, we may cut imaginary valleys out of the even layers that were deposited last; and then the different coloured pieces that are exposed, on looking at the surface of the whole mass, would give a very good idea of the phenomena exhibited by a geological map. Illustrations of this kind in wood have indeed been prepared by Mr. Sopwith, and they form admirable models for the student.

The object of a geological map is therefore to indicate the areas where the various rocks of which the earth's crust is formed appear at the surface. And we must bear in mind that, although there was a regularity in succession, there was much irregularity in the area over which each series was deposited, so that some may be absent in places; and that wherever we find one deposit resting on the upturned edges of another, we know that between the two there was a great interval of time when some other deposits were forming which we shall find elsewhere, where no disturbance took place to prevent a regular succession.

Mere soils are omitted in our maps, and in general also those irregular superficial deposits of gravel, sand and boulder-clay, known as drifts; but their importance is becoming more and more apparent the better they are understood, so that before many years they will probably be represented on most of our geological maps.

We may now turn our attention to the way in which our geological maps are constructed; how the lines are drawn which separate the different rocks which are exposed at the surface. To anyone walking over a flat grass-covered or well-wooded country, probably the difficulties attending a minute survey would appear insurmountable, and they might conclude that a great deal is done by conjecture. It is true that the geologist is in a great measure forced to be guided by inference when there is no direct evidence; but when he has surveyed all round any obscure tract of country, the inferences which guide him in determining the boundaries of the rock or rocks of which it is composed, and of drawing his lines to join with others in the surrounding area, would probably be safe enough, and something more than mere conjecture. Moreover, with experience one notices many little facts that afford valuable hints in mapping, which by a person not accustomed to the work would pass unnoticed: such as a slight feature in the ground, a spring, or some peculiarity of the soil.

In mapping a country, therefore, the first thing is to get acquainted with the best sections; to observe whether the rocks be of the stratified or unstratified kind, or both; to observe their relations one to another, and also to the form of the ground. In sections of the stratified rocks we must examine each bed, and particularly notice the junction between any two formations, which if conformable may require some assistance from a study of the fossils to fix. We must carefully note any features such junctions may make in the ground, whether in the form of a terrace due to the resistance of some hard bed to denuding agents, or in the wetness or dryness of the soil, due to springs and the pervious or impervious nature of the rocks. We must also endeavour to ascertain to what extent the country is covered with drift deposits, and how far the soils may be an indication of the rocks beneath. The best sections are seen in a railway-cutting, a sea-cliff, a quarry, a deep road-cutting, or a foundation-pit. The sections recorded in a note-book are useful for comparison with other sections, so that some notion of the general character and thickness of each formation, and of the beds at different horizons in it, may be arrived at. Then, when one has a general notion of the rocks and their relations to one another, the boundaries between them may be traced out on the ground. The character of the mapping here, however, depends very largely upon the nature of the rocks; if they be the older rocks, much disturbed and contorted, or penetrated by igneous dykes, or if they be secondary rocks maintaining great parallelism and conformity, or tertiary rocks covered irregularly by drift deposits. Having fixed all the clear junctions that may be observed in a preliminary survey of the best sections, one may then draw the lines which mark the junctions across the intermediate ground, noticing every section on the way, in the banks of a stream, or in ditches, which usually afford some indications of the strata.

In the igneous and older stratified rocks one usually gets some bosses of the rock projecting here and there on the hill-sides, and even on the high roads. Attention must be paid to the general direction or dip of the older stratified rocks, great care being taken to discriminate between this and the "slaty cleavage" which cuts up the beds at all angles, and is a phenomenon produced by pressure subsequent to the consolidation of the beds. So difficult is this sometimes, that the late Professor Jukes has remarked, "You may sometimes 'toss up' which is cleavage and bedding and jointing." The dip of the beds, the direction of which is marked by arrows on the map, is of the greatest importance in mapping conformable rocks such as the carboniferous, or the secondary strata; for frequently this and the feature together, with some notion of the thickness of the beds, will be our sole guides in tracing a boundary for some distance. In conformable beds, where the dip is at a low angle of 3° or 4°, a very small irregularity in the ground, a gentle hollow, may cause the boundary line to run a long way from the strike or general line of outcrop of the beds along a level surface; whereas, with a high dip, the lower bed would run but a short distance even in a deep valley. Care must be taken to avoid mistaking false or current bedding for the dip. In the tertiary strata, from the general absence of hard beds, few dips can be taken; but they usually maintain great regularity and horizontality. In tracing the boundaries along escarpments, the ground is often obscured by rain-wash and small land-slips.

The superficial deposits are usually well shown in ditch sections, besides the numerous brick-yards or gravel-pits.

Of course it is impossible here to do more than give a rough idea of the nature of the evidence which guides the geologist in his survey. The work is not to be learnt from books, but can only be gained by experience in the field. The object of the Government geological survey is to obtain all the information on the geology of the country. The coal-crops that are laid down on the maps are, to a great extent, obtained from colliery sections and data. Much information about mining has to be gleaned from private individuals; and the late Professor Jukes tells how he has had to spend many days in search of some old fellow who had left the district, but who was said to be able to "tell him all about it."

The accompanying Plate (XCIII.), upon which the principal classes of stratified rocks are represented, will enable us to point out more readily the objects of a geological survey. A glance at the index will give the order of succession of the rocks; and it is very important to bear in mind the succession of all the British strata, the unconformities, overlaps, and faults which affect their arrangement, in order to thoroughly understand the phenomena exhibited even in such a small area as this. Thus the newer deposits, the alluvium and the gravel, rest irregularly on the rocks beneath; the oolites, lias, and trias—rocks of Secondary age—are all conformable, and they rest indifferently on the upturned edges of the older (Palæozoic) rocks, from the coal-measures to the mountain limestone. These latter are themselves conformable, and have in this area been together upheaved and bent into a fold or "anticlinal," and the summit of it worn away before the newer secondary rocks were deposited. The accompanying horizontal section, taken along the line marked on the map, will show the general arrangement of the rocks. It is the knowledge of an anticlinal like this which leads to the inference that coal occurs on the south of the Mendips, where it is not actually seen nor has yet been proved. The coal comes to the surface on the north of this range of hills, and is there largely worked; while, on the south of the anticlinal, as represented in the section, the coal-measures occur again, though they are entirely concealed at the surface by the overlying Secondary deposits. Such a conclusion shows us one of the practical bearings of geology.

A study of the science will enable us to point out not only where the coal-measures exist at the surface, but generally with great confidence those areas where coal cannot exist, and also to estimate the probability of its existence beneath those rocks which were formed subsequently to it. Thus it is that coal is considered as likely to occur in the south-eastern counties of England, beneath the tertiary and secondary rocks of that area; it being considered that there is a thinning out of the rocks which normally occur between the cretaceous beds and the coal, so that it might be reached at a reasonable depth.

In our section we find that a slight "fault" or disturbance affects the older rocks, and has shifted and let down those on its southern side. This shows more plainly on the map, as in consequence of it the outcrop of the Millstone Grit has been considerably modified. The phenomena exhibited in the section show that there are many important considerations to affect our ideas of the rocks at some depth below those coloured on our maps. Though the series has a regular arrangement, many rocks may be absent in places, and the older ones affected by denudation and disturbance before the newer ones were deposited upon them; so that in mining and well-sinking the opinion of the geologist is very necessary. It is astonishing that even now-a-days so many attempts are made to find coal in places where a geologist would at once discern there could be no chance of getting it. Two years ago we came across a shaft which was being sunk in the lower limestone shales of the Mendips, and had indeed just reached the old red sandstone, two or three thousand feet below the coal-measures, which had been denuded off!

The chief economic uses of geological maps are to point out the localities where may be found limestone for building purposes and to be burnt for lime; sandstones and grits, fit for building and paving, for millstones, &c.; sands and gravels, for making paths and mending roads; clays and loams, for the manufacture of tiles and bricks; slates, for roofing purposes and for school-boys to draw upon; marbles, for the sculptor and for ornamental purposes; granites, for building and for road-metal.

Of course the economic value of each rock cannot be made out from the map alone; this is a point on which reference must be made to a published memoir or explanation of the map, upon which alone the boundaries and extent of the rocks can be depicted.

The relation between health and geology is also a point which has in recent years received a good deal of attention; and maps have been published and memoirs written to show the relations between certain forms of disease and geological structure—even between geology and lunatics! It is well known, indeed, that a gravelly, sandy, or chalky soil is more healthy than a clay foundation, because the former are pervious to water, and the latter is impervious. On the former there is less consumption than on the latter, as Mr. Whitaker and Dr. Buchanan have clearly demonstrated: the artificial removal of sub-soil water has, however, largely decreased it. Again, the water-supply is a most important subject, for in some small country villages and towns the inhabitants suffer very much from this cause. Situated perhaps on elevated ground, with a good porous soil, they yet suffer because of the disgraceful state of the drainage, the wells being shallow and the sewage, even the churchyards, draining into them. The cause of teetotalism will not find many admirers when it is known that women and children suffer most from drinking impure water, while the men who take their beer are less subject to disease.

Enough has been said to show the many practical uses of geology, and the importance of geological maps. To the agriculturist their value is of an indirect character; for although the soils are not laid down on the maps, yet in almost every case they bear a direct relation to the sub-soil beneath, being generally to a great extent formed out of it.

We need hardly dwell upon the interest imparted to a tour or journey from an acquaintance with geology, it has been so frequently remarked upon. Undoubtedly, a good geological map is to the traveller the readiest, if not the best, mode of obtaining information. It furnishes a sort of index to the geology of a country, and is for most purposes to be preferred to any written description or guide, though if possible both should be taken together. In the British isles, as we have pointed out, we are well provided with geological maps, and there are many excellent ones of the greater part of Europe, besides many illustrating the geology of other countries, particularly North America, India, and Australia, the results of private labour, and of our colonial or foreign geological surveys.

Such is the intimate connection between physical features and geological structure, that to the geologist a glance at the geological map of a country would enable him to obtain a very good idea of the character of its scenery. Denudation and the origin of scenery are most interesting subjects; how hard and soft rocks are acted upon by rain, river, and sea; how our bays and gulfs, islands and straits, cliffs and gorges, hills and valleys, were formed, are subjects now much discussed: they link geology with physical geography. Elevation gave the plan; denudation did the work. Geology is but the "physical geography of past ages;" we must interpret the past by the light of the present. Everything betokens change, and we cannot but sigh when we think of the vast amount of denudation that is going on. At this rate, by atmospheric agencies alone, a mass of land as large as Europe must, according to a rough estimate of Professor Geikie, disappear in about 4,000,000 years! What use, then, will our geological maps be? However, if we have thrown any light upon them, and pointed out some of their uses, so that they may be more fully appreciated at the present day, we may feel happy that our labour has not been lost.

THE BATTLE OF LIFE AMONG PLANTS.

By MAXWELL T. MASTERS, M.D., F.R.S.

EVERY day, every hour, there is going on around us a veritable death-struggle. It excites little attention. People would be in no hurry to read the telegraphic despatches concerning it from the seat of war, even if there were any to read. Special correspondents there are, but their letters are appreciated but by a few. Nevertheless, it cannot be said that mankind in general is not interested in the result of the struggle. On the contrary, little as the affair is heeded, it is of very serious import to the human race. Our food-supplies depend on it; the well-being of our flocks and herds is essentially dependent on it; the building of our houses, the fabrication of our raiment, are to a large extent contingent on it; nay, the soil beneath our feet, and the very sky above our heads, are materially, very materially, influenced by the result of the contest of which we are about to speak. Edward Forbes was wont to say that the movement of a periwinkle over a rock might be of greater consequence to the human race than the progress of an Alexander; and the results of the wars of the plants are assuredly of no less importance, seeing that the very existence of an Alexander depends in no slight degree upon them. The campaigns we speak of are real; they are not mental figments, or allegorical illustrations. Success in the practice of horticulture, of agriculture, of forestry, depends on the action we men take towards the combatants. If we remain neutral, the weakest goes to the wall, overpowered by the stronger; if we interfere, we exert a very powerful influence for the time; but immediately we cease to exert our power, the combat begins again, and with enhanced violence. The essence of successful cultivation often consists almost entirely in the removal of the plant from the influence of that hostile "environment" to which, under natural circumstances, it would be subjected. It is this that accounts, in a great measure, though of course not wholly, for the oft-observed fact that certain plants, flowers, and fruits, attain far greater perfection in our gardens than they ever do in their native countries.

That a war of extermination is thus going on around us may strike some with surprise. They are so accustomed to associate flowers and plants with peace and repose, that they are astonished to find that other far less amiable ideas may, with even more justice, be associated with them. And yet a moment's reflection, or a passing glance at the nearest hedgerow or pasture, will show the reality of the struggle. All that beautiful disorder, that apparently careless admixture of divers forms and colours—the sweeping curves of the brambles, the entwining coils of the honeysuckle, the creeping interlacement of the ground ivy or the pennywort—all are but indications of the fray that is constantly going on. It would seem as if the weakest must succumb, must be overpowered by the stronger-growing plants, and so they are at certain places and at certain times; but, under other conditions, the victory may be with the apparently weaker side, just as the slow-going tortoise may outrun the fleeter hare. In any case the success is often only temporary; the victor becomes in time the vanquished; the vanquished, in its turn, regains its former conquest; and so on.

It is proposed in the following notes to give a few illustrations of the nature and effects of this conflict, of the way in which it is carried on, and of the circumstances which favour it.

Agriculturists had long been practically conversant with the advantages derivable from the practice of not growing the same crop on the same soil for too long a period. The advantages consequent on this so-called rotation of crops are due to more than one cause; but it was Dureau de la Malle who, in 1825, called attention to the phenomenon of natural rotation. From long observation of what takes place in woods and pasture-lands, he established the fact that an alternation of growth, as he called it, occurs as a natural phenomenon. In pasture-lands, for instance, the grasses get the upper hand at one time, the leguminous plants at another; so that, in the course of thirty years, the author whose observations we are citing was witness of five or six such alternations.

It follows from all this that a plant, as was pointed out by the late Dean Herbert, does not necessarily grow in the situation best adapted for it, but where it can best hold its own against its hostile neighbours, and best sustain itself against unfavourable conditions generally.

The sources of success in the contest are manifold; they vary more or less in each individual case. Probably they are never exactly the same; nevertheless, there are certain circumstances which must always be operative in conducing to the victory. A few illustrations must suffice. It is easy to understand why first comers, duly installed, should have an advantage over later visitants; why the more prolific should outnumber the less fertile; and how it is that a perennial plant has a better chance on any given spot, *cæteris paribus*, than an annual whose progeny would find the ground occupied, and their chances of survival materially interfered with by their longer-lived neighbours.

Again, there is no difficulty in understanding why such plants as quitch (*Triticum repens*) or bearbine (*Convolvulus Sepium*) hold their own so tenaciously and so much to the prejudice of their neighbours. The long creeping underground stems rooting, or capable of rooting, at every joint give them an immense advantage over plants not so favourably organised. The ends of the shoots of the convolvulus, moreover, dilate into tubers, which are thrust into the ground to form in the succeeding spring fresh centres of vegetation. A great rooting power is obviously of great benefit; not less so is an extensive leaf surface. It is not only that the copious feeding roots absorb the available nourishment from the soil, not only that the wide leaf surface avails itself of every ray of sunlight, every whiff of air that plays over it, and thus serves to build up the tissues of the plant to which the root or leaf respectively belong, but they practically oust other plants less favourably circumstanced than themselves. The roots occupy the soil, and rob the weaker plants of their share of its resources. The tree with dense foliage shuts off from its lowlier neighbour much of the light and air necessary for its existence; and hence, in a measure, the absence of vegetation in pine forests or under the shadow of dense woods.* Some plants there are specially organised to resist and overcome these hostile conditions. Among them are the climbers, the twining plants, and those with tendrils of one sort or another. The bramble or wild rose, with its slender, arching, hook-beset branches; the wild hop, with its coils of cord-like sprays; the clematis, clinging on firmly by means of its leaf-stalks to anything it can lay hold of; the ivy, grappling with the trunk of a tree—all these are, in some sense, weakly plants; they would be overweighted in the struggle with their stronger neighbours if it were not for the special adaptation of their structure just alluded to, and which enables them to bear their part bravely in the conflict.

* These struggles were not unknown to ancient naturalists, as witness the following passage from Pliny, "Nat. Hist." lib. xv. cap. 24:—"Necant invicem inter sese umbra vel densitate atque alimenti rapinâ . . . necat et edera vinciens, nec viscum prodest et cytisus necatur eo quod halimon vocant Græci."

It is easy to understand how an alteration of the conditions under which plants grow influences very materially the struggle we have been alluding to. A very slight change in climatal conditions—produced, for instance, by the growth of sheltering trees, or by the drainage of the soil—may be followed by the growth of quite a different set of plants from those that occupied the ground previously. The altered conditions have been advantageous to the one and disadvantageous to the other set of plants.

As an illustration of the complexity of the checks and relations between organic beings struggling together, Darwin mentions the case of a barren heath which fell under his observation, part of which was left intact, while another portion had been enclosed and planted with Scotch fir. The change in the native vegetation of the planted part of the heath was most remarkable. "Not only the proportional numbers of the heath plants were wholly changed, but twelve species of plants, not counting grasses and carices, flourished in the plantations which could not be found on the heath."

This sort of change was pointedly referred to by Dureau de la Malle, who relates how, after the felling of the timber in forests of a particular district of France, broom, foxglove, heaths, birch-trees, and aspens sprung up, replacing the oaks, the beech, and the ash felled by the woodman. After thirty years the birch and poplars were felled in their turn. Still very few of the original possessors of the soil, the oaks, &c., made their appearance; the ground was still occupied with young birch and poplar. It is not till after the third repetition of the coppicing—after an interval of ninety years—that the oaks and beech reconquer their original position. They retain it for a time, and then the struggle begins again.

Antiquarian researches also have proved that in the natural state of things, without any violent change in external conditions, the nature of forests becomes altered. The Hercynian forests, of which Cæsar speaks, and which then consisted of deciduous-leaved trees, are now made up principally of conifers. A forest which, in the Middle Ages, was of beech, is now stocked with oak, and *vice versâ*. Again, we have the evidence afforded by submerged forests and peat bogs, according to which certain plants, now extinct in particular localities, once flourished there. We are not alluding to plants that may have required a different climate from what they now experience, but to such cases as the silver fir, the Scotch fir, *Pinus Mughus*, &c., which are found in this partially fossilised condition in spots where there is apparently nothing to prevent them from growing now, where in fact they do grow well when planted.

Foresters in all countries are perfectly well aware of these facts, and botanists watch with interest the appearance of a different vegetation, when some accident has interfered with the previously existing conditions. When woods are cut down, when soil from a depth is laid on the surface, when extensive fires occur, when lakes are drained; in fact, when any sudden alteration takes place in external circumstances, then we may expect to find a corresponding change in the vegetation. One set of plants profits by the change, another suffers. It may be asked, "Where do the new arrivals come from?" Sometimes, no doubt, the seeds are wafted from a distance, and, finding a suitable abiding-place, germinate. This is, perhaps, more especially the case with the spores of fungi, whose extreme minuteness favours their dispersion in this way. But it often happens that the facts of the case will not admit of such an interpretation, and then we can only fall back on the supposition that the seeds or bulbs existed in the soil, but under circumstances not favourable to their development.

The ground in this way is looked on by Alphonse de Candolle and Darwin as a vast magazine of seeds, &c., capable of retaining their vitality for a more or less prolonged period, according to circumstances, and ready to avail themselves of any change that may be beneficial to them. That this is so in some places has been proved by results, but it seems equally clear that this does not hold good in all places. Allusion has already been made to the apparently capricious appearance of our British orchids. The downs or the fields that in one summer yielded abundance of bee, of fly, or of spider orchids, may, in another year, scarcely furnish a single one. The explanation of this peculiarity lies in the special organisation of the plant well described by Prillieux and other botanists, from whose observations it appears that the plants in question naturally pass through several stages, which, for our present purpose, it is not necessary to detail, and these stages may be prolonged according to circumstances. The flowering stage is thus arrived at in one season, while in another all the energies of the plant may be taken up in forming tubers and leaves. A very remarkable instance of the fact just alluded to was communicated to the writer by a competent observer, Mr. George Oxenden, of Broome Park, Kent. This gentleman had been acquainted with a particular field for some forty years, during which time it had been under the plough, but at the expiration of this period it was laid down in grass, when the very next year a profusion of bee orchids was observed in it. In this case the time was too short for seeds to have germinated and to have progressed to the flowering state. There seems no other solution than that the tubers must have been in the ground some time previously, but that, from the ploughing and cropping of the soil, they had not had a fair chance of developing flowers.

The facts we have mentioned are, in the main, intelligible enough. We can see the why and the wherefore without much difficulty; but it is not so always. For instance, it is difficult to account for the signal defeat that native plants often incur at the hands of invading strangers.

Why does the water-cress, harmless enough in our ditches, block up the water-courses in New Zealand to such an extent as to become a costly nuisance? What can there be in English ditches and canals so propitious to the growth of the American water-weed (*Anacharis*) as to have caused it to obstruct even our navigable rivers? In America, whence it came, it is no more of an inconvenience than any other water-weed. Why in other places does the white clover (*Trifolium repens*) overcome the native grasses, and dispossess them of their territory? Why has a particular grass, the *Stipa tortilis*, invaded the South Russian steppes to such an extent as to displace almost every other plant?

There are numberless such instances—from that afforded by the island of St. Helena, in which the original vegetation is almost completely dispossessed, and its room occupied by foreign importations, to the banks of a Surrey river, yellow with the flowers of an American balsam—and the reason is not obvious. The fact is patent, and is not without analogies in the virulence with which epidemic diseases spread when introduced for the first time among a population not heretofore subjected to them.

Such cases as these recall the opinions of Humboldt and others on the antipathies of plants. According to this notion certain plants are positively injurious to others, not so much by any peculiarity of structural organisation as by the excretion of matters hurtful to other plants. It has been asserted, for instance, that the darnel (*Lolium temulentum*) is injurious to wheat; that a species of thistle (*Serratula arvensis*) is obnoxious to oats; that a spurge (*Euphorbia Peplus*) and a scabious (*Knautia arvensis*) are detrimental to flax; and spurrey (*Spergula arvensis*) similarly prejudicial to buckwheat.

In so far as this detrimental influence is due to any excrementitious product from the plant, the verdict given by modern physiologists amounts to "not proven." Some would even say "not guilty;" but we do not see clearly how those who take this view can reconcile it entirely with the existence of that natural alternation of which Dureau de la Malle speaks, and which is admitted by all subsequent observers.

Mere exhaustion of the soil will not account for the phenomena in all cases, because a crop will fail on a particular soil after a while, and yet chemical analysis of that soil will reveal the fact that the particular elements required by a given plant are still contained in sufficient abundance in it. Land, for instance, that is "clover sick"—on which, that is, good crops of clover cannot be grown—is by no means necessarily deficient in the constituent required for the growth of the plant; and, indeed, in the Rothamsted experiments the constituents in question have been supplied as manure, but without any good result. Again, root-excretions (assuming their existence) cannot be productive of injury, as we are assured by Dr. Gilbert that clover has been grown in the same plot of garden soil at Rothamsted for eighteen years in succession, while only a few hundred yards off no condition of manuring has hitherto been successful in restoring the clover-yielding capabilities of the land.* Reverting, however, to the alleged antipathies of one plant to another, we may make passing mention of the curious circumstance recorded by M. Paul Lévy,† that the lianas or climbing plants of the forests of Central America have their likes and dislikes, and that they will not attach themselves to particular trees even when brought into juxta-position with them. It is significant that the trees which are thus slighted by the twiners are just such as are ill-adapted for the support of such plants, being such as have tall unbranched trunks with smooth bark and a dense overhanging dome-like canopy of foliage. It is not only the climbing plants that refuse to grow on such trees, but to a less extent, also, the mosses, ferns, orchids, Bromeliads, and other epiphytal plants.

It is obvious, from what has been previously said, that human interference affects these internecine conflicts of plants very materially. It is clear also that the cultivator can very often avail himself of them to his own profit. From this point of view the experiments and observations carried on at Rothamsted by Mr. Lawes and Dr. Gilbert are most important, especially those relating to the struggle among pasture plants, and the circumstances favouring certain plants more than their fellows. No detailed report of these particular experiments has hitherto been published, and only a few scattered notices in the Proceedings of the Horticultural Society (June 2, 1868) have appeared concerning them. We can, however, give some idea of their scope and nature by stating that a part of the park at Rothamsted, which has been under grass for centuries, has been divided into plots of equal size, placed side by side under conditions as nearly equal as possible. Some of these plots have

* "Journ. Hort. Soc." New Series, vol. iii. p. 91.

† Cited in "Gardeners' Chronicle," 1870, p. 383.

been left unmanured; others, some twenty in number, have, for the last ten or twelve years, been subjected to various manures, the constitution and proportions of which are accurately determined. The general herbage of the park, like that of the unmanured plots, consists of some fifty species of plants, including sundry grasses, clovers, docks, umbellifers and other plants commonly found in such situations. In the several manured plots a change is observable, sometimes slight, at other times vast, and the change does not show itself so much in the superior luxuriance of any one plant, or in the starved condition of another, as it does in the more or less complete exclusion of certain plants, and in their replacement by others. Thus, while the unmanured plots contain, say, fifty species of plants, others comprise less than half that number; from some plots the clovers and umbellifers are banished altogether, while in other cases they may be proportionately increased. Even among the grasses the competition is very severe, and the result in some cases is that all or nearly all have to give way to the cock's-foot grass (*Dactylis cæspitosa*), the growth of which is so fostered by certain manures as to cause it to overcome its fellows and remain master of the situation. To the plots to which a mixed mineral manure, consisting of salts of potash, soda, magnesia, and lime is applied, but little difference in the number of species is observable. On the other hand, manures containing ammonia salts, or nitrates, cause a great diminution in the number of species living in the plot to which they are applied. While the unmanured plots furnish by weight about 60 per cent. of grasses, the remainder, consisting of plants of other families, the plots to which admixture of mineral and nitrogenous manures is added contain as much as 95 per cent. of grasses, and these belonging to a comparatively very few species. Salts of potash and lime, which are comparatively inert as regards grasses, manifest their influence in increasing the vigour and the absolute numerical proportion of the leguminous plants.

The manner in which these results have been arrived at is worthy of a short description in this place.

Notes are taken at frequent intervals during the season of growth, the appearance of the plants noted, their relative luxuriance observed, and their comparative tendency to produce flower or stem and leaf, the abundance of flowers, &c., &c. Root-growth is studied, and also the character of the soil in the various plots, and the way in which its texture and its capacity for holding or transmitting water are modified according to the manure applied. When the crop is cut from each plot, its weight is estimated, and also the amount of dry produce. In some cases chemical analysis is pushed further, and the ashes duly examined. In addition to these no trifling observations, three "separations" have been carried out at regular intervals. These separations consist in the picking out, from a sample of a certain weight taken from each plot, every fragment of every species contained in the sample. In this way the relative quantity and weight of each of the different plants in the several samples is accurately determined, and the proportion in the whole plot computed. The labour is enormous; but the results, when fully brought out, must be most important, both as regards the scientific aspect of the question, the history of the life-struggle between plants so circumstanced, and also as regards the practical hints to be derived by the cultivator.

Some experiments of a somewhat similar character, and bearing directly on the struggle for life among plants, have been made by Professor Hoffman of Giessen, and they are of such interest that we introduce here a very condensed account of them taken from the pages of "The Gardener's Chronicle," 1870, p. 664:—

In a previous set of experiments the Giessen Professor had ascertained that the particular plants under observation grew equally well in all the varieties of soil in which they were placed, provided due care was taken to prevent the growth of intruding weeds. Having arrived at this result, Prof. Hoffmann next left the several plants to themselves, with a view of ascertaining how they would comport themselves without assistance against the inroads of weeds. The result was, that the weeds completely gained the upper hand, as might have been expected from their known habit. The species which held out longest was *Asperula cynanchica*. This plant, after having been grown in a bed for three years, and protected from weed-invasion by the use of the hoe, was then left to take care of itself. It held out for four years, but was ultimately elbowed out by the intruders. Acting on the principle of "set a rogue to catch a rogue," Prof. Hoffmann then set himself to observe the results of the internecine struggle between the weeds themselves, thinking that the ultimate survivors would perhaps prove to have special affinities for the soil in which they grew.

Thus left to themselves the beds became so densely covered, that in a square foot the Professor counted 460 living plants, and the remnants of many others, which had succumbed in the encounter. Every year, in July, the plots were examined, and every year the number of species was found to have diminished. Melilots, at first abundant, gradually disappeared; *Artemisia vulgaris* succumbed after two or three years; and so on, till at length only a few species were left, and these not only persisted, but slowly gained ground from year to year, and ultimately remained in possession of the plot. The plots under observation were 2 mètres 30 cents. long, 1 mètre broad, and all as nearly as possible under the same conditions, save that the soil was varied, in some cases consisting of the ordinary soil of the garden, in others of an admixture of lime, in others of sand, or of sand and lime, and so forth.

Of the 107 species under observation, all, or nearly all, found the most essential requisites of their existence equally well in all the varieties of soil; so that, other conditions being equal, the nature of the soil was indifferent. The species which remained victors, all the others being ultimately dispossessed, were *Triticum repens* (couch), *Poa pratensis*, *Potentilla reptans*, *Acer Pseudo Platanus* (sycamore), *Cornus sanguinea*, native plants; and *Aster salignus*, *A. parviflorus*, *Euphorbia virgata*, and *Prunus Padus*, derived from other portions of the garden.

It may, therefore, be inferred that the district in which these experiments were made would in process of time, if no obstacle were afforded, become covered with meadows and woods—meadows in the low ground and woods in elevated places. Again, the experiments show that the survival of certain plants has not been influenced by the nature of the soil; thus the couch-grass was ultimately spread over all the plots, whether of sand, or of loam, or of lime, whether drained or undrained. So also with *Poa pratensis* and *Potentilla reptans*. So that the chemical and physical nature of the soil, as has been so often shown in similar investigations, plays only a secondary part.

As to the action of shade, it was found by Professor Hoffman that low-growing plants, especially if annuals, disappeared rapidly, while taller-growing plants, such as couch, *Prunus Padus*, &c., survived. The survival of certain plants, then—couch, *Aster*, *Potentilla*, &c.—is due much less to external conditions than to the "habit" of the plant itself; that is to say, to the facility the plant has of adapting itself to varying external conditions, and thus of triumphing over others less favourably endowed in this wise.

The immediate source of victory lies in the powerful root-growth of the survivors, including under the general term "root" not only the root proper, but the offshoots and runners which are given off just below, or on the surface of the ground. Indeed, the latter habit of growth is more advantageous to plants in such a struggle than the development of the true root downwards would be. Among those plants where the roots were equally developed there were, nevertheless, inequalities of growth, dependent probably on the greater need for light in some species than in others, &c.

It is clear from Professor Hoffman's experiments that, but for the continual use of the hoe, and the diligent extirpation of the weeds in our fields, the stronger growing ones would not only destroy our crops, but also other weeds less vigorous than themselves. But they are not sufficient to explain all the conditions of this complicated problem; as is shown by the fact that in the district adjoining the locality where Professor Hoffman's experiments were carried on, the predominant plants are not the same as those which ultimately proved victors in the experimental beds.

We may add, that for two years a series of observations was carried on in the gardens of the Royal Horticultural Society, at Chiswick, with a view to ascertain how certain selected plants, twelve in number, and naturally growing in pastures, would be affected when growing by themselves, by the addition of manures of five different descriptions, and similar to those used at Rothamsted. In some cases the results of these experiments were unsatisfactory, from circumstances that need not be detailed here; still a large body of facts was accumulated, and, with reference to the property by which certain plants prove victorious in the struggle for life, it was clear that the natural habit or organisation of the plant was, *cæteris paribus*, the mainspring of its success over its competitors. The several manures intensified or deteriorated this peculiar organisation, as the case might be, and thus favoured or impeded its growth accordingly.

THE POISONOUS SNAKES OF INDIA.

By Professor J. REAY GREENE, B.A., M.D.

[PLATE XCIV.]

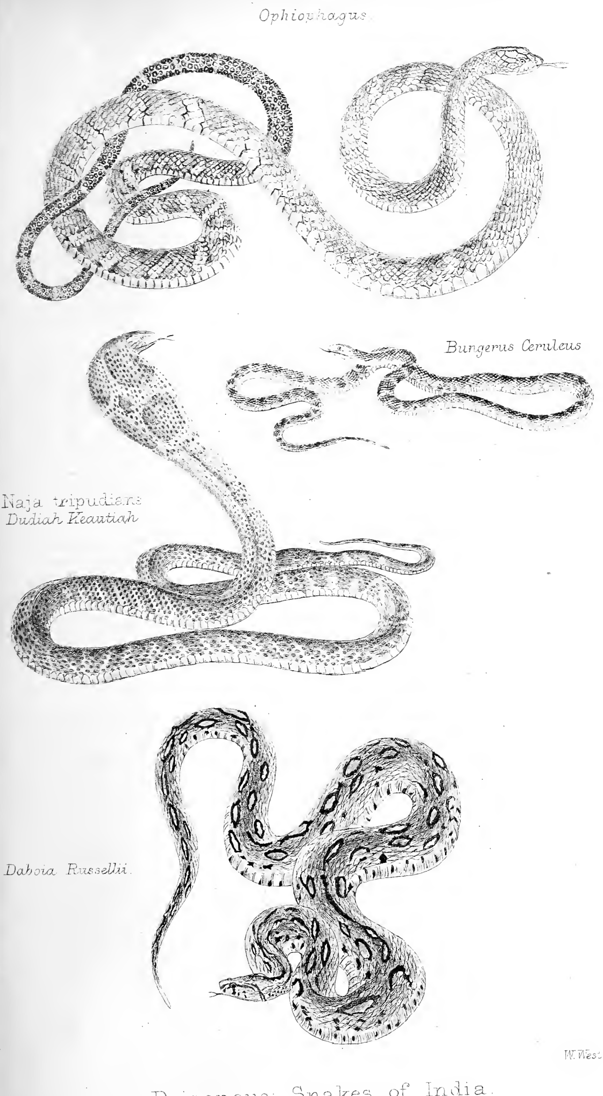
NO animals are so abhorrent to most persons as are snakes. Their lurking habits and insidious approach, their anomalous aspect, their movements effected without the aid of limbs, above all their venom, usually excite feelings of disgust and apprehension. Yet the study of snakes attracts us, as snakes themselves are said to fascinate their victims. The biblical stories of the serpent beguiling Eve and of St. Paul's miraculous escape from a poisonous snake at Melita, the famous myth of the sea-serpent, the worship of snakes in the East, the tricks of the snake-charmers—these, with other such-like traditions and customs, tend further to enhance its interest. Of animals directly formidable to man, none, beyond the limits of his own species, are so deadly as the poisonous snakes. Against their silent and sudden attack he guards himself with difficulty. Against their wounds he can seldom find a remedy.

Serpents more especially interest the zoölogist because of their form, their mode of progression, and their mode of swallowing their prey. They show numerous points of structure obviously related to these peculiarities, besides other and not less remarkable anatomical characters which cannot be so explained.

Though not the highest, serpents ought perhaps to be regarded as the most specialised of reptiles; a class, next to fishes, notable for the diversity of the organisms which it includes. They are also the latest reptiles in time. The earth was already peopled with lizards, crocodilians and tortoises; ichthyosaurs, plesiosaurs, pterodactyles, iguanodonts and other strange mesozoic reptiles, had come and gone—before serpents made their appearance.

Most serpents are inhabitants of the tropics. They are less abundant in sub-tropical and temperate regions. No American species is found beyond 60° of north latitude. The most

Plate XCIV.



W. West & Co. lith.

Poisonous Snakes of India.

northern snake of Europe, our common viper, has its limit at 62°.

Serpents constitute one of the best marked orders of vertebrate animals. It is true that their external form is parodied by the so-called spurious snakes, or pseudophidians, and still more closely by certain lizards. Some of the extinct labyrinthodonts would seem, also, to have had a snake-like body. Both these and their recent allies, the pseudophidians, are easily distinguished from the serpents by most of the characters which separate the class of batrachians from that of reptiles properly so called. Moreover, the pseudophidians have the tail absent or very short, and the scales, which are quite rudimentary, placed between transverse wrinkles of the smooth glutinous skin.

It is more difficult to distinguish snakes from snake-like lizards, but the difficulty is not so great as at first appears. Those who ought to know better often erroneously state that the transition from serpents to lizards is so gradual that nowhere can a line of demarcation between them be drawn—an error copied in most text-books of zoölogy. Some have gone so far as to place snakes and lizards in the same order. But, in truth, the supposed passage from one of these groups to the other is effected only by means of such characters as the presence or absence of eye-lids, the form of the body, the relative elongation and consequent asymmetry of the lungs, the appearance of the scales, and the developement of posterior limbs. Not to mention other characters, all serpents are sharply differentiated from lizards by the structure of their skull and jaws, and by their total want of a shoulder-girdle.

Nevertheless it is curious to note the cross relationships between the two orders. Thus, some of the more typical snakes have traces of hind limbs, while we find lizards with well developed limbs, and not their aberrant congeners, exhibiting a near approach to that peculiar and complex articulation of the vertebræ found in most serpents.

With three striking exceptions,* no other order of vertebrate animals is more extensive than that of serpents. The number of known species may be estimated at a thousand, of which two hundred are venomous. These venomous snakes we shal l now exclusively consider, with special reference to those which inhabit the peninsula of India.

* These are (1) carinate birds, (2) acanthopterous fishes, and (3) phystomous fishes. Lizards and the mammalian group of rodents are, next t serpents, richer in species than any other orders of vertebrates, so far as a present known.

It is usual to distinguish four families of venomous snakes—the Crotalids or pit-vipers, the true vipers, the Elapids and the Hydrophids or sea-serpents.

The pit-vipers are, of all venomous snakes, the most modified in structure, those which depart furthest from the harmless * serpents. The long poison-fang is firmly fixed to the maxillary bone, which is extremely short and high, and moveable upon two other bones of the head. Behind the poison-tooth lie the rudiments of its successors, the so-called fangs of replacement. There are no other teeth in the maxillary bone. The sides of the poison-tooth are prolonged forwards and inwards to meet one another along the front of the fang, where they serve to enclose a tube, or canal, open near the point of the tooth for the escape of the poison, while, at its opposite end, the base of the fang communicates with the principal duct of the poison-gland. So large is the fang in proportion to the maxillary bone which supports it, that both might be said to constitute a single structure. The fangs share the movements of their bony supports and, when not in use lie hidden in the gum, along the roof of the mouth, with their points directed backwards. As the mouth opens, the maxillæ rotate sufficiently to erect the fangs, which are thus most favourably placed for at once inflicting a wound and discharging their venom.† Each maxillary bone has on its outer side a deep excavation, indicated externally by a conspicuous pit placed between the eye and nostril. The Crotalidæ have a stout body, a moderate or rather short tail, and a broad triangular head, flattened above and very wide behind, passing suddenly into the neck. The tail is prehensile in some, not in others. The eyes are moderate, with vertical pupils. The head is variously covered with shields or scales, which supply characters used in defining the genera. These serpents are viviparous.

Almost all the characters common to the Crotalidæ are presented, in a slightly reduced degree, by the true vipers, which want, however, the maxillary pit distinguishing the first-men-

* The words *harmless* and *innocent*, when used in the case of snakes, are synonymous with *non-venomous*. Most of these last are truly harmless to man; not so, however, with the larger constricting serpents (Pythons and Boas), which, though not poisonous, are more to be dreaded than some species of Thanatophidia.

† For a good account of the complex biting mechansim of serpents, which it is not our business here to describe at length, reference may best be made to Professor Huxley's "Anatomy of Vertebrated Animals," pp. 238-241. The reader, desirous further to study the anatomical characters of this order, should next consult the admirable "Zootomie der Amphibien" of Professor Stannius; 8vo, Berlin, 1856.

tioned family. The tail of the Viperidæ is never prehensile. The head is covered above with scales; or the shields, if present, are incomplete.

The Crotalidæ and Viperidæ taken together constitute the tribe of Viperiformes, which are sufficiently distinguished from other venomous snakes by their relatively stouter body, larger and more distinctly limited head, and, above all, by their short moveably articulated maxillæ.

The Elapidæ have a smaller head, passing gently into the neck, a more slender body, and moderately long maxillary bones which are fixed (or nearly so) to the other bones of the face. Their fangs, therefore, are permanently erect. These fangs are relatively not so large as those of the vipers, and instead of a perfect tube, they display on their anterior surface a more or less open groove, in consequence of the approximation, without junction, of their incurved edges. Other smaller solid teeth may arise from the maxillary bone behind the poison-fangs. But in many Elapidæ these additional teeth are wanting, or one such tooth only is present. The head has its upper surface covered with shields, after the manner of most serpents; the eyes are small, with round pupils. The tail is of moderate length. Some are oviparous, others viviparous. Notwithstanding their poison-apparatus, the nearest affinities of these snakes are not with the vipers, but with those numerous families of typical serpents which make up the great majority of their order and constitute the tribe of Colubriformes.*

The Hydrophidæ, or sea-serpents, are still more closely related to the non-venomous colubrine snakes. Their maxillæ are long and display numerous teeth behind the poison-fangs, which are usually much smaller than those of the Elapidæ, like which they are furnished with open or nearly open grooves. When, therefore, an Hydrophid bites, it leaves a mark requiring carefully to be distinguished from that of a non-venomous snake. The eyes are small, with round pupils, as in the Elapidæ. The nostrils are on the top of the head, not at its sides. Their tail is much compressed. Unlike their mythical

* The name Proteroglyphes was given by Duméril to the venomous colubrine snakes, on account of their *grooved* fangs; that of Solenoglyphes to the viperine snakes, their fangs being *perforate.* But in two African genera, Dinophis (or Dendraspis) and Atractaspis, the fangs, though perforate, are permanently erect. This latter character should remove them from the vipers. Dinophis has long maxillæ, and appears truly to belong to the Elapidæ. Atractaspis, a genus containing very few species, was raised in 1858 by Dr. Günther to the rank of a family, and placed near the Elapidæ among the colubrine snakes. Mr. Cope, on the other hand, considers it allied to the vipers. Stannius leaves the venomous snakes (Thanatophidia) in one group, which he names Iobola.

relative, the true sea-serpents are of small size. They are viviparous. They feed on fishes, never voluntarily quit the water, and soon die when brought on shore.

The peculiarily situated nostrils and high flattened tail—characters obviously connected with their mode of life, not to speak of the exceptional arrangement of their head-shields—at once separate the Hydrophidæ from the preceding families, and indeed from all other snakes.

There, is however, one genus of Hydrophids, Platurus, which makes a near approach towards the Elapidæ. The number and disposition of its head-shields is almost identical; its nostrils are lateral, not superior. "The poison-fang is short, and not followed by a series of other simple teeth, as in Hydrophis. A very small single tooth is implanted at some distance behind the poison-fang, and is frequently lost. These snakes have quite the physiognomy of an Elaps, and the cleft of the mouth is not turned upwards behind, as in other sea-snakes."*

The families of venomous snakes show well marked peculiarities of geographical distribution. Thus we may consider America as the head-quarters of the Crotalidæ, Africa of the Viperidæ, Australia of the Elapidæ, and the Indian Ocean of the Hydrophidæ.

The Crotalidæ are absent from Europe, Africa, and Australia. Asia contains several species of this family, but they are smaller in size, and far less venomous than those of America. When we consider their highly modified structure as well as their geographical range, it might reasonably be conjectured, from the point of view afforded by Mr. Darwin's hypothesis, that the Crotalidæ first appeared at a later period than any other family of snakes, and that in all probability their American have succeeded their Asiatic representatives.†

The Viperidæ, on the other hand, are quite wanting in America. But two species are found in Asia, one of which is likewise African. Three European species are well known. One of these, the common adder (Vipera berus), extends its range to England and Scotland, but not to Ireland. Another species, the so-called Death-adder (Vipera acanthophis) is the sole representative of its family in Australia.‡

* Quoted from Dr. Günther's "Reptiles of British India," which contains a critical revision of all the Hydrophidæ known in 1864. Before this date the species of sea-snakes were in a state of thorough confusion, in consequence of the half-attempts made by previous naturalists to explain their character.

† So that snakes have been preceded by the other orders of Reptiles, venomous by non-venomous snakes, viperine by venomous colubrine snakes, and Crotalidæ by Viperidæ.

‡ Australia is further remarkable for the disproportion between its

The other venomous snakes of the Australian continent belong without exception to the Elapidæ. About a dozen species of African Elapidæ are known, but others probably await discovery. The genus Elaps itself, as now restricted, is characteristic of tropical America. Some fifteen species have been carefully distinguished, besides those which are doubtful. The number of species of this family inhabiting Asia and its islands may for the present be put down as not far from twenty.

Beyond the Indian Ocean Hydrophidæ are scarce, save in the adjoining waters of the Pacific, along the coasts of Australia and the Eastern Archipelago. A few are found in other parts of the Pacific, and it is said, on good authority, that they have been seen, though not captured, in the neighbourhood of Panama. None are known from the Atlantic ocean.

India is much richer in snakes than any other region of the globe. Some allowance, of course, must be made for the fact that the tropical fauna of our eastern possessions is far better known than that of Africa or Australia. Nearly a hundred and fifty species of snakes, inhabiting the Indian peninsula, have already been described. Of these at least twenty-five are venomous. This estimate excludes the Hydrophidæ. The true vipers are represented by only two species. The other terrestrial venomous snakes are about equally divided between the two families Crotalidæ and Elapidæ.

Two-thirds of the Indian Crotalidæ belong to one genus, Trimeresurus. These snakes rarely attain a length of three feet. Their prevailing colour is grass-green or brown, tints in obvious harmony with their arboreal life. They exhibit notably the characteristic physiognomy of the viperiform serpents, having a broad triangular head, a very narrow neck, and a

venomous and non-venomous snakes; the number of species of the former being double that of the latter. Thus Mr. Krefft, in his "Snakes of Australia," published at Sydney in 1869, describes 21 non-venomous species, 41 species of Elapidæ and 1 viper, besides 15 species of sea-snakes, all venomous. To understand these numbers aright, let us remember that non-venomous species make up four-fifths of the snake population of the entire globe. We may add that of the non-venomous Australian species of snakes six are Pythons, while eight belong to the genus Typhlops. This is of all snakes that which least displays the most striking features of its order, that which is farthest removed from the mobile-jawed Crotalidæ. There remain but seven ordinary colubrine species. Thus, while colubrine snakes prevail most in Australia, their aberrant and not their typical forms are those which predominate in this division of the globe, so noted in other respects for the peculiarities of its fauna.

robust body. They are not, however, often fatal to man, and in this respect they offer a striking contrast to the American Crotalidæ. While statistics prove that death in some instances follows the bite of the larger Trimerisuri, it is still easier to show that its more common effect is but a train of unpleasant symptoms, of varying duration, ending in recovery. The general health and vigour of the patient usually enable him to resist the influence of the venom, where a more weakly subject would probably succumb. There is still less evidence of the homicidal powers of the other Indian Crotalidæ. Of these the most interesting is the genus Halys, represented by two species in British India. Halys is remarkable for the long spinous scale in which its tail terminates—a rudiment of the "rattle" which some of its formidable American relatives possess.

Of the two Indian Viperidæ one is the 'Tic-polonga,' or Russell's viper, a most fatal snake. The other is the little Echis carinata, a species, however, which can no longer be separated from the Echis arenicola of Egypt. This prettily marked brownish snake may reach a length of twenty-three inches; usually it is much smaller. Evidence as to its lethal powers is wanting. Dr. Günther, writing in 1864, was not able to prove that its bite is ever fatal to man. Dr. Fayrer holds a more positive opinion, judging from the fact that an Echis in his possession "killed a fowl in four minutes, another in two minutes, and a dog in about four hours." He describes it as "very fierce and aggressive—it is always on the defensive—ready to attack; it throws itself into a double coil, the folds of which are in perpetual motion, and as they rub against each other, they make a loud rustling sound, very like hissing. This sound is produced by the three or four outer rows of carinated scales, which are very prominent and point downwards at a different angle to the rest; their friction against each other causes the sound." He adds that "its eye has a peculiarly vicious appearance."

The Elapidæ having the sides of the neck dilatable to form a hood constitute the sub-family of Najidæ. This group contains two genera, of which both are Indian. Naja itself is represented by the famous Cobra (N. tripudians), a near relative of the Egyptian Haje (N. haje). Another hooded snake, Ophiophagus elaps, the only species of its genus, ranges from the Indian peninsula to New Guinea.

Of Indian Elapidæ without a hood the most noteworthy are the two species of Bungarus. B. cæruleus is the dreaded "Krait." The much larger B. fasciatus, a species marked by broad alternate transverse bands of black and yellow, is by no means so fatal in its effects. For the rest, excepting one or two doubtful snakes, the Elapidæ are represented on the Indian continent by half-a-dozen species of the genus Callophis. These are small serpents, with sluggish movements and dull senses. They have short fangs. They feed on harmless snakes, the Calamariæ, which curiously resemble them in habit and physiognomy. The Callophides will not bite unless irritated. According to Dr. Fayrer "it is probable that a fatal result would not be produced by their bite in man. The poison is virulent, neverthelesss, and fowls bitten by some of the species succumbed in from one to three hours."

The seas around India swarm with Hydrophidæ, the number of which is about equal to that of the Thanatophidians on the adjacent continent. They are active snakes, and move very gracefully in their own element, seeking rather to escape from man than to attack him, which, however, they are ready to do when captured or irritated. In spite of their small size and relatively small fangs, they are extremely venomous. Dr. Fayrer was "informed by Mr. Galiffe that a fisherman bitten by a salt-water snake somewhere near the salt lakes, died in one hour and a quarter." Dr. Fayrer's "own experiments and those of Mr. Stewart at Pooree prove, that not only when able to bite voluntarily, but even when weak and unable to bite, when the jaws were compressed on the animal, death resulted. The fishermen on the coast know their dangerous properties, and carefully avoid them."

From a practical point of view four of the terrestrial venomous snakes of India far exceed in importance their fellows. These four species are the Cobra, the Ophiophagus, the Krait, and the Tic-polonga. The name of the species causing death cannot, it is true, often be ascertained. It is, therefore, possible that we may underrate the venomous power of some snakes, especially of Bungarus fasciatus and of Echis. But the fact remains—that whenever an Indian snake, which has killed a man by its bite, is secured and examined, it is found almost invariably to belong to one of the four species just mentioned.*

The Cobra and Ophiophagus are easily distinguished by their hood from the Krait, which shares with them the characters of the Elapidæ. All these differ from the Tic-polonga in having

one or two small solid teeth behind each fang,
two nasal shields,
smooth scales,
a rather small head, and
eyes with round pupils.

* India, therefore, resembles Australia, and not Africa or tropical America, in that its most formidable venomous snakes are Elapids, together with a single characteristic species of viper.

The Cobra is the most celebrated of venomous snakes. It deserves to occupy the post of honour among the lower animals. For man is the great persecutor of living creatures, and the cobra has killed more men than has any other animal, save man himself. Power gains respect, and we cannot therefore wonder that in some parts of India this terrible snake is superstitiously protected by the ignorant natives. It is the favourite of snake-charmers, because of its imposing aspect, and of the ease with which their skill enables them to handle it, even when not deprived of its fangs.

The Cobra "is by no means confined to the continent and Ceylon, being found in a number of the larger islands of the Archipelago. It extends eastwards to the Sutlej, and westwards to the Chinese island of Chusan. Singularly, it has never been observed by Mr. Hodgson in the valley of Nepal, but occurs in different parts of the Himalayas, reaching an altitude of 8,000 feet in Sikkim. It attains to a length of 5 feet,* feeding on small mammals and birds, on lizards, frogs, toads, and fishes; in order to obtain its prey it occasionally climbs trees or the roofs of huts ; it is an expert swimmer, and is sometimes found at a considerable distance out at sea. It is more a nocturnal animal than a diurnal one, and ovoviviparous. Its chief enemies are the jungle fowl, which destroy the young brood, and the Herpestes or ichneumons, which will attack and master the largest Cobra : in districts where the Cobras or other venomous snakes have too much increased in number, the most efficient way of destroying them is to protect their natural enemies.

"The Cobra, the most common venomous snake of India, is so much an object of dread to the natives, of wonder to the Europeans, and of profit to the numerous itinerant snake-charmers, that it has become as celebrated an animal as its cousin, the Naja haje, which was a symbol of female divinities among the ancient Egyptians. Almost every writer on the natural productions of the East Indies has contributed to the natural history of this snake, which has been surrounded by such a number of evidently fabulous stories that their repetition and contradiction would fill a volume.

"This snake is frequently brought to Europe, and will live

* Dr. Günther, from whose great work on the Reptiles of British India (p. 340) the above extract is made, here speaks cautiously, within the limits of his own knowledge. His estimate of the Cobra's size is, however, too moderate. Dr. Fayrer mentions a living specimen "five feet eight inches long, including the tail, which measures eleven and a quarter inches. In girth it is six and a quarter inches. It is very powerful and fierce, and Dr. Beatson tells me that it killed a fowl in one minute. This is the largest Cobra I have seen, but I believe they attain even a greater size than this."

in captivity for years. Two may be well kept together; and it appears as if they felt some attachment for each other, for when they are excited by having food brought into their cage, or by some other incident, they will frequently fight each other, raising the anterior part of the body, spreading the hood, and darting as if to bite, but always carefully avoiding to wound. When, however, a third individual or any other snake is brought into the same cage, they attack and kill it. They feed more frequently at dusk and during the night than in the daytime; they drink often and much."

Floods cause the Cobra to shelter itself in villages, whereby its opportunities for mischief are much increased. Various returns made to the authorities amply attest that it far surpasses all other snakes in the number of its victims.

The Cobra is very prone to variation. Nine of its principal varieties are figured in the first six coloured plates prefixed to Dr. Fayrer's recently published work* on the Thanatophidia of India. These varieties may be referred to two sub-species distinguished by the natives as "Keautiah" and "Gokurrah,"—the former with an eye-like spot or simple band at the back of the hood, the latter with the well-known "spectacles," from which this snake is often named.

Ophiophagus elaps, the other hooded snake of India, sometimes known as the Hamadryad, is also variable, but not to such a degree as the Cobra. It too, as we have said, is widely distributed. Fortunately, it is not very abundant, for "it grows to the length of twelve or fourteen feet, and is not only very powerful, but also active and agressive." It injects a large quantity of venom, which "is less deadly in equal quantities than that of the Cobra." Its home is in hollow trees, where it preys on other snakes; whence its generic name. When young it closely resembless another species of tree-snake, the harmless Dipsas dendrophila.

The Hamadryad occasionally takes to the water. Its native name in Bengal is "Sunkerchor," or shell-breaker; in Orissa it is called "Ai ráj."

Compared externally with the Cobra, it not only differs in colour, but "is longer in proportion to its size; it is, however,

* The drawings in this work were executed by native students at the School of Art in Calcutta, "most from life itself." They represent the Cobra, the Ophiophagus (two varieties), Bungarus (two species), Callophis (one species), the two Indian Viperidæ, eight species of Crotalidæ, and fourteen sea-snakes. Three other plates, not coloured, show the mode of holding the snake and the structure of the poison-apparatus. The most valuable portion of the work itself is its concluding section, which gives the results of Dr. Fayrer's own experiments, showing the effects of snake-poison on the lower animals, and the utter inutility of the native antidotes.

more graceful in its movements, and turns more rapidly. It is occasionally seen with the snake-charmers, who prize it highly as a show; but they say it is exceedingly dangerous to catch, and difficult to handle before its fangs are removed."

The Krait (Bungarus cæruleus), having a slender body and no hood, wears an aspect much less formidable than either the Cobra or Hamadryad. In length it reaches fifty-four inches. Three varieties are distinguished by Dr. Günther, none ranging beyond the Indian peninsula. This species is very common, "and next to the Cobra is the snake most destructive to human life." Its fangs are much smaller, "and its poison is not so rapid in its action, which circumstance, with the comparative smallness of the wound, gives greater hope of cure," but such hope is not to be relied on.

Dr. Fayrer points out that the Krait "may be mistaken for Lycodon aulicus, an innocent snake, the colouring and general appearance being in many cases very similar. The least examination of the mouth * would detect the difference, but at first sight they are much alike, and are often mistaken, the Lycodon suffering for its resemblance to its poisonous facsimile."

The Indian viper (Vipera Russellii), a hardy snake, fifty inches in length, is sometimes placed in a distinct genus, Daboia. Though without a hood, its physiognomy is more decidedly thanatophidian than that of the three preceding serpents, from which it is at once distinguished by its well defined relatively broader viperine head, unlike that of any non-venomous snake. The top of the head is covered with ordinary scales; the pupil is vertical; the large nostril lies between three shields; the body-scales are strongly keeled; similar scales cover the sides of the head. This dangerous snake is stoutly built, and its greyish-brown body is most beautifully dappled with large black, light-edged rings, calling to mind the spots of the jaguar. These markings are very variable. A common species, it abounds in Burmah, Southern India, and Ceylon. Dr. Fayrer says it is often caught in the Botanic Gardens near Calcutta. It has several local names; that of Tic-polonga, given to it in Ceylon, is the best known. Its prey consists of various small animals, and it is reported that it "often kills cattle, biting them when grazing." Though a terrestrial snake, "it will go into water." Dr. Russell believed the Indian viper to be as poisonous as the Cobra. The experiments of Dr. Fayrer incline him "to agree with Dr. Russell, and to give it, at all events, a place next to the [illegible]

* Dr. Fayrer does not tell us how this pleasant operation is to be performed.

bitten by this snake expired in from thirty-five seconds to several minutes ; dogs, in from seven minutes to several hours ; a cat in fifty-seven minutes ; a horse in eleven and a half hours. Death was not in any case so rapid as after the Cobra bite, but though slower in its action, the poison seemed just as deadly. The blood remains fluid after death from the poison of the Daboia, whereas after Cobra poisoning it coagulates firmly on being removed from the heart and great vessels. The Daboia is nocturnal in its habits ; in confinement it is sluggish, and does not readily strike unless roused and irritated, when it bites with great force and determination. When disturbed it hisses fiercely, and when it strikes, does so with great vigour." Dr. Fayrer kept one "for a whole year, without food or water ; it obstinately refused either, and was vigorous and venomous to the last."

The reader will note the great variability of these four venomous snakes—a phenomenon, as in other animals, often according with a wide geographical distribution. Also, that two of them are closely simulated by, or rather simulate, harmless species found in the same situations. This applies even to the Cobra, for which an innocent snake (Tropidonotus macrophthalmus), with its dilatable neck and similarly arranged scales, is often mistaken.

Our space will not allow us to add more than a few figures, taken from the work of Dr. Fayrer, giving some account of the loss of life due to Indian Thanatophidia, but chiefly to the four justly-dreaded serpents * whose history has been sketched only in part.

In one year alone (1869) the deaths by snake-bite in the Bengal Presidency amounted to 6,219. Many other deaths from the same cause, not officially recorded, must also have occurred.

Of these deaths 959 were ascribed to the Cobra, 160 to the Krait, 348 to "other snakes," and 4,752 to "snakes unknown."

The snake causing death is often not seen. "Doubtless, as the Cobra is in excess in the recorded cases, so it is in those of "other snakes" and "unknown," whilst the remainder "must be assigned to the Hamadryad, the Bungarus cæruleus, Bungarus fasciatus, Daboia Russellii, and probably a few to the Trimeresuri and Hydrophidæ."

It is curious to note that "there was an excess of 145 females over the males ; the adult females appear to have been

* Of these four snakes that which is by far the largest—doubtless because of its relative scarcity—causes by far the smallest number of deaths.

the greatest sufferers, by 2,576 against 2,374; whilst, on the other hand, female children were fewer, being 606 against 663 male children."

Of 120 deaths recorded during the same year from British Burmah, 45 were due to the Cobra, "and all the rest, with a few exceptions to the Viper (Daboia)."

These and other estimates lead us to infer that Dr. Fayrer speaks within the truth when he concludes that, were returns made from all Hindostan, it would be found that more than 20,000 inhabitants of British India die annually from snake-bite alone.

HALLUCINATORY MANIFESTATIONS.

By DR. RICHARDSON, F.R.S.

SALVERTE, in his remarkable work on the occult sciences, states that the principle by which he has been guided in all his researches is that which distinguishes two very different forms of civilisation: the *fixed* form, which in times past prevailed universally throughout the world, and the *perfectible* form, or that which prevails in communities that have become learned in letters, science, and art. The natural tendency of man is to love and seek the marvellous; and as the love of the wonderful always prefers the most surprising to the most natural accounts, the natural is too frequently neglected. At the same time the most surprising phenomenon does not long continue potent to surprise even when it is real, while surprising unrealities pass away as fast as they come. "Credulous man," says this learned author, "may be deceived once, or more frequently, but his credulity is not a sufficient instrument to govern his whole existence. The wonderful excites only a transient admiration, for man is led by his passions, and chiefly by hope and by fear."

The psychological argument thus adduced is an argument always to be remembered when we have before us the subject of natural as opposed to supernatural readings of any class of phenomena, of which we become individually or collectively conversant; and in overlooking this position, men of science, I venture to think, often err. They, disdaining the fixed principle of human thought and action, in their strain after the perfectible, treat as childish or even as idiotic all notions of phenomena that become marvellous by surprise, and unanswerable by immediate illustration. This has been peculiarly the fact in respect to those manifestations which assume to be mental receptions derived from uncommon, unexplained, and unknown causes.

I propose in this short and simple essay to avoid all prejudice and reproach, acknowledging the ancient and fixed principle of belief as something worthy of deep regard; as the conservative restraining element in the politics of the world of reason. I shall aim, nevertheless, to sustain the principle of the perfectible form of thought, as at once the most advantageous and the most endurable.

I begin at once, then, by admitting phenomena. From the first of man until now, as we know him, there have been opened to him an ever-recurring series of phenomena, provable by a ready reference to experience, but which are not rendered so familiar to him by their frequent repetition as to lose their novelty in their repetition.

The phenomena are all of the senses; necessarily so, because every recognised phenomenon is sensual, in the completed meaning of that term. The universe enters into the man by the doors for its entrance, and according to the capacity of the man he becomes homogeneous with the universe so long as he lives in it: that is to say, so long as he is in the condition to receive it.

Of the man we know something; of the universe we know little. There may be in it motions, or material forms in motion, which are not at all times present, which are not perceived equally at any time, and which, on the fixed principle, are as real as common things; one only singular, in fact, from being uncommon, and in not being accounted for, when recognised, by an immediate and obvious explanation. As the phenomena, however, are all sensual, so they are developed according to the working value of the senses, if I may so express myself. The ear is the most ready organ concerned in the recognition of occult phenomena; it hears sounds the mind does not appreciate the source of. The eye is the next susceptible organ; it sees forms and shapes for which the mind finds no ready explanation. The tactile sense, and even the common sensitive surfaces, come under influence; they appreciate blasts or blows or heats or colds, the causes of which are incomprehensible. Less frequently the olfactory sense is invaded, and conveys impressions of odours agreeable or loathsome, of which the mind can form no instant estimate whence they came or wherefore.

All, in a word, that is surprisingly phenomenal is by a surprise through a sense, and it increases in wonder as it includes the work of the greatest number of senses. That ghost of Hamlet's father seen only, were but half enough; heard only, but half enough. Seen and heard, it is the less a ghost, the more a wonder.

I, for one, do not consider it at all a remarkable circumstance that the fixed ideal as to the cause of obscure phenomena should be that of an outward or external reality appealing to the mental organs through the sensual. It is the common experience that whatever is recognisable *is*; and if this were not the common and universal belief, the world would wander on in vain doubting and fear. Sometimes by accident we meet with persons who are actually possessed with unbelief in what is the common experience of the majority; to those who constitute the majority these persons are insane.

Every allowance must therefore be made for the fixed belief on the reality of obscure manifestations, and indeed the allowance will be enforced until the major part of mankind is educated to see that there is a method of accounting for the manifestations which destroys the supernatural reality, and assigns the wonderful to the natural. To this latter explanation of the phenomena most men of science have now come: they claim the perfectible principle as the standard under which they reason.

Considered by the method thus noticed, the obscure manifestations we have admitted are not derived from objects in the outside universe at all, but belong entirely to the individual. They are simply due to aberration of function in one or other of the organic parts concerned in the processes of common human observation: they are, in a word, not receipts by the man, but interruptions within him, or reflects from him.

What I have called, after Salverte, the perfectible principle of opinion, is not deemed by its supporters to be a principle perfected, but one leading towards perfected discovery. It is devoid of dogma, and proclaims only what seems to be the nearest approach towards what is true. In this sense the following is in brief outline the exposition of the nature of the occult phenomena now under consideration—hallucinatory manifestations.

A whole series of mysterious manifestations, and these of the simplest kind, are connected purely with the physical conditions which modify the natural mode of conveyance of an object or act to the senses: the mirage, the double sun, the monster in the fog, the reflected sound (echo), even the reflected image in the clear stream; these—the mysterious manifestations of the earliest history of man, when the fixed principle of his thought had no rival—are now acknowledged, all but universally, to admit of a physical exposition that strips them of their mystery. Such obscure manifestations as remain, and are not traceable to external influences, are discoverable in the processes for observation possessed by the observer, in his senses, and the parts to which they minister.

For the full action of every part accomplished by and through the senses there are many factors. There is a collective organ for condensing the external fact that is brought to the man, a seeing organ, a hearing organ, touch, taste, and smelling organs; there is in each organ also a receiving nervous surface; there is from this surface, leading unto the man, a communicating nervous cord; and, at last, ending the communicating cord is a nervous centre, in ready communication with a congeries of nervous centres, for taking up the impression conveyed, for fixing it, and for bringing it into union with other impressions that have already been received, fixed, associated. Suppose all these parts at all times natural, at all times in harmony, then everything that seems unnatural would be fairly ascribed to the reception of actual outward manifestations that are not of the common denomination of nature. Suppose, on the other hand, that these parts are not always in harmonious working order, then the design unfolds itself that there may be impressions, made by or within the man, that are mysterious, unreal in so far as the true reading of the outer universe is concerned, and, in a word, hallucinatory.

And this is what physical science teaches, that each of the parts named as factors are, at times, disturbed or deranged in function. The collecting organ may be at fault; the receiving nervous surface may be at fault; the communicating cord may be at fault; the receiving centre may be at fault: and, in accordance with error of function in one or more of the parts, there will be aberration varying from that which is simply physical to that which is psychological in the most refined degree.

The simplest illustration of derangements of function are met with when there is perversion of action in the collecting organ, as in the eye, in instances of colour blindness or of muscæ volitantes—floating specks appearing in the field of vision. More complex, is a condition in which the reception of an impression on the receiving nervous surface of an organ of sense is too long retained, so that the impression remains when the first cause of it is gone.

Sir Isaac Newton, looking too intently at the sun, had left upon his vision a vivid picture of the sun, a phantom to some men, to him a phenomenon, painfully persistent, but understood by him as a pure physical fact. I knew once a gentleman who had a peculiar impression of an odour left on his olfactory surface, and for months it remained a source of constant discomfort, anxiety, and even timidity. In vision an aberration of function in the receiving surface may occur from mere strain to see in obscurity. Thus in looking at an object in partial darkness, as at night, when the stars are beclouded, an object, steadily and strainingly gazed at, seems to come and go, or, as is commonly said, to vanish and reappear.

There are various states of the nervous organization in which the conduction of external impressions from the organs of sense to the sensorium is so perverted that modifications of external impressions are both induced and sustained. The delicate muscular mechanism by which the two great organs of the senses, the eye and the ear, have their various parts correctly adapted, are under refined nervous control, and easily loose their adaptations when the nervous control is either defective or changed from its natural use. The nervous atmosphere through which impressions vibrate from the receiving surface to the receiving centres is susceptible of change, and thus under various circumstances there is an easy step to perverted appreciation of external things. We have many known agents which exert their power by thus interfering with the healthy relations that should subsist between the organs of sense, the conducting way, and the mental centres to which all impressions are finally delivered. Alcohol taken in excess leads to such disturbance of balance of action, and therewith to false impressions of external objects—phantoms not made by the imagination, but constructed out of perverted sensual action. Opium, haschish, and some vapours and gases made to enter the body, induce the same perversions. So that objects that are really before the observer to the perverted sight appear far distant, or larger or smaller than they are. Slight sounds are exaggerated into tempestuous noises, and sensations of smell, taste, and touch, are either exalted into undue activity or lost altogether.

In connection with this subject I may observe that the tendency of recent physiological research is to the effect that in certain conditions of the body there are produced, within the body itself, some organic products which in the most potent manner affect the organs of the senses, and interfere with their function. In a recent investigation on the action of organic compounds of the sulphur series, I found that the most marked changes in the reception of impressions could be induced by certain of these bodies, together with symptoms of hysteria and of muscular debility singularly analogous to those states of the body in which debility of the motor organs is attended with what is called excessive nervous susceptibility and excitability. In certain diseased states these same organic products exhale from the body, or pass off by the secretions, as products derived from organic chemical changes progressing within the organism.

It would be an easy task to fill page upon page with illustrations of translations of external objects into mysterious manifestations under the mere influence of perverted functions of the senses and their dependent parts; but I must forbear, and content myself with one remark in reference to these phenomena. The remark is this: that the man, under any of the influences cited, is never supposed to be anything less than deceived. The man suffering from muscæ volitantes explains the form of the shadowy things he sees with the utmost exactitude, he may (I have known such a case) give to the appearances fanciful names from their forms; yet it is not at any time supposed that the seeings are realities: the man who tells you a red object is colourless, or is of different colour to what all other men call red, is considered, however persistent he may be in his opinion, peculiar only and deluded: the man who explains that he sees but the half of an object, or that he sees two objects when there is but one before him, is at once accepted as incorrect in his observation: the man who, under opium or haschish, receives the impression of being in rooms of infinite space, of grasping in one sweep of apprehension incalculable intervals of history, is held to be for the time of disordered mind: and the man who, under the poison of alcohol, turns the simplest of objects into the likeness of the fiend, is credited with obvious derangement so long as he thus misinterprets what exists before him. Yet there are many persons who, recognising such everyday truths to the full, accept other hallucinatory phenomena, of a similar origin, as actual external realities, and who, once believing it, adhere to the opinion they have formed more determinately than to any ordinary fact or business with which they are hourly concerned. The story is an old one:—

> "John Absolute believed he could not be deceived,
> When to prove his own belief he took the pains;
> So he vowed he'd seen a ghost, though he'd felt it was a post,
> And his head had paid the forfeit for his brains."

The illusions depending upon changes of functions in the receiving nervous surface of an organ of sense, or in the conducting cord, are comparatively simple. It is when we come to consider the reception and the fixing of impressions in the brain that the profoundest difficulties arise. Here we pass, with ease, out of the domain of current physical science into what is but useless speculation, unless we are ever on our guard in thought. I shall touch, consequently, on but few subjects; on such as are nearest to the physical basis of research.

The brain receives and retains external impressions brought to it through the senses. In the exercise of this function it may become unduly impressionable, and may be the seat of illusion. Under these circumstances, one particular impression may so overrule every other impression that it shall persistently present itself. Sometimes a sudden impression is made upon the brain so potently that it is stamped, as it were, in persistent relief, coming forward at any time—but specially when the mind is unoccupied or is weakened—with all the force of a new reality. The distinguished French physician, Andral, one of the most accurate of observers and least superstitious of men, affords an illustration of this illusion. When he was a pupil commencing his medical studies, he was terribly impressed at seeing, for the first time, a dead body on the lecture-table. Many years afterwards, during an attack of illness, he saw in his room a dead body stretched out before him, and it was not until some minutes had elapsed that he recalled the connection between this outward vision and the early impression that had been made upon his brain. I know myself another instance, differing in detail, but belonging to the same order of phenomena. A youth, who had all his life been easily moved by any painful sight, entered the profession of medicine, and saw, as a first experience, an eminent surgeon perform the operation of amputation at the shoulder-joint. This was before the introduction of means for the abolition of pain, and the effect on the mind of this observer was terrible. He did not faint, as some of his neophyte comrades did, but stood resolutely transfixed in wonder and fear. In time he got over the dread, from that moment lost all dread at seeing operations, and, in fact, has himself many hundred times since taken part in surgical art. But this remains, that whenever he is present at any operation, the first operation that so impressed him is always present to him in its minutest details, as if it also were veritably in progress.

Connected with this form of hallucination is that of hearing sounds, with which the ear has been at one time very familiar, without external obvious cause. Dr. Samuel Johnson, in this manner, heard, he believed, the sound of his mother's voice calling his name, Sam! when separated from him by the distance between Lichfield and Oxford.

In studying this class of illusion, it is necessary to observe that the illusion is not an act or effort of memory: *i.e.* it is not an effort called forth by any act of volition. It is akin to that singular sensation which they who have lost a limb occasionally experience, spontaneously, as if the limb were still in its place, and were endowed with sensibilities it once had, but which practically are forgotten. It is the source of that illusion of "pre-existence" which many have experienced, when a recognition seems to be felt of something already known, and which the memory is utterly unable, however severely it is taxed, to recall. In a word, it is illusion *sans* volition.

A number of mysterious manifestations are traceable to the simple fact of recurrence of impressions altogether independently of the will. There are others which are purely volitional, and these constitute a distinct class of hallucinatory phenomena. They are illusions produced by what I should call the faculty of projection of objects that have been received from without, by the brain and fixed in it. We exercise this faculty, naturally, when at will we re-picture to ourselves, or project what we have seen, heard, felt, or otherwise received by the senses. We recall a landscape we have surveyed, a tune we have heard, and the like; and if the impression be correctly fixed in us, and we will it to return, it comes back correctly. In the act we project from us that which we recall, and look at it, or listen to it, as if it were again external to us. This faculty, exalted to unnatural degree, is a fruitful source of illusion. Wigan supplies a striking illustration of the kind in the case of an eminent portrait painter who followed Sir Joshua Reynolds. The painter in question once produced three hundred portraits from his own hand in one year. When asked on what this peculiar power of rapid work depended, he answered that when a sitter came to him, he looked at him attentively for half an hour, sketching from time to time on the canvas; then he put away the canvas and took another sitter. When he wished to resume the first portrait, he said, "I took the man and put him in the chair, where I saw him as distinctly as if he had been before me in his own proper person. When I looked at the chair I saw the man." After a while the painter began to fail to discover the difference between the real and the imaginary sitters, so that he became actually insane and remained in an asylum for thirty years. Then his mind was restored to him, and he resumed the use of the pencil; but the old evil threatened to return, and he once more forsook his art, soon afterwards to die.

Talma, the actor, had a faculty of mental projection equally singular with that possessed by the artist whose history Wigan has related. Talma could project before himself the form of a human skeleton with such perfection of detail that to him the form was a reality, and when he stood before the footlights he had in his presence, in the theatre, an audience of skeletons. Goethe, who conceived that if Shakespeare was the greatest of men who had lived he himself was the second, once projected his own figure and viewed it as if it had been another person.

I might prolong the record of these hallucinations, but to prove that they exist is all sufficient for the purpose I have in view. They are, the reader will see, nothing more than the results of an exaggeration of a natural faculty, which faculty, well possessed is a marvellous accomplishment, but over possessed is a disaster to the possessor.

There is another form of hallucination, having its seat in the brain, and which springs from what has been called the effect of the imagination. Imagination, brought to its true meaning, is the art of the will to combine into various groups the pictures or impressions that have been condensed in the brain through the senses. We are accustomed to speak of men of imaginative turn as original men. In a sense, this is false and true. It is false, if we mean by the expression that a man can originate absolutely; it is true, if we mean that a man can originate combinations of impressions he has received from the outer world. The power, or faculty, of forming by the will original combinations of things, events, facts, received and stored up in the brain, is as varied in men as is the faculty of forming combinations or arrangements of things and facts that lie before the observer for his use or application. One man makes out of his inner hidden properties the most perfect of forms or stories, and puts them forward in language or in writing to charm and captivate his kindred. Another puts forward mean and common-place forms of combination; a third puts out his treasures in such rank confusion, that we are unable to recognise the pictures he directs us to; him we conceive to be estranged, for he produces, according to the general judgment, impossible combinations; his crowded or squalid, fantastic, imageries appeal to no recognisable realities. Such men, in the wildness of their combinations, give to us pictures of new heavens, new earths, new shades, which they have mentally surveyed until the impression, in all its wantonness, is to them an absolute truth, a truth it is a duty straightway to communicate to mankind. To name only one, from what might be a volume of illustrations of this type of hallucination, there is that of Benvenuto Cellini, who, visited by an invisible spirit, was carried even into the effulgence of the sun itself, discovering the luminary, when divested of its rays, to be a ball of molten gold, and seeing emanate from it divine forms of infinite splendour, which he could afterwards describe as faithfully as he could the prison in which he was incarcerated, or the couch on which he slept.

Uneducated sceptics, hearing what they call these stories of the marvellous, are wont to say that all narratives of the kind are the results of disordered imagination. In this they are often greatly wrong. The power of combining received impressions is, I admit, easily and frequently exaggerated into the production of hallucinations which, recited as realities, constitute a very large class of hallucinatory phenomena. But the class is, nevertheless, distinct, and is only a division of a more extensive series of such phenomena.

The last types of hallucination, depending upon disordered function of the receptive brain, to which I shall refer, occur from physical changes in the brain itself, and which interfere with natural physical action.

These changes of function are due to what may be called disturbance of the vascular tension of the brain. In order to receive external impressions in a perfect natural state, it is necessary that the nervous organisation, like a musical stringed instrument, should be accurately attuned, its various minute parts, its fibres, tense, yet not unduly strained. This tension is maintained by the pressure of the blood, the silent, purely mechanical, streaming current, that is ever, in life, in circuit, filling up vacuities, supplying new portions of matter, supplying fluids to be distilled ever by receiving organs and regulating pressures. To the brain this blood may come in equal streams, or it may ebb, or it may enter like a tide; so that the tension may vary from low to high, with varying phases of mental change following upon varieties of tension.

When, under any circumstances, the blood current ebbs, so that the brain is indifferently supplied with blood, external impressions rush in through the senses in such disturbed profusion, that a new existence may seem to have opened itself to the mind, with flashing, flickering manifestations of the past, over which the will loses its steady command. The light of day is insupportable in its brilliancy; sounds the faintest are exaggerated into torrents, or peals, or blasts; faint odours are overpowering, and other physical impressions, not appreciated by the healthy bystander, are recognised by the prostrated organism. A woman who was saved from drowning, and who, from what seemed the unconsciousness of death was restored to life, once related to me her experiences of the phenomena I have named with wonderful and simple fidelity. As she sank the noises of the water,—though it was still water,—and of the voices of persons who were calling for her rescue were appalling from their intensity—"they were like thunder." The touch of the water seemed as if it were creating the dissolution of her body; and, at last, as if being distributed into some immeasurable expanse, she was lost, knowing no more until she found herself, hours afterwards, in a warm bed, with friendly hands supporting her, and friendly voices pressing her to try and swallow nourishment. The extasies of the starving or festive person, often so poetically described, are of this order of phenomena, but in minor degree.

There is an opposite condition of brain to the above, in which the tension is unduly increased by pressure of blood. Under this condition the tendency is not to receive the impressions of the outer world into the nervous organisation in overwhelming confusion, but to project certain of the impressions it has received into the external world. A perfect illustration of this perversion is supplied in the narrative of Nicolai, a bookseller of Berlin, who himself describes what he experienced. Nicolai had been accustomed to be bled twice in the year, as was the fashion in his day; but at the close of the year 1790 the process was omitted. In the beginning of the year 1791 he was affected in his mind by several incidents of a disagreeable character, and on the 24th of February of that year he observed, at the distance of ten paces from him, the figure of a person he had known in life but who was deceased: the figure remained before him for seven or eight minutes; then, as he became exhausted, he fell into a troubled slumber, and slept the ghost away.

Later in the day the same figure and other figures returned to the astonished Nicolai, and until April continued to return, so that he became accustomed to them; and, learning to distinguish phantoms from phenomena, observed the phantoms, correctly knowing them to be projections from his own brain. The forms, he said, were, for the most part, human figures of both sexes; some of persons dead or distant, whom he knew, others of persons he did not know: they came without his will, and went without his order. Occasionally the figures were mounted on horseback or were accompanied by animals of natural size and colour, but all perhaps were a little *paler* than natural. To Nicolai, the figures, when he got familiarised with the phenomena of their appearances, spoke; their speeches being short and not disagreeable.

In the whole history of spiritual manifestations, so called, there is nothing that equals in marvel this experience of Nicolai. How his spiritual history would have ended had it progressed to his death, and what beliefs would have been founded upon it, had it received no correction, it were indeed hard to say. Fortunately, as I think, in the month of April 1791, a cold-blooded Sangrado of a surgeon formed a conclusion that the loss of a little blood by means of leeches might clear the vision of the haunted bookseller. On the 20th of that month the surgeon carried out his design at eleven o'clock of the forenoon. During the operation, says Nicolai, the room swarmed with human forms, and continued full till four o'clock, "when the digestion commences:" then the figures began to move more slowly: afterwards they became paler: at half-past six they were all entirely white, and moved very little, though they were distinct in form. The figures did not glide away, neither did they vanish, but in this instance they dissolved immediately into air, some of them remaining, in pieces, for an interval. By degrees they were all lost, and at eight o'oclock there did not remain a vestige of them; neither did they return. Nicolai was cured by his Sangrado.

One important feature, solemn I am bound to say, remains to be said about all these peculiar hallucinations. It is, that the organic conditions leading to their development may become contagious. At first the hallucinatory disorder has its origin in individual persons, but it may become endemic, and in the end epidemic. The process of contagion is easy. Through the ear, the eye or other sense, the brain receives marvellous as readily as natural or ordinary impressions. These, by repetition, soon are properties of the brain, which, projected by the volition, at first vaguely or dimly, are at last, under continued practice, brought into material sounds and sights with such fidelity and readiness, as to become like external realities, to the possessed.

The art of thus framing and projecting self-created existences, and of peopling other organisms with the same, is, I regret to observe, a too facile art; it is most fascinating, in common English, bewitching; it has organised the illusory; it has led thousands of wretches to torture, thousands to death, thousands to that mental destruction which follows ever the break between healthy organic function and mental organisation. In this light so-called spiritual manifestations, ancient or modern, though they may often have mixed up with them gross and scandalous impostures, are, primitively, phenomena developed through the individual, and afterwards are extended, like light from one torch to another, until they reach to masses of mankind, and become systematised beliefs.

In conclusion. On the perfectible view of the question, the argument is:

(*a*) That the phenomena of mysterious manifestations are not those of manifested external realities; but are the projections from the observer, belonging to him as surely as the picture on the screen belongs to the lantern.

(*b*) That all such manifestations of a purely individual kind, are, like inevitable diseases and accidents, parts of the part that has to be performed by the individual in his short journey through the universe; that they are not appearances to be feared, but to be accepted as occasional symptoms indicating an organic disturbance which it were wise to endeavour to remove.

(*c*) That although individual manifestations are too closely connected with physical individual errors to be universally removed, the increase of them by contagion may be, and by all sensible persons ought to be, kept under the stern control of the volition; the volition itself, which can only be applied to one act at one time, being employed, at all times, to more profitable and nobler developments of human invention and practice.

REVIEWS.

THE EXPRESSION OF THE EMOTIONS.*

WE do not think we err in expressing the opinion that the volume which is now before us is unquestionably the work of most importance as regards the doctrine of Evolution which has appeared since the publication of the "Origin of Species." And we think so because it offers us a new path of argument in favour of the belief that man has come, in a long line of descent, from the lower animals. It affords us a series of arguments, patent to everyone, in favour of the belief held by Mr. Darwin and his numerous school. Moreover, it is a work which by its style, by its illustrations, by the interest attaching to its arguments in the "home-thrust" which the view of natural selection obtains from the examples given, must become a handbook in every family accustomed to read anything better than the usually dreary three-volume productions. We cannot hope, in our space, to do much towards reviewing this book; for, though its number of pages is not 400, it is devoid of padding, and its every column contains hosts of examples which, the author believes, support his theory. Further, it contains many allusions to foregone work of other authors, and embraces the results obtained by the numerous individuals whom Mr. Darwin asked to return him answers to a set of printed questions. Still, although nothing short of a "Quarterly" review can hope to do it justice, we may pick up a few of the crumbs which fall from its well-laden table. However Mr. Darwin divides his subject, in order to render his ideas on the matter as clear as possible, we shall not follow him in these portions of his work. For we fancy that all which refers, for example, to how much the nervous system may operate independently of the will in giving rise to habits of a peculiar nature, must be a subject, in the first place, extremely difficult of debate, in the next instance, liable to vary according to the condition of mental physiology, which is still in an unsettled state. But, apart altogether from this, the work contains ample and abundant reliable testimony in reference to the one point, the view that the expression of many of our emotions are

* "The Expression of the Emotions in Man and Animals," by Charles Darwin, M.A., F.R.S., with photographic and other illustrations. London: John Murray. 1872.

unquestionably derived, in the second place, from a primitive stage of man, and in the first case from the quadrumanous animals which must, through some branch—possibly an extinct one—be our ancestors.

But the numerous examples which Mr. Darwin gives, render it impossible for any rational person to incline to any but the belief of our evolutional descent. Of these we shall select but a few, which not only demonstrate the author's opinions, but which show how extraordinarily close his observations have been. Concerning the remarkable habit possessed by dogs after discharging excrement, he says:—

"Dogs, after voiding their excrement, often make with all four feet a few scratches backward, even on a smooth stone pavement, as if for the purpose of covering up their excrement with earth, in the same manner as do cats. Wolves and jackals behave in the Zoological Gardens in nearly the same manner, as do cats; yet, as I am assured by the keepers, neither wolves, jackals nor foxes, when they have the means of doing so, cover up their excrement, any more than do dogs. All these animals, however, bury superfluous food. Hence, if we rightly understand the meaning of the above cat-like habit, of which there can be little doubt, we have a purposeless remnant of an habitual movement, which was originally followed by some remote progenitor of the dog genus for a definite purpose, and which has been retained for a prodigious length of time."

This is remarkable enough; though it may be objected, that it does not prove anything with regard to man, it is of value as proving that habits have undoubtedly descended through the Mammalia.

But it is in regard to the expressions of monkeys and of ourselves that the best part of this work relates. Assuredly, the results are most remarkable, and so far as we can see, it is impossible to put any other conclusion upon the observation of these results, than that they are the one parental to the other. Mr. Darwin gives numerous examples from his own observation and from that of others, showing that the monkeys are excited to express laughter, and pain, and anger, very much as we ourselves are; and though this is not so manifest in the higher apes because of their want of eyebrows, it is still displayed to a careful observer. The author, speaking of some observations made at the Zoological Gardens, says that "the Anubis baboon was first insulted and put into a furious rage, as was easily done by his keeper, who then made friends with him and shook hands. As the reconciliation was effected, the baboon rapidly moved up and down his jaws and lips, and looked pleased. When we laugh heartily, a similar movement or quiver may be observed, more or less distinctly, in our jaws; but with man the muscles of the chest are more particularly acted on, whilst with this baboon, and with some other monkeys, it is the muscles of the jaws and lips which are spasmodically affected."

Many other instances are given by the author with reference to monkeys, among others, one with regard to the closure of the mouth. "When," he says, "we try to perform some little action which is difficult and requires precision—for instance, to thread a needle—we generally close our lips firmly, for the sake, I presume, of not disturbing our movements by breathing; and I noticed the same action in a young orang. The poor little creature was sick, and was amusing itself by trying to kill the flies on the window-panes with its knuckles. This was difficult, as the flies buzzed about, and at each attempt the lips were firmly compressed, and at the same time slightly protruded."

Although the elephant is not very near man relationally, it is remarkable that in one respect there is a singular analogy, if it be only that between the eye and its purposes in both. Of this there are various examples given, the most singular of which is a case recorded by Sir E. Tennent, in his book upon Ceylon. In this he distinctly cites cases of weeping in the elephant. Of these, it was only some which had been absolutely captured that wept; the others, which were still at large, did not weep, it being supposed that they kept their eyes clear for the purpose of seeing and avoiding those who were in pursuit of them. Mr. Darwin, too, very carefully compares the expressions of men, which he appears to have made an elaborate study of, with the similar ways of expression carried out in the ape tribe, and with most interesting results. But, apart from this he has gone carefully into the muscular movements of the face in man, and has most elaborately illustrated them by photographs, which are taken from M. Duchenne's and other equally reliable sources. This part of his book is most interesting and instructive, and will well repay perusal. We think that, in some few cases, the author has pushed his opinions farther than rigidly logical reasoning would permit. But in all such cases he puts his views forward as tentative, and appears to be quite ready to give them up should other and more conclusive ones be established. While we are finding fault, we may mention a character which strikes us as being singularly apparent in the present volume, and that is, the scrap-book tendency of the book. There sometimes is a want of that clear, calm, and closely-reasoned mode of giving examples and of drawing deductions which is so essential in a work like the present. Of course it is only in occasional instances that it is apparent, but if it were avoided the book would be unquestionably improved. To be sure, the last chapter is clearly logical; but then this is to our minds, if anything, a little too conclusive, when we consider how extremely rudimentary are the facts. Still, *tout entier*, the book is marvellous in its forcible and terse dealing with a vast multitude of facts; and the illustrations which the author has given are as effective as they are truthful renderings of physiognomic facts.

MANUAL OF PALÆONTOLOGY.*

THERE can be little doubt that, as the author says, there is a want of a good treatise on Palæontology. Indeed, that want has been sadly felt by students. For it has been impossible to find in the English language any treatise on the general history of fossil organisms which was quite within the range of the student, and withal gave some account of the more

* "A Manual of Palæontology for the Use of Students, with a general Introduction on the Principles of Palæontology." By Henry Alleyne Nicholson, M.D., D.Sc., B.A., F.G.S., Professor of Natural History in University College, Toronto. Edinburgh: Blackwood & Son. 1872.

recent discoveries. To be sure, Lyell's "Student's Elements" exists, but then that is more a general manual of geology and palæontology. If we except this one work, which, as we have had occasion before to say, is an admirable one, abundantly illustrated, we may be said to have been destitute of students' manuals of palæontology for the past ten years. We certainly do not see why it should have been so, but unquestionably we have not had a full work on fossils devoted exclusively to the student's wants for many years. Dr. H. A. Nicholson has, therefore, rather an empty field in which to display his merits, for assuredly there are no candidates to oppose him. This volume is one of 8vo. size, and of nearly 600 pages. It is admirably illustrated, having over 400 woodcuts many of which are excellently executed; but the author has been unhappy in his selection of both type and paper, the former being of a size decidedly too small, and the latter being not white but of a sickly yellowish hue. But having said so much, we have most probably said the worst we shall have to say against the volumes. The author commences with a few chapters on the principles of palæontology; and in these we think he does himself credit for his calm admission of the difficulty of assuming that because rocks are similar in appearance and structure, they are of contemporaneous origin. Dr. Nicholson shows, by reference to Dr. Carpenter's researches, which he is quite prepared to admit, that this is one of the greatest difficulties of the geologic task. Nor is he ready to admit that identity of fossil remains indicates similarity of age of deposit, for he is well aware of the fact that, at the present moment, there are being developed huge formations in the Mediterranean, the Atlantic, and the Pacific, which will one day see the light as rocks, unquestionably the same, in point of time, yet as different both in composition and fossils as it is possible to conceive. We admire, then, the manner in which Dr. Nicholson has dealt with these questions. In the generality of instances, he cites from the most eminent and recent authorities; and he gives the student ample materials for forming an opinion, without binding him to any special theory in cases where two or three views may exist and have a good deal of support.

The next part of his work is unquestionably the most important, and there is but one point we have to object to—that is, to the term palæontology as applied to animals alone. In our opinion, palæontology should be a generic expression, having two specific names included within it. This, however, though adopted in the work itself, is not adopted in the author's preface, for herein he speaks of the animal remains found fossil forming the branch of *Palæontology*, and the plant-remains being properly called *Palæobotany*. However, in the work itself he has the two specific names rightly placed—*Palæozoology* and *Palæobotany*. In the several chapters which he has devoted to palæozoology, we find that he has followed a tolerably recent classification of the animal kingdom, and that in each case sub-kingdom, class, and order are clearly defined. Of course, we could find fault with the definitions in many cases, but we are aware that that is a condition that may be said for every classification on earth; for there is hardly any system which, if defined literally, will include every animal placed within it. But, on the whole, Dr. Nicholson has framed his definitions with terseness and comprehensiveness, and in nearly all cases his classes are placed in their right positions and with their proper names. Then he describes the several animals, in most cases very fully, and he gives numerous examples of both fossil and recent animals and illustrations of the two to satisfy the most acute student of his work. We note, also, that in many cases he adopts the classification and definition of the most recent authors. Thus, for instance, in his description of the two sub-orders *Eurypterida* and *Xiphosura* of the *Merostomata*, he follows the definitions which have been given by Mr. Henry Woodward, which must unquestionably be the best. We have observed this tendency of the author in many other instances.

In palæobotany he has not done so well. The space devoted to the fossil plants is evidently too small; and besides the character of the book is absent here, for he has not placed the living beside the dead. Indeed, this section bears evidence that the author is not a botanist, and we cannot but regret the fact that so excellent a plan as he has followed in the greater portion of his volume should have been avoided here. However, even in this place, we find him giving Mr. Carruther's opinion on the *Sigillaria* as opposed to Dr. Dawson's, and this shows us that he has not been unmindful of the recent disputes between these two palæontologists. Next in order follows his sketch of historical palæontology, which is really not palæontology at all, but purely physical geology with a very slight addition of palæontological matters of interest. And, lastly, comes his glossary, which will, we doubt not, be found useful by the younger student. It is a tolerably extensive list of palæontological terms, briefly explained, and extends over more than twenty pages. Altogether, the book has pleased us well; and we are the more glad of this, because we have been obliged before to give a somewhat unfavourable criticism of one of Dr. H. A. Nicholson's books. Of the present we can only say, we wish it all the success it undoubtedly merits.

HANDBOOK OF NATURAL PHILOSOPHY.*

WE believe that in the present volume, which is the fourth of the series, Dr. J. D. Everett has completed his labours, and has translated the whole of M. Deschanel's work. We only regret that he did not give what we expected, and what would have conferred a great advantage on the book, an alphabetical index. It is, of course, of little use for the ordinary student, who has to travel regularly through the volume; but, to the man who only takes up the volume to read a particular portion, it is immensely troublesome and annoying. Besides, it is not a mere student's book. Professor Everett has taken it out of that category by his numerous and important additions, in some cases amounting to entire chapters. We hope, therefore, that the publishers will, in the event of their binding the volumes together, take the trouble of adding an exhaustive index. This volume seems to be the best of the whole—certainly better than the first

* "Elementary Treatise on Natural Philosophy." By A. Privat Deschanel. Translated by J. D. Everett, M.A., D.C.L., F.R.S.E. Part IV. London: Blackie & Son. 1872.

one—and the Editor, by his additions relating to consonance and dissonance, the undulatory theory, and polarisation, gives it a value which of course it would not otherwise have had. The treatment of subjects such as terrestrial refraction, the calculation of the curvature of rays, mirage and its explanation, etc. etc., give a particular interest to this volume. The illustrations are, as usual, of a good kind, and number nearly 200. We are well pleased with the work as a whole, and we recommend it to our readers' notice as being really worthy of their attention.

THE ORBS AROUND US.*

THIS is a volume of that popular nature which the English world is now almost familiar with from the pen of Mr. R. A. Proctor. It is distinctly a work in which the author's power as a popular scientific writer is clearly and successfully displayed. He treats his readers to a number of discourses which originally appeared in some of our literary monthlies, and which are as full of interesting knowledge as they are eminently written in a style which is most taking to anyone who is not familiar with the scientific mode of study. The first paper in the volume strikes us as being a particularly good popular essay, and as being one which even the most ordinary popular reader must understand if he read it carefully. The author seeks to popularise the subject of spectrum analysis in so far as it relates to astronomical subjects. To do this he compares it to the various sounds that are included in the gamut; and—of course admitting the danger of the comparison—he succeeds in making what most persons would regard as a very unreadable subject an extremely popular one. Among his various chapters, each of which deals with a separate subject, it appears to us that his remarks on "the Rosse Telescope set to new work," "Professor Tyndall's Theory of Comets," "What, then, is the Corona?" are decidedly the best papers in the volume. Still it must not be thought that the other contributions are devoid of interest; for, in our opinion, even the slightest of them is not without some particular interest.

A BUDGET OF PARADOXES.†

THIS is a reprint, with some slight modifications, of a series of contributions to the "Athenæum," on Paradoxes, by the late Professor De Morgan. These articles were written with the intention, we are told, of enabling persons who were puzzled at the discoveries of the successful few,

* "The Orbs Around Us: a series of familiar Essays on the Moon and Planets, Meteors and Comets, the Sun and coloured pairs of Suns. By Richard A. Proctor, B.A., Hon. Sec. R.A.S. London: Longmans. 1872.

† "A Budget of Paradoxes." By Augustus De Morgan, F.R.A.S. and C.P.S., of Trinity College, Cambridge. London: Longmans, Green, & Co. 1872.

to view discoverers as a whole; and contain the history, arranged in chronological order, of a century of repeated attempts to solve a few impossible problems. As the paradoxes are, for the most part, connected with mathematics or astronomy, it would be difficult to find a person better qualified than Professor De Morgan for such a task. He was an eminent mathematician, and took a great interest in all matters connected with the progress of mathematical science in England during the last century. The problem, which seems to have taken the greatest hold on the paradoxers is the quadrature of the circle; and it will no doubt surprise our readers to learn that, in spite of continual failures, and the existence of positive proof that the diameter and circumference of a circle are incommensurable co-finite terms, there are persons who spend their time in barren attempts to solve it; but that such is the case is abundantly shown by the many instances cited. Paradoxers appear to ignore their brethren, and though chiefly found among those *a priori* reasoners who form their premises to suit their conclusions, are not peculiar to any class of society. The book is written in a clear and vigorous style, and several of the descriptions are most humourous. We would especially refer to the account of the mathematician Walsh (p. 156); the discussion between Sir William Hamilton and De Morgan (p. 207); and the deduction drawn from the formula $A \delta X$ (p. 297). It also contains a good deal of information not often to be met with, coupled with shrewd and caustic remarks on men and customs, and is well worthy of perusal.

VESUVIUS AND ITS LAST ERUPTION.*

PROBABLY the most interesting work which has ever been published on the subject of any particular volcano is that which now lies upon our table—the history of the recent eruption of Vesuvius, by Professor Palmieri, the Director of the Observatory, which is situated on the summit of the mountain itself, and which is translated by no less an authority than Mr. Robert Mallet, F.R.S. Certainly, to anyone who is at all interested in volcanic action, this volume must prove of extreme value. But, apart from those who are professionally interested, the book is one which can readily be understood by any educated person, and which, from the number of details connected with the general destruction of the last eruption, must be interesting reading to anyone. It is in reality two books, for the translator's preface or introduction occupies more than half of the present volume, and is certainly interesting reading. This preliminary portion is intended by its author to give what he considers, apparently, has not been before laid before the English public, some general account of the nature of volcanic actions. Mr. Mallet's remarks are to the point and are most valuable, but we do not cordially approve of his method of dealing with

* "The Eruption of Vesuvius in 1872." By Professor Luigi Palmieri, Director of the Vesuvian Observatory. With an Introductory Sketch of Terrestrial Vulcanicity, etc. etc., by Professor Mallet, F.R.S., etc. London: Asher & Co. 1872.

other writers. There is, if we may be excused the expression, a tone of bitterness all through his writing, which gives the reader a most uncomfortable sensation, and which leads a person who is altogether unbiassed to imagine a feeling of jealousy on the part of so distinguished a writer as Mr. Mallet, which we are sure cannot exist in reality. After giving a sketch of the various authors who have ventured to give different and erroneous opinions on the subject of vulcanicity, the writer gives himself the following definition of an earthquake, it being the same which he has supplied in his original memoir in the "Transactions of the Royal Irish Academy":—"The transit of a wave or waves of elastic compression, in any direction, from vertically upwards, to horizontally, in any azimuth, through the crust and surface of the earth, from any centre of impulse or from more than one, and which may be attended with sound and tidal waves, dependent upon the impulse and upon circumstances of position as to sea and land." And, having given this definition, we may leave the editor of the work for the present, as any attempt to enter upon the numerous and cleverly-stated arguments which he advances would be to extend our notice to an unimaginable space. We therefore pass on to Professor Palmieri's admirable account of the eruption. In the first place, we are informed of what we assuredly did not know before, viz., that the Italian Professor foretold this great eruption; for he says it was the last phase of the eruption which began in the end of January 1871, or, in his own words, "An account of which I was unwilling to write, because I was convinced that it would not really terminate without a more or less violent explosion, such as I have often predicted." From this period all through the year, and the four first months of the succeeding year, the Professor watched the mountain giving out its different discharges, and he observes that on the 23rd, 24th, and part of the 25th of April it was an excessive action; but then that it remained nearly quiet till the morning of the 26th of the same month. At which time, the Professor observes, "Numbers of visitors, attracted by the splendour of the lava-streams of the preceding night, which they supposed still continued, soon arrived; but finding them exhausted, were for the most part conducted by their guides to see the one still flowing. It was almost inaccessible, and to reach it one had to walk over the rough inequalities of the scoriæ. It took me two hours to get there from the Observatory, when I visited it that morning, and therefore I endeavoured to dissuade those who wished to visit it at night from the attempt, but set out myself from the Observatory at 7 P.M., leaving my only assistant there. The instruments were agitated. After midnight the Observatory was closed, and my assistant retired to rest. Late and unlucky visitors passed unobserved with an escort of inexperienced guides; at half-past three o'clock in the morning of the 26th they were in the Atria del Cavallo, when the Vesuvian cone became rent in a north-westerly direction, the fissure commencing at the little cone which disappeared, and extending to the Atria del Cavallo, whence a copious torrent of lava issued. Two large craters formed at the summit of the mountain, discharging numerous incandescent projectiles, with white ashes and glittering with particles of mica, which frequently recurred. A cloud of smoke enveloped these unfortunates who were under a hail of burning projectiles and close to the lava torrent. Some were buried beneath it and disappeared for ever; two dead bodies were picked up and eleven grievously injured, one of whom died close to the Observatory." The Professor, after giving the names of those who thus perished, goes on with the most interesting and instructive discourse as to the fissures, the cones, the amount of lava and where it ran; and he mentions what will possibly surprise many of those who appear to think that his observatory is completely removed from any danger, that, "on the night of the 26th of April, the Observatory lay between two torrents of fire, which emitted an insufferable heat. The glass in the window-frames, especially on the Vetrana side, was hot and cracking, and a smell of scorching was perceptible in the rooms." The several other points of the book to which we cannot refer through want of space are the following, and are of the deepest interest: The fall of projectiles and tempest; diminution of height of the cone; MM. Lamond and Gauss' apparatus; nature and chemical analysis of the lavas; bombs, lapilli, and ashes; the craters and their fumaroles; electricity of the smoke and ashes; the Bifilar electrometer; and, lastly, the conclusions, eighteen in number, which the author arrives at from his investigations. As we have said already, the work is an admirable one, and is remarkably soon published after the eruption. We have omitted to say a word about the plates, which are both numerous and excellent, more especially those which represent the seismographic apparatus, which are extremely delicate and somewhat complex.

RECORDS OF THE ROCKS.*

SINCE the days when the late Hugh Miller gave us his "Old Red Sandstone," and his various other works, popular in title and style, and eminently scientific in their treatment of the subject taken up, we have not had one book of a similar class. We are delighted to say, however, that in the volume which has now been sent us, we have a work at once popular, clear, and terse in style, and at the same time soundly accurate and novel in the matter which it conveys. In these "Records of the Rocks" which Mr. Symonds has placed before us, we have the work of one, who, though he be merely a country clergyman, is yet exquisitely learned in the subject of geology, and that, too, not as a mere bookworm, but as a calm and careful student of the rocks, who has spent nearly thirty years in exploring with his hammer almost the entire geology of England. And there is too a charm about his book which the mere study of geology would have failed to give, and which arises from the manner in which the author takes care not to weary his readers with mere geological details, but turns off at the proper moment to a sketch of the scenery of some of the villages of picturesque old Wales, or to a learned discussion anent the history of some

* "Records of the Rocks; or, Notes on the Geology, Natural History, and Antiquities of North and South Wales, Devon, and Cornwall." By the Rev. W. S. Symonds, F.G.S., Rector of Pendock. London: John Murray. 1872.

ancient castle which lies upon the spot, or enters upon some general sketch of the botany of the neighbourhood. In this way he has provided a work which the most fastidious must like, for on not one of the subjects that we have mentioned is there supplied matter that is not of the highest interest, whether geological or antiquarian. Although the more important of the geological facts stated are to be found in most of our great geological essays, yet are there many points which, so far as we can see, possess the originality of the author, and are facts which only a careful observer who has had his eyes about him for many years could have discovered. But in the archeological especially, and also in the botanical portions, there are many passages which will convey new matter to most of our readers. The former is especially interesting and instructive, and will, no doubt, prove of help to render many a future geological journey more enticing and attractive. In many instances the author expresses his own opinion on geological points, after giving those of Lyell, Murchison, &c. And this we think of great advantage, for besides giving freshness to his reading, in many cases it will point out to future workers the paths in which just speculation may be indulged in. In no case is this more observable than in the chapter on the Devonian formation. For in this the author evidently disbelieves the idea that the upper Devonian of Ireland is the same as in England. In fact, the fossil deposits are so different. In England, peculiar fish, generally salt-water fish, are to be found. In Ireland, ferns, stigmaria, and a species of Anodon. The one evidently a freshwater, the other as clearly, or nearly so, a marine deposit. Why then should they bear any relation to each other? It is a pity that the author did not give a better sketch of the *Sphenopteris Hibernica.* That which he has given represents but one infinitesimal portion of a frond. We have seen some specimens which measure about five feet in height, and which represent what once was a most noble plant.

All through, the author gives the opinions of the most celebrated geologists and palæontologists; in all cases giving their names to the reader. Furthermore, his book is exquisitely illustrated: many of the sketches of the scenery by Sir W. Guise being admirably artistic pieces, and the sketches of fossils by Murchison and others, and some by the author himself, being most creditably drawn.

ELEMENTS OF ZOOLOGY.*

MANY works as have been written upon Zoology, there are very few indeed that can be really called excellent. Of the few Greene's Manuals of "Cœlenterata" and "Protozoa" are unquestionably the best, and if Professor Greene had continued his labours, and had given us a similar series on the *Mollusca*, *Annulosa*, and *Vertebrata*, we should not want a book on zoology for some time. Still we must be grateful for the food we do get, even if it is not from the first garner. The little book before us is, we suppose,

* "Elements of Zoology for the Use of Schools and Science Classes," by Andrew Wilson, Lecturer on Zoology. Edinburgh, 1873.

intended for junior students, and to such we commend its perusal. But we must say that it is in very few respects superior to Carpenter's well-known volume, while it is decidedly inferior in many points.

ELEMENTARY GEOLOGY.*

ASSUREDLY we are not badly provided with geologic manuals, for there have appeared several within the past few years. Yet we do not think that any has been written, addressed exclusively to pupils in schools, and yet sufficiently modern and adequately illustrated, until Mr. Ward issued the present modest little manual. We have looked over it carefully, and we may say we approve of it very highly; indeed if it were not for the poetry, which the author should have confined to the Keswick Literary Society, before which the substance of the work was originally delivered, we should be almost perfectly satisfied with Mr. Ward's labours. For it must be admitted that the method of laying a subject before an audience of grown people must be essentially different from that adopted in the teaching of young boys and girls. It is, of course, most general and rudimentary, as such a work should be; at the same time it is clear, and contains some features worthy of note. Among them we may mention an account of the method of laying down a geologic map of a part of country which has just been explored. This is illustrated by a capital full-page illustration, which shows very clearly the mode pointed out by the author. Appended to the volume is the well-known "Geologic Dream on Skiddaw," which the author published in 1859, of which we at the time received a copy. It gives a very good popular summary of the condition through which this country has passed during the several geologic periods, which are mapped out in fifteen small illustrations of the country in its several phases. The book is one we have pleasure in commending to the notice of schoolmasters; it is carefully and abundantly illustrated.

A THEORY OF GALVANISM.†

"Heat is considered no longer exclusively a theory of thermometers and pyrometers, but as a great power in chemistry. Heat is held the fundamental cause of most of the beautiful, complex, and enigmatical phenomena of chemistry. Heat is considered to be as closely akin to electricity as is infancy to manhood, and thus to be all-worthy of scientific apotheosis." With these words the author introduces us to his volume, which, we regret to

* "Elementary Geology Specially Adapted for the Use of Schools and Junior Students." By J. Clifton Ward, F.G.S., of H.M. Geological Survey. London: Trübner, 1872.

† "The Electro-Thermology of Chemistry, Electricity, and Heat, Phases of the same Principle." By T. W. Hall, M.D., L.R.C.S.E. Edinburgh: Edmonston & Douglas. 1872.

say, we do not understand any better having read it than we did before we had opened its pages. It seems to us that the author sadly requires a study of the more important works on chemistry; for we think that, if he perused any of them carefully, he would recognise the fact that heat is not the unrecognised agency he imagines it to be, either in chemistry or physics. We are perfectly certain that a careful perusal of Dr. Tyndall's admirable volume would satisfy him that he has, with a considerable degree of affectation, been talking a very large amount of nonsense. We generally find that men who desire to express their opinions in language which is entirely of their own choice most frequently expend the largest share of their brain-power upon the dictionary faculty which they possess.

SHORT NOTICES.

Table of Classification of the Animal Kingdom. By Professor J. Reay Greene, M.D., of the Queen's University in Ireland. London: Churchill. 1872. Here we have three tabular arrangements of the animal kingdom, intended to be hung on the walls of schools and lecture-rooms, and which measure over five feet in length and about a yard in breadth. They give the entire animal kingdom, divided into its several branches, including many sections which are below the Orders in point of rank. Further, in the upper part of the third chart, is given a classification of the entire animal kingdom, showing, in so far as modern research will go, the relationship of descent of the several divisions, whose allies have been as yet made out. Altogether, it is not too much to say that these sheets are unquestionably the best of their kind, but we may further say they are so far advanced beyond the ideas of many lecturers in zoology, that we fancy these will not purchase them from the fear of their involving a new course of lectures. However, such will be unconscientious men. For it is unquestionable that Professor Greene has not simply followed some individual zoologist, but has endeavoured to take the best from all European authorities. We only regret that he has not printed the extinct orders in a different type from the living ones.

The Travelling Birds, by Cuthbert Collingwood, M.A., F.L.S. London: Bean, 1872. The author has adopted the Marcetian principle in this volume, and so we have a prolonged conversation between Harry, Amy, and the various birds as to their habits of migration. The facts are generally true, but in our opinion the style is abominable.

Strength of Materials and Structures, by John Anderson, C.E., LL.D. London: Longmans, 1872. This is another of that excellent series of books for the masses which are being issued by Messrs. Longmans. The first part deals with the strength of materials as depending on their quality and as ascertained by testing apparatus. The second treats of the strength of structures, as depending on the form and arrangement of their parts and on the materials of which they are constructed. The author refers to many experiments, almost all of which have been made at Woolwich with the American testing-machine, and shows very clearly how the strength of rope and such like materials is ascertained. We hardly think the publishers could have selected a more trustworthy author: he has certainly done his work well.

By Flood and by Fell; or, Causes of Change Organic and Inorganic in the Material World, by Charlotte Eyton. London: Goodwin, 1872. The title of this work would suggest the idea of many volumes, yet, singular to say, the authoress describes the whole subject in about 100 pages. The Sub-Kingdom Protozoa contains the Amorphozoa and Rhizopoda. "Rhizopoda include Infusoria . . . the lowest of which is the *Amœba diffluens*." The rest of the Animal Kingdom is divided into *Radiata*, *Articulata*, Mollusca, and Vertebrata. The book is useful as a child's book, but the style is too grandiose for childhood's fancy.

The Causation of Sleep, by James Cappie, M.D., Edinburgh: Thin, 1872. We do not ourselves believe that the author's opinions are correct. Still they are fairly laid before the medical public, and they deserve every consideration.

The Civil Service Arithmetic, by R. Johnston. London: Longmans. Seems to be a good little book, but is unfortunately rather poorly got up, and is not in respect to its appearance creditable to Messrs Longmans.

Notes on River-basins, by R. A. Williams. London: Longmans, 1872. "These short notes on river-basins were drawn up some twelve years ago." They are intended to form a supplement to the usual geography of the schools. So far as we can see it is fairly done, but some of the Irish names are rather phonetically given.

Contributions to the Therapeutics of Diabetes Mellitus, by Balthazar Foster, M.D.—This gives a report of several cases most scientifically treated, with the consequences of such treatment. It does not appear, however, that any of the remedies tried were particularly successful. Still the results obtained are most valuable.

Of other pamphlets which our space will not permit us to notice, the following are the titles:—"On the Law of Wages," by John Tomkins, R.N. "Consumption and the Breath re-breathed," by H. MacCormac, M.D. "The Mosasauroid Reptiles." "Hesperornis Regalis and Additional Remains of Pterosauria," by Prof. O. C. Marsh, U.S.A. "The New Patent relating to the Sewage of Towns," by J. B. Pow. "Examination Questions in Geology, with Answers," by E. Wilson. "Provident Knowledge Papers," by G. C. T. Bartley. "Ninth Annual Report of the Belfast Naturalists' Club." "Sixth Annual Report of the Aeronautical Society of Great Britain," for the year 1871.

SCIENTIFIC SUMMARY.

ASTRONOMY.

The recent Shower of Meteors.—The shower of meteors which took place on the evening of November 27 must be regarded as the most interesting astronomical event of the quarter. In splendour the display fell considerably short of the shower of November 13-14, 1866, few of the meteors being large, but in number the earlier display was far surpassed. In places where the sky was clear, it is probable that between 5.30 and midnight some 15,000 meteors could have been seen in this country. But in Italy Signor Denza estimates the number at 33,400. All the accounts agree in placing the radiant near γ Andromedæ, between this star and 51. The most interesting circumstance of the shower is its presumed, we might almost say its undoubted connection, with Biela's comet. This was first announced (so far as we know) in the columns of the "Daily News," on Monday, December 1, and at that time some doubts were expressed as to the reality of the connection. But at the meeting of the "Royal Astronomical Society," on December 13, a paper by Mr. Hind was read, in which it was announced that while the best determinations of the radiant assigned its position as in R.A. 1h. 44m. and N.P.D. 46°, the calculated position for the radiant of bodies following in the track of Biela's comet was in R.A. 1h. 41m., and N.P.D. 48°—an agreement so close as to leave no room for doubt as to the real connection between the comet and the meteors. It is worthy of notice that Prof. Alex. Herschel had, in the supplementary number of the "Notices of the Astronomical Society," expressed the opinion (first suggested by Weiss and d'Aerest) that meteors following on the track of Biela's comet would be seen late in November.

Search for Biela's Comet. — It was hoped that during the present perihelion passage of this interesting object, astronomers would be able to detect at least the brighter of the two comets, into which, what was formerly called Biela's comet divided itself in 1846. But although Mr. Hind published three ephemerides, calculated on different hypotheses as to the date of perihelion passage, the comet was not seen. It seems little likely that it will ever again be recognised as a comet, though, as we have seen, the meteoric train which is associated with it is capable of producing showers of considerable magnificence.

Origin of the November Meteors or Leonides.—Mr. Proctor has advanced a new theory as to the origin of the Leonides. He points out that although Uranus could undoubtedly so influence the motion of a single body rising from interstellar space as to cause that body to travel in an orbit like that of the November meteors, yet, to produce this result, a body must pass very close indeed to Uranus to receive the requisite degree of retardation. "We need not enter into numerical calculations," he remarks, "because in our ignorance of the actual circumstances under which, according to the theory, the members of the meteor system approached Uranus, calculation would be more laborious than profitable. But it can readily be shown that to produce the retardation required, Uranus must have been within 30,000 miles of a body arriving from interstellar space, and eventually travelling in such an orbit as that of the November meteors. But this is not all. We know that at present the November meteor system, counting only those members which travel near enough to the orbit of Tempel's Comet to come under the reasoning here employed, has an extension measured by millions of miles in breadth and depth, and by hundreds of millions of miles in length. It seems impossible to explain how all these bodies can once have been gathered within so small a space that the whole system was set travelling on its present orbit by the disturbing influence of Uranus. If ever so compact, the system should have been able by the mutual attraction of its members to maintain its compactness for a very long time—at least not to be scattered over a space hundreds of millions of miles long, within the astronomically short interval of seventeen centuries. One is thus led to doubt whether the November meteors have had an extra-planetary origin at all. They must once have been, all in a compact body, so near to Uranus, th t the idea is suggested that they came from Uranus; that in fact he expelled them in some tremendous volcanic outburst. Strange as this may sound, it is after all not a whit more strange than the theory (which seems forced upon us by other evidence) that meteoric bodies have in some instances been expelled from our sun or from his fellow-suns the stars. If we suppose that at any former epoch Uranus was in a sunlike state, it would have required no greater proportional expenditure of power in that small sun to expel meteoric matter than for the central sun to overcome by his explosive energy the might of his own gravity. Uranus would have had to impart but a velocity of 13·7 miles per second to expel matter from him for ever—even if we leave out of account the way in which the sun's action would help in bearing away matter once carried to a certain distance from Uranus. It would be a natural consequence of such explosive actions as have here been suggested, that each of the greater planets would have a dependent family of meteor systems, or comets, revolving in orbits approaching very near to the orbits of their respective parent planets. We might not, or rather we certainly should not, be able to detect from the earth one in many hundreds of these dependent comets; and if any were detected, the just inference would be that an enormous number of such comets existed. Many comets depending in just such a manner on the planet Jupiter have been already detected; that the case is the same with Neptune; that there is one comet at least, which on this view of the matter must be regarded as Saturnian; and that of course the system of bodies I am considering would be regarded as a dependent of the planet Uranus. A rather singular result would follow (as Professor Herschel has reminded me) from the theory here considered. Comets expelled from Jupiter, partaking of his rapid motion of advance, would be found to travel for the most part in the same direction as the planet. Comets expelled from the much more slowly moving Neptune would be as likely to travel in either direction. This agrees with observation."

Probable Early Appearances of Comet I. 1866 (*the Comet of the November Meteors*).—Mr. Hind supplies an interesting paper to the Monthly Notices of the Astronomical Society on the subject of the early history of the November meteors. "Some ten years since," he says, "I calculated three or four orbits for the comet, observed by the Chinese during the last week in October, 1366, somewhat varying in each case the interpretation of the path described in their annals as it is presented by M. Edouard Biot in the appendix to the "Connaissance des Temps" for 1846. The orbits bore a sufficient general resemblance to indicate the possibility of arriving at a correct idea of the elements, though one point in the interpretation there remained a doubt. When the similarity of the orbit of the November meteors, with that of the first comet of 1866, discovered by M. Tempel, was pointed out by Dr. Peters, I remarked that it also presented considerable resemblance to the orbits I had deduced for the comet of 1366, and the probability that this was an early appearance of Tempel's comet immediately occurred to me. Under these circumstances I applied to our Assistant-Secretary, Mr. Williams (whose extensive acquaintance with the Chinese language and Chinese astronomy is well known to the Fellows of this Society), requesting his aid in clearing up the doubt I have alluded to; and I am indebted to Mr. Williams for enabling me to state, with what I conceive a high degree of probability, that the comet of 1366 (which does not appear to have been remarked in Europe) was the one now known to be associated with the November meteor stream. Now, in October 1366, we have recorded a most imposing shower of meteors, one of the November series, discovered by Professor Newton. It was observed on the banks of the Tagus, and also in Bohemia. Humboldt gives us a description from a Portuguese Chronicle, which is thus translated in one of our editions of *Cosmos*: "In the year 1366, and xxii. days of the month of October being past, three months before the death of the King, Dom Pedro, there was in the heaven a movement of stars, such as men never before saw or heard of. At midnight, and for some time after, all the stars moved from the east to the west; and after being collected together, they began to move, some in one direction and others in another. And afterwards they fell from the sky in such numbers, and so thickly together, that as they descended low in the air, they seemed large and fiery, and the sky and the air seemed to be in flames, and even the earth appeared as if ready to take fire. That portion of the sky where there were no stars, seemed to be divided into many parts, and this lasted for a long time.' Then follows a reference to the 'great fear and dismay' which this phenomenon occasioned. We have here, I do not doubt, a description of the appearances in the heavens occasioned by the proximity of a comet, for it is certain that the comet observed in China was close upon the earth at the time of this memorable display, and, as I have stated, it appears highly probable that this was the comet in the track of which these swarms of meteoric bodies revolve. It is not unlikely that in the rich store of cometary record which Mr. Williams has lately enabled us to consult, several other appearances of the meteor-comet of November may be recognised. At present I have only succeeded in finding one, in addition to that of 1366, and in this case it is the European Chronicles which put us in possession of the track of the comet. In 868, at the end of January, a comet was observed under the tail of Ursa Minor, which moved in seventeen days almost to the constellation Triangulum. In China, it was seen in the 1st Moon (February), with the same right ascension as stars in Aries and Musca. I find, by calculation, that when Tempel's Comet arrives at perihelion at the end of March or early in April, it must follow this path in the heavens, being first situated at the end of January in the constellation Camelopardus, when, for want of conspicuous stars of reference, it might be said to be below the tail of Ursa Minor, afterwards moving to Triangulum and Aries. Between 1866 and 1366 we should have fifteen periods of 33.28 years, and between 1366 and 868, also fifteen periods, of 33.34 years."

BOTANY.

The Age of the vast Sequoias.—Professor Asa Gray, in delivering his address before the American Association at Iowa, naturally dwelt more especially on botany. He gave a valuable lecture, in which he pointed out the more remarkable features, botanically, of the American Continent, and as a matter of course he dilated on those singularly aged trees the Sequoias. Concerning them he asks, Have they played in former times and upon a larger stage a more imposing part, of which the present is but the epilogue? We cannot gaze high up the huge and venerable trunks, which one crosses the continent to behold, without wishing that these patriarchs of the grove were able, like the long-lived antediluvians of Scripture, to hand down to us, through a few generations, the traditions of centuries, and so tell us somewhat of the history of their race. Fifteen hundred annual layers have been counted, or satisfactorily made out, upon one or two fallen trunks. It is probable that close to the heart of some of the living trees may be found the circle that records the year of our Saviour's nativity. A few generations of such trees might carry the history a long way back. But the ground they stand upon, and the marks of very recent geological change and vicissitude in the region around, testify that not very many such generations can have flourished just there, at least in an unbroken series. When their site was covered by glaciers, these Sequoias must have occupied other stations, if, as there is reason to believe, they then existed in the land.—*Silliman's American Journal*, October 1872.

Do Habits of Plants change with Climate?—This question is answered by an able paper of De Candolle's, in a late number of "Archives des Sciences." He details a series of investigations of the question whether the habits of plants are changed by the action of the climate acting through a succession of generations. For this purpose he obtained seeds of plants which are widely dispersed over Europe, from different localities, Edinburgh, Moscow, Montpellier and Palermo, and sowed them simultaneously and under similar conditions at Geneva. The general results of a somewhat limited series of experiments were that the seeds obtained from the more northern localities germinated on the whole somewhat earlier than those derived from more southern latitudes, and were also rather more rapid in arriving at maturity. The difference was still more observable in the second generation; but sufficient variation was shown in the seeds obtained from the same locality to make the results of but small value without a much larger series of observations.

How the Eruption of Vesuvius affected the Plants in the neighbourhood.—"The American Naturalist" for September contains an interesting note on this subject by A. W. B., who takes his facts from a paper laid before the Academy of Sciences of Naples. The writer says that the newest vegetation has suffered from contact with the ashes, though the effect has been neither a scorching nor drying up. The action has not been a mechanical one; for a mere closing of the pores of the epidermis could not have caused death in so short a time. The closing of the pores and stomata is undoubtedly a secondary cause of death, but only after the lapse of some days. No change was observed similar to that produced by the vapour of boiling water. The scorching action of a high, dry temperature occurs only in the immediate vicinity of the volcano. Neither an acid nor alkaline reaction is shown by any change of colour in the flowers or leaves except a few instances of a change to blue of rose, orange, or violet coloured organs, which might be attributed rather to an alkaline than an acid reaction; but these are few and doubtful. Many phenomena concur in pointing to chloride of sodium as the chief agent in the destruction of vegetable tissue. The salt was present in sufficient quantity in the falling ashes to be readily discernible to the sight, and is also met with as an efflorescence in the ashy soil.

The late Dr. Curtis's Herbarium.—This fine collection of plants is, we learn from "Silliman's American Journal" for November, to be sold by his family, under directions from Dr. Curtis that it shall be kept together if practicable. Clearly, in the opinion of the Journal, this collection ought to be retained in North Carolina, being authentic for the flora of that State and the exponent of his full catalogues and descriptions of the plants of North Carolina, published by the State Government. A moderate sum would probably secure it, and would be most worthily invested to that end. If the State should not acquire it, or if it should be found necessary to divide it, the collection of Fungi ought to find a ready sale, as it contains the types of the hundreds or even thousands of species which Dr. Curtis has described, or at least determined and catalogued. Its loss to science would unquestionably be irreparable.

The Grape Disease Investigated.—This disease, which is of so much importance in Europe, has been very carefully investigated by Mr. C. V. Riley, an American writer, who has contributed a lengthy paper on the subject to the "American Naturalist" for September. The paper is of considerable length, so much so indeed, that an abstract is utterly impossible. However, we may mention that the author has, in the paper mentioned, gone with considerable ability into the whole subject, and has shown very clearly that root-lice, which he has minutely described, constitute by far the greater portion of the disease.

Boussingault's Recent Researches on the Chemistry of Respiration in Plants is referred to by a recent writer on the subject, Mr. Dewar, as being of great importance. His (Boussingault's) observations on the amount of carbonic acid decomposed by a given area of green leaf seem to him to afford interesting data for a new determination of the efficiency of sunlight. By experiments made between the months of January and October, under the most favourable circumstances, in atmospheres rich in CO^2, one square decimètre of leaf was found to decompose in one hour, as a mean, 5·28 cub. centims. of CO^2, and in darkness to evolve during the same period of time 0·33 cub. centims. of CO^2. In other words, one square mètre of green surface will decompose in twelve hours of the day 63·36 cub. centims. of CO^2, and produce in twelve hours of the night 3·96 cub. centims. of CO^2. The quantity of carbonic acid decomposed does not represent the whole work of sunlight for the time, as water is simultaneously attacked in order to supply the hydrogen of the carbohydrates. Boussingault, in summing up the general results of his laborious researches on vegetable physiology, says, "Si l'on envisage la vie végétale dans son ensemble, on est convaincu que la feuille est la première étape des glucoses que, plus ou moins modifiés, on trouve répartis dans les diverses parties de l'organisme; que c'est la feuille qui les élabore aux dépens de l'acide carbonique et de l'eau."

The History of Mucor Mucedo.—In his recent address to the Botanical Society of Edinburgh, Professor Wyville Thompson gave an interesting account of some of the forms of mould. He said that the life history of *Mucor mucedo*, one of the commonest of the mildews, is not yet thoroughly known. In it the cells are simple and undivided, but each sporangium-bearer usually ends in several large sporangia. Under certain circumstances this sporangium-bearer sends out tufts of finely dividing twigs, each of which ends in a small sporangium, which, to distinguish it from the larger form, has been called a sporangiolum. At other times processes are produced from the main cells which rise into delicate tubular branches, and give off globular cells which are called *conidia*—simple external spores, differing entirely in their character from the spores produced in sporangia; and if this mould be grown in a solution in which it is fairly nourished without a full supply of oxygen gas, long fibres are produced which break up into a multitude of separate bead-like cells filled with protoplasm, and capable of reproducing the organism.

The American Lichens have been partly recorded in a work on their arrangement, by Mr. Edmund Tuckerman, M.A. This work has just been published in America, but it will not be complete till the companion work, the "Synopsis of the North American Lichens," is finished and given to the public. This, however, will not be for some time, as the author is now travelling in Europe for the benefit of his health. The book is 8vo., and has about 296 pages.

How Mushrooms increase in Number. — At a recent meeting of the Academy of Natural Science of Philadelphia, Mr. Thomas Meehan, who appears to be one of the most industrious botanists in America, said he had observed this season that the spawn of the common mushroom (*Agaricus* *campestris*) radiated from a central point in a manner which he thought had not been recorded by other observers. As usually seen, the mushroom seemed to rise from various points along the mycelium, or underground thread, without any regular order or system. Fungi, like flowering plants, had other modes of propagation besides seeds. As in the potato, we had one system elevating its parts into the atmosphere ending in seeds, and another sending thready stolons under ground terminating in distended stems or tubers—the threads dying away after the tubers were mature—so in the common agarics we have the parts known as the "mushroom" which elevates itself into the atmosphere, and produces reproductive bodies like seeds called spores; and we also have underground white threads starting out from the base of the mushroom which at their terminus bear buds which next year become mushrooms, as the swollen ends or tubers of the potato produce plants. The observations which he supposed new referred to the distance which the spawn-threads traversed in one season, and the regular manner in which the mushrooms appeared from the parent of the past year.

The Compositæ of Bengal.—Mr. C. B. Clarke recently (November 21) read a paper on this subject before the Linnean Society. The author corroborated Mr. Bentham's estimate of the very small proportion of *Compositæ* relatively to the whole flora of flowering plants in the Indian peninsula as compared with other countries. In Bengal they show only the proportion of about one in twenty-two, and in Malacca the still smaller proportion of one in about forty-five species. The number of Indian species of *Compositæ* in De Candolle's "Prodomus" will probably have to be considerably reduced.

CHEMISTRY.

Is or is not Water an Electrolyte?—M. Bourgoin, who has recently investigated this subject, says that water is not an electrolyte, notwithstanding that current opinion is to the opposite effect (Bull. Soc. Chimique II., xvii. 244). His apparatus consists of a cell, divided into two equal compartments by an impermeable septum, which septum is pierced with an opening so minute as to prevent any mixing of the liquids on its two sides, while yet it allows the passage of the current. The cell is so arranged that the gases evolved from the electrodes may be collected and measured. Both compartments are filled with water acidulated with sulphuric acid, and the currrent is passed for a given time, the hydrogen being collected. When the experiment is concluded, the contents of the compartments are separately analysed. Under these circumstances it is found that, in the positive compartment, the acid has increased in amount by a certain quantity a, while in the negative it has diminished by the same amount. The quantity of sulphuric acid decomposed is equal to $2a$. But this quantity of acid can furnish only a third of the hydrogen obtained; or, calling P the weight of the hydrogen measured, the acid can yield a quantity of hydrogen equal to $\frac{P}{3}$. It is therefore certain that it is not H_2SO_4 which is decomposed, but $H_2SO_4 + (H_2O)_2$, or H_6SO_6. Two hypotheses may be offered to explain this result, which are then given at full length; but the explanation is too long to admit of further abstract.

The German Chemical Society of Berlin.—In a late number of its journal (No. 17, 1872) there is an address, published by Dr. Liebreich, congratulating the President (Dr. A. W. Hofmann) and the members of the society on the fifth anniversary of the foundation of this society, already one of the most successful scientific societies established in Germany. The speaker gives a review of the history of the past lustrum, and pays a well-deserved tribute to Dr. A. W. Hofmann, to whose energy the success of the society is in a great measure due. Dr. Oppenheim proposed that a subscription list should be opened for the benefit of the orphans of the late J. C. Brough. The amount subscribed up to November 18 was 158 thalers = 23*l.* 14*s.* Of course this will increase, and we trust, with the collection now being made in London, will eventually amount to a handsome sum.

What is Noctilucine?—It is the substance, according to Dr. Phipson's recent researches, which produces the peculiar luminous appearance that certain animals seem to present, especially the glow-worm and the medusoids. At the ordinary summer temperature noctilucine is a semi-fluid, almost liquid substance, containing nitrogen; it is white, and in its natural state contains a considerable amount of water; it has a slight odour, resembling that of caprylic acid; it is only slightly soluble in water, and is somewhat lighter than this liquid; it is insoluble in alcohol and ether, and is decomposed by acids and alkalies. Nitric acid easily dissolves and decomposes it; sulphuric acid, also, and potash evolves ammonia from it. In fermenting, in contact with water, it produces an odour of putrid cheese; as long as it is moist, it absorbs oxygen and evolves carbonic acid in the air. When left to itself it dries up, in the course of a few hours, to thin, shining, translucent films, quite devoid of structure, and resembling the *mucine* of the common garden snail.

Dulcitamine, a new base from Dulcite.—In a late number of the "Comptes Rendus," M. Bouchardat states that he has succeeded in obtaining an organic base containing oxygen, by acting upon one part of dulcite monochlorydrin with ten parts of alcohol saturated with ammonia gas, for six hours, at 100°. The chlorydrate of the new base—which the author calls dulcitamine—is dissolved in absolute alcohol, from which it crystallises out in long needles on the gradual addition of ether. It is freely soluble in alcohol and water, insoluble in ether; its solution in water is neutral and tastes sweetish. Treated with silver oxide, it yields free dulcitamine, as a powerful base, easily displacing ammonia from its combinations, blueing strongly red litmus paper, and attracting carbonic acid from the air.

Analysing compound Ethers.—There is a dispute between Dr. Wanklyn and Dr. Dupré as to the claim to one of the above processes. The latter has written a letter to the "Chemical News" of October 4, stating that one of the processes for analysing compound ethers, brought before the British Association at its late meeting, by Prof. Wanklyn, viz. heating the ethers with an alkali and estimating the amount of alcohol liberated, has already been described by himself as long ago as the year 1867, and will be found fully explained in the "Journal of the Chemical Society" of that year, as also in the work on "Wine" by Dr. Thudicum and Dr. Dupré.

How to extract Grease from Bones.—In a comparatively recent number of the "Revue Hebdomadaire de Chimie," M. Lichtenberger states that the following method, is in his opinion, the best:—The bones are first crushed, next treated with high-pressure steam, and to the semi-gelatinous mass thus formed is added hydrochloric acid (2 per cent.), with which the material is boiled; by this operation the fat is separated, and, floating on the top of the boiling liquor, is readily collected, and further purified by treatment with boiling water, a very small quantity of caustic soda having been added. Next the grease (a fluid oil-like substance) is treated with animal charcoal, and lastly filtered.—See also *Chemical News.*

An Analysis of a recent Meteorite, which Herr Haidinger has recorded, is given by E. H. von Baumhauer, and appears in the "Chemical News." The composition of this stone is, in 100 parts:—Nickeliferous iron, 5·0; sulphuret of iron, 2·2; chrome iron, 0·8; olivine, 39·9: insoluble bisilicate, 52·1.

A Gas-burner for bending Glass Tubes.—The following note may interest some of our readers. It is from the "American Chemist," and appears in the "Chemical News" of November 8. The writer, Mr. H. C. Bolton, states that he has employed for some years an ordinary bat-wing burner, attached to a small, short stand (three inches high, burner included), so as to rest low upon the table, in order that raising the arms inconveniently high may be avoided. Such a burner insures a broad flame, by which the tube is heated for two or more inches in length; the tube is turned while in the flame, and removed for bending as usual. The deposit of carbon, which at first sight might seem an objection, is really one of the chief advantages of using this burner. On placing the glass in the flame, the deposit begins immediately, and prevents too rapid a rise of temperature and consequent cracking of the glass; during the heating the carbon tends to distribute the heat equally over the surface of the tube; and finally, on withdrawing the glass from the flame too sudden cooling is prevented, and the glass is, as it were, annealed. The black deposit is readily removed by a dry cloth. This plan was commonly employed in "Hofmann's Laboratory," Berlin. In bending tubes of more than three eighths of an inch in diameter, the end should be closed tightly with a cork (or wax), and air blown into the other end at the moment of bending the tube; by regulating judiciously the pressure of the air upon the sides of the somewhat softened tube, the latter will neither bulge out nor collapse, but will retain its proper calibre. This cannot be effected, however, with very large tubes, or with very thin ones, which require the nice manipulation of the professional glass-blower.

Explosion caused by a Mixture of Acetate of Soda and Nitrate of Potass.—In the "Journal de Pharmacie et de Chimie" for November it is stated that while M. Violetti recently was heating a mixture of nitrate of potash and acetate of soda in a small glass flask, he was seriously injured by a sudden and violent explosion of the substances he operated upon. This accident gave rise to further investigation, the result of which is that a mixture of 100 parts of nitrate of potassa and 60 of acetate of soda, when heated and fused at about 300°, do not explode, and may even, after cooling, be pulverised and granulated; but if the salts are heated to 350°, or ignited by means of red-hot iron, a violent explosion instantly takes place. When either the nitrate or acetate is in excess of the quantity mentioned, the mixture only burns as dry wood would do.

A Hydro-carbon hitherto Fossil, now Recent.—Dr. J. W. Mallet, of the University of Virginia, describes a case of recent fichtelite. He states that some nearly colourless crystalline crusts found in clefts between the annual rings of growth of a log of long-leafed pine (*Pinus australis*), in Alabama, were found to dissolve in boiling alcohol (more easily in ether), and, on cooling, to crystallise in monoclinic forms with greater distinctness. A specimen was exhibited of this material, purified by two or three re-crystallisations; it had been found to agree perfectly in physical and chemical properties with the fichtelite of Bromeis and Clark, and on analysis yielded—

Carbon	87·82
Hydrogen	11 91
	99·73

agreeing with the formula x (C_5H_8). The fusing-point was found = 45° C. —*Chemical News*, October 4, 1872.

How to Detect and Estimate Paraffin in Stearine Candles.—Herr Hock, in a tolerably recent number of the "Bayerisches Industrie," reviewing the various methods employed for this purpose, states that it is best to saponify the stearine (really stearic acid) with moderately strong caustic potassa, to convert the soap thus obtained into a soda-soap, by means of chloride of sodium, and to treat the soda-soap on a filter, first with cold water, and next with some dilute alcohol; the soap is dissolved, and the paraffin set free; the filter is then dried at a temperature of about 35°, after which the paraffin is dissolved in ether, and this solution evaporated, and the residue weighed. This method has been tried by the author with mixtures of known quantities of stearine and paraffin, and found to answer well.

Is Resin an Adulteration of Soap?—According to a letter of Prof. A. G. Anderson, in the "Chemical News" for November, resin cannot be called an adulteration of soap. He states that Mr. Jean, who has written upon the subject of soaps, makes a great mistake in classing resin amongst the fraudulent adulterations of soaps. Its employment in certain kinds is, beyond cavil, clearly insisted upon by the greatest number of consumers of the article. They will have soap so made, and no other. "Enquiry of any one merely acquainted with the routine of a soapery will suffice to prove this. Moreover, as I have been intimately associated with the practical details of the manufacture for twenty years past, I am enabled to add that this requirement as regards resin is simply a matter of fact. The demand for pale or yellow soaps—an indispensable feature of which is that they must contain from one-fourth to about one-third of resin—has existed for about a century past; and the call for these sorts, so far from diminishing, continues steadily on the increase."

Cambridge; the Chemical Præ-Lectorship.—This appointment is, at the period of our going to press, unfilled. We learn that Mr. J. Alfred Wanklyn is a candidate for the vacant office. We sincerely hope that Mr. Wanklyn may be successful, for there are very few, if any, more worthy of such an office.

GEOLOGY AND PALÆONTOLOGY.

Tinoceras anceps; what is it?—This is a large mammal from the Tertiary formation of Wyoming, U.S.A., discovered by Mr. O. C. Marsh. In "Silliman's American Journal" for October the discoverer states that he has proved it to be a proboscidean. The limb bones of this animal are similar to those of *Mastodon*, but other parts of the skeleton, especially the skull, differ widely from that genus. The Museum of Yale College has portions of several skeletons, which will soon be fully described.

A Palæontologist exploring.—We hear that Professor Joseph Leidy, the eminent comparative anatomist of Philadelphia, is exploring the West for fossil vertebrates. He is also making a study of the minute forms of life under the microscope, and will present a report on the minute fauna and flora of the districts he visits.

Fossil crustacea of the Limuloid type.—Mr. Henry Woodward communicates to the "Geological Magazine" [October] some remarks on the order *merostomata*, additional to those in his splendid memoir in the Palæontographical Society's publications. Since 1865, when he very fully described some of the Limuloid forms to the Geological Society, other fragments have been found, and also another nearly perfect example (obtained by the late Mr. Henry Wyatt-Edgell) of the form named by Mr. Woodward *Hemiaspis limuloides*, which, having the upper central portion of the carapace preserved, nearly completes our knowledge of this species. The great interest attaching to this form arises from the fact that it offers just the desiderated link by which to connect the *Xiphosura* with the *Eurypterida*. *Limuli*, apparently differing but little as regards their carapace from the recent species now found living on the coasts of China, Japan, and the north-east coast of North America, occur as early as the deposition of the Solenhofen Limestone of Bavaria; and in the Coal-measures of England and Ireland several species of *Bellinuri* and *Prestwichiæ* occur, in which behind the cephalic shield the body is composed of five more or less free thoraic segments, and the rudimentary abdomen, if not anchylosed in all, is so in most. Mr. Woodward's present paper is of considerable length, and is illustrated by a capital plate.

The Trimmerellids.—The labours of Professor King and Mr. T. Davidson, F.R.S., on these fossils, have enabled them to confirm, for the most part, the conclusions of previous writers as to the numbers of species, and to determine the existence of some others. The three genera are severally constituted in species as follows:—

Trimerella grandis, Billings.
" *acuminata*, Billings.
" *Lindströmi*, Dall.
" *Billingsii*, Dall.
" *Ohioensis*, Meek.
" *Dalli*, Dav. and King.
" *Wisbyensis*, Dav. and King.
Dinobolus Conradi, Hall.
" *Canadensis*, Billings.
Dinobolus Galtensis, Billings.
" *Davidsoni*, Salter.
" *transversus*, Salter.
" *Woodwardi*, Salter.
" *magnifica*, Billings.
Monomerella Walmstedti, Dav. and King.
" *prisca*, Billings.
" *orbicularis*, Billings.

With one or two exceptions, all the species will be fully illustrated in five lithographic plates in the authors' forthcoming memoir: in addition to which there will be two wood-cut plates of diagram-figures, explaining the various parts briefly noticed on the present occasion, and another showing the relationship of *Lingula* to the family.—*Geological Magazine*, October.

The Geology of Biluchistan.—Mr. W. T. Blandford contributes a paper to "Records of the Geological Survey of India," part II., May 1872, which is of particular interest as being upon an unexplored territory. His observations relate to the geological formations seen along the coast of Biluchistan (commonly called Makran), and those of Persia from Karachi to the head of the Persian Gulf, with observations on some of the Gulf Islands. Three distinct systems of rock are exposed in these localities, in descending order:—1. Littoral concrete (sub-recent); 2. Makran group (post-Nummulitic); 3. Hormuz salt formation (of unknown age). The island of Hormuz is a most singular place. It is almost destitute of vegetation, and consists of a mass of low craggy hills, brilliantly coloured. Beds of volcanic origin, dolerites and trachytes, rock-salt, shales and sandy-beds, are found interstratified, all belonging apparently to the same series. The rocks are much disturbed; beds of salt and volcanic bands alike dip at high angles. There is no evidence to determine the age of these salt-beds; but they are clearly older than the Makran group, for in the Island of Hanjam they crop out here and there beneath this group, which rests uncomfortably upon them.

The Geology of the London Basin is dealt with very ably by Mr. W. Whitaker in the "Memoirs of the Geological Survey." In the area explained by him the formations exposed are the Bagshot Beds, London clay, Lower London Tertiaries and chalk. Their general nature is first noticed, and then their range, lithological character, and sections are described in detail. One chapter is devoted to the sands of doubtful age on the chalk, originally classed with the crag by Mr. Prestwich, and subsequently referred to the Eocene period by Mr. Whitaker and others. The concluding chapters are devoted to Disturbances, with a notice of the likelihood of there being an underground ridge of older rocks along the valley of the Thames; to Denudations, and to Economics and Springs. In the Appendix there are accounts of 488 well-borings, arranged according to counties. To these Mr. Whitaker has added many remarks of his own in regard to the classification of the beds passed through; and, together with accounts of 36 borings, they form a most valuable record of facts. Other appendices contain copious lists of fossils, minerals, &c. The whole work—embracing as it does a minute account of the Chalk and Eocene Tertiaries of the London Basin—is in the highest degree creditable to Mr. Whitaker.

The Physics of Geology.—Professor Le Conte, in "Silliman's American Journal" for November, thus concludes a paper which is to be continued: "I think, therefore, I am justified in asserting that the *phenomena of plication and of slaty cleavage demonstrate a crushing together horizontally, and an up-swelling of the whole mass of sediments; and that slaty cleavage demonstrates in addition that the up-swelling produced by this cause alone is sufficient to account for the elevation of the greatest mountain chains.*"

The genus Rhynobolus or the genus Obolellina, which is it to be?—Professor Hall writes to "Silliman's Journal" for August, asserting that he was first discoverer, and that it should be *Rhynobolus*. On the other hand, Mr. E. Billings, in the same Journal for November, says, that with regard to publication, he holds it to be the duty of an author who describes new fossils to make his work accessible to the public. If he fail to do this he cannot claim priority over one who has published in the regular way. His work may be adopted as a matter of courtesy, but not to take precedence over fair publication. "Professor Hall's pamphlet was not accessible to the public at the time my paper was published, and therefore his genus *Rhynobolus* cannot take priority over my genus *Obolellina*." Meantime, who shall decide?

The Volcano of Mokuaweoweo.—This mountain, which we believe is in Hawaii, has lately been in a magnificent condition of explosive activity. A writer in the "Pacific Commercial Advertiser" thus describes his observations, which, for lack of better ones—though they are exceedingly graphic—we give our readers. On ascending the mountain he watched steadily the grand fountain playing before him, and called frequently to his companions to note when some tall jet, rising far above the head of the main stream, would carry with it immense masses of white-hot glowing rock, which, as they fell and struck upon the black surface of the cooling lava, burst like meteors in a summer sky. As soon as he had reached the summit level of the mountain, he heard the muffled roar of the long pent-up gases as they rushed out of the opening which their force had rent in the basin's solid bed. And now that he was in full view of the grand display, his ears were filled with the mighty sound as of a heavy surf booming in upon a level shore, while ever and anon a mingled crash and break of sound would call to mind the heavy rush of ponderous waves against the rocky cliffs that girt Hawaii. At night the jet looked loftier, and gazing intently into the fiery column with a good glass that he had, he could see the limpid sparkling upward jet rising with tremendous force from out an incandescent lake. Following up the glowing stream, he saw it arch itself and pour over as it were in one broad beautiful cascade. While the ascending stream was almost silvery in its intense brightness, the falling sheet was slightly dulled by cooling, and thus the two were ever rising, falling, shooting up in brilliant jets, and showering down with mingled dashes of bright light and shooting spray, while in the lake out of which rose the fountain, and into which fell the fiery masses, danced and played a thousand mimic waves, and fiery foam swirled round and round. Upon its surface danced myriad jets and bubbles, and from its edge flowed out the rivulets of lava, that in a tangled maze of lines covered all the lake.

The term Cambrian should be used instead of Primordial in America.—Professor S. Sterry Hunt, F.R.S., writing in "Silliman's American Journal," November, asks why this is not done. The term Silurian, as used in Great Britain, has, he considers, included a wide range of formations, from the Lingula Flags to the top of the Ludlow group, and all this in spite of a wide range in the tribes of fossil species, and notwithstanding the unconformability between the Upper and Lower Silurian. Now the Lingula Flags pass into the Cambrian without break or unconformability, and with but a small change in the life. What good scientific reason is there for cutting off this comprehensive division of geological time, the Silurian, at a point both stratigraphically and paleontologically unimportant? Why should

Murchison's or Sedgwick's determination of the limits of the Silurian, made in an early stage of the science, have anything more than a historical interest? To throw the Lingula Flags down into the Cambrian, as Lyell has done, is violating "historic truth" as much as to throw the Primordial Cambrian beds up. "Historic truth," in fact, has little weight in the question, though important as regards the labours of two eminent English geologists. Whichever course best exhibits the system of geological truth should be the one adopted by the science. If the term Cambrian has advantages over Primordial sufficient to make its substitution for the latter desirable, that will take place, whatever the past may say; but otherwise, not. In a similar manner, if the distinction between a *Paradoxides* and an *Olenus*, and other differences less important between the living species of these groups, is not enough to demand that the Primordial (or Cambrian) should be separated from the Silurian, and be made a separate and equivalent grand division in the system, it should not be done, whatever the authority for it.

A new Fossil Bird.—"The Scientific American," October 26, is responsible for the statement that the skeleton of a fossil bird, found during the past summer in the upper cretaceous shale of Kansas, indicates an aquatic bird as large as a pigeon and differing widely from all known birds in having *biconcave* vertebræ. The species is termed *Ichthiornis dispar*.

The Edinburgh Geological Society.—We have received the first part of the second volume of this Society's Transactions. It is full of admirable papers, though they are somewhat late in their publication. Several fine plates accompany the volume.

MECHANICS.

Steam Traction on Roads.—Professor R. W. Thurston recently gave a very interesting address before the Polytechnic branch of the American Institute. He showed conclusively that for heavy truckage on common roads and streets, the steam traction engine may be used with an economy of seventy-five per cent. over the cost of employing horses. In other words steam-carts can be employed at only one fourth of the present expense of horse-carts. During the subsequent conversation, the subject of steam street cars and carts was talked over, and one of the members expressed the ridiculous and monstrous opinion that the reason why horses were frightened at the steamers was because the animals were superstitious. They saw the machines were without horses, and instantly assumed that the movement was the work of the devil.

A Perpetual Motion Swindler.—A correspondent of the "Scientific American," Mr. H. R. Birdsall, of Green, New York, gives a description of "a perpetual motion," constructed by an adventurer, which worked so well that he succeeded in obtaining sums of money (2,500 and 1,800 dollars) from various simpletons, and then left "to secure his European patents." He has not returned, and a visit to his deserted apartment has revealed a hole in the wall and certain surreptitious mechanism by which the perpetual motion was driven. The beautiful device which elicited the subscriptions of the inhabitants of Chenango county was a self-moving pump, and, actuated by some concealed clock-springs, it was the delight and wonder of the vicinity.

Rules to be Observed to Prevent Explosions of Boilers.—In the "Bayerisches Industrie und Gewerbe Blatt," for September, Herr W. Born gives a series of rules which we have no doubt will be most valuable to engineers. If these rules were constantly adopted, we doubt not that explosions would be of far less frequency than they now are.

The Great Pumping Engine of Chicago.—An immense pumping engine has lately been completed and successfully operated in Chicago. It is of 1,200 horse power, and consists of two machines connected by a single shaft. The two steam cylinders are each 70 inches in internal diameter, and allow a 20 ft. stroke of piston. The steam-chests are provided with double puppet-balanced valves, and the unhooking gear is arranged so that both engines may be controlled at the front of either. The flywheel is 25 ft. in diameter and weighs 33 tons. With the exception of the great machine at Haarlem, Holland, of which the diameter of the cylinder is 12 ft. and stroke 10 ft., there is probably no larger pump in existence.

Mechanics of the Proposed Channel Steamers.—With regard to this interesting subject we may refer to our original articles. Mr. Merrifield, F.R.S., has there described the three principal vessels that are proposed, and how far each of them is likely to fulfil the desired result.

A Mechanical Means for preventing Hay-ricks from Heating has been just adopted at the late Prince Consort's farm and the Norfolk farm at Windsor. A long perforated tube, fixed in short lengths which fit into each other, is built into the body of the rick as it is carried up, and snrmounted by a cowl, which turns with the wind and provides a constant downward current; an upward current is also arranged for in an inner tube, which is solid, opens at the bottom, and so completes the circulation. This invention is also adapted to granaries and ships in transit, but in these cases several arms are provided, running out from the central shaft at right angles, so as to distribute the air through the body of the grain. The use of perforated tubes for preserving grain, meal, &c., in storehouses, granaries, and in barrels, is an American invention, and has long been in use in the United States.

A huge Railway Tunnel.—A contract has lately been signed between the directors of the St. Gothard Railway, Switzerland, and M. L. Favre, of Geneva, for the boring of a new railway tunnel through the Alps, which promises to surpass anything of the kind yet attempted. The length of the tunnel will be a little more than nine miles. Cost 2,000,000*l.* The work is to be finished within eight years; and if sooner finished the contractor is to receive 200*l.* a day for each day in advance of the contract time.

Improvement in Steel Manufacture.—At the Austrian Steel Works of Neuburg, Styria, Chevalier Stummer, of Trauenfels, has carried out a large series of experiments in order to weld the interior particles of cast steel to each other as strongly as possible, and to prevent the honeycomb, which is an accumulation of fine pores, filled with elastic gases, which are inclosed in the cooling metal. The principal result of these experiments is that it is quite possible, by exposing the semi-fluid metal to great pressure, to unite all the pores within a very limited space in the centre of the steel block. This fact is of the utmost importance in the manufacture of heavy steel ordnance, which is intended to bear the strain of very great charges, as in that case it is just the central part of the barrel which is bored out and the perfectly sound part of it left to form the wall of the gun. Thus the pressure of from 6 to 9 tons on the square inch will be sufficient to compress a red-hot steel ingot before its solidification, and give it an even structure throughout the whole mass, while the impact even of a very heavy steam-hammer, like Krupp's 50-ton hammer, is principally spent on the outer part of the block, and the result will be the absorption of the power before it reaches the centre, and the exterior of the mass will be elongated and cause the tearing asunder of the central part. Only very heavy hammers or rams will effectually overcome the *vis inertiæ* which a very heavy casting opposes to them.

MEDICAL SCIENCE.

A General European Pharmacopœia is likely to be formed eventually. At all events already a considerable number of distinguished medical men are strongly in favour of it. Dr. Thudichum read a paper on the subject at the meeting of the Pharmaceutical Society on the evening of November 16th. Attempts have been made, according to Dr. Thudichum, for the past 200 years, but alas! unsuccessfully.

The Value of Chloralum as a disinfectant has been tremendously overrated. This is not, as many represent, a quite recently discovered substance, but a very old one, and one too, whose disinfecting qualities were known. Regarding these properties a recent writer, Professor A. Fleck, states that both the disinfecting and purifying power of chloralum stand below those of alum, or sulphate of alumina and copperas (protosulphate of iron), which further recommend themselves by their much greater cheapness. To sum up the argument concerning the value and composition of the preparation of chloralum: 1. The preparations of chloralum have nothing in common with the similarly-sounding chloral hydrate, and are, in point of fact, mixtures of chloride of aluminium. 2. The preparations of chloralum contain chlorine combinations of lead, copper, and arsenic, which renders their employment not free from danger, and which would render their employment, as a medicine or as an astringent for open or suppurating wounds, dangerous. 3. The price of the preparations of chloralum bears no relation either to their nature or their effect. Considering that the liquid chloralum yields a clear profit of at least 700 per cent., and the wadding 400 per cent., the limits of trading may be considered as overstepped. 4. The result of these experiments is that chloralum and the preparations made from the same must be classed among the worthless arcana, and in the interests of the public health, as well as in the material interests of the public, a most decided warning must be given against the purchase of the same.

Effects of Substances which alter the Blood-corpuscles.—M. Ritter, of Strasburg, gives the following *resumé* of the results of his researches on this subject. ("Chemical News," Sept. 27.) When animals are subjected to the action of substances which greatly alter the blood globules (as compounds of antimony, arsenic, and phosphorus), crystals of hæmoglobin appear in the deformed globules; the blood is anemic, the albumen in the globules diminishes; the fibrin increases, the proportion of gas diminishes; glucose generally, but not always, increases; fatty matters and chlosterine always increase; and the variations in these correspond to the dose of the poison and the alteration in the globules. The composition of the urine varies also; the entire quantity of nitrogen and urea diminishes; the acidity diminishes and gives place to alkalinity; uric acid always increases, when the globules are greatly changed. The urine contains abnormal principles, which are most frequently colouring matters of the bile, albumen, and sometimes hæmoglobin. The compounds whose actions we are considering promote formation and deposition of fat, but only when administered in certain doses.

Microscopic Structure of the Brain.—The "Monthly Microscopical Journal" for November states that Professor Gerlach has been recently examining into this subject, and that he has published the results of his inquiries in the "Centralblatt," No. 19. It seems that, on applying the gold method of hardening microscopic specimens, he found: 1. That besides the well-known white medullated nerve-fibres running from the white into the grey substance, and which are arranged in fasciculi radiating towards the periphery, there are also numerous horizontally-running, medullated fibres, which communicate both with one another and with the radially-disposed fibres, forming a coarse plexus visible even with a power of sixty diameters. 2. That in the meshes of this plexus are contained the ganglion cells, and a second far finer plexus of extremely delicate non-medullated fibres which can only be brought into view with the highest powers of the immersion system. This second plexus is formed of the finest proto-plasmatic processes of the nerve-cells, whilst the medullated fibres appear in part to take their origin in it, the individual fibres becoming surrounded by medulla. 3. Some of the protoplasmatic processes of the ganglion-cells develop directly into medullated fibres without branching, and thus such fibres originate partly from the cells themselves, and partly from a plexus of non-medullated fibres.

Physiology as an Aid to Medical Science is the subject of the Academy of Sciences of Venice's prize for next year's (1874) best essay. The prize will be worth 3,000 francs. The essays may be written in the French language, and are open to foreigners. The following is the exact title of the prize:—"The advantages derived by the medical sciences, especially physiology and pathology, from modern discoveries in physics and chemistry; with a retrospective view of the systems which prevailed in medicine in past times."

Lady Investigators into Structure.—The "British Medical Journal" says that two Russian ladies, Misses Olga Stoff and Sophie Hasse, have employed themselves during the autumn recess in investigating the circulation in the spleen, by means of injection and microscopic examination. Their researches, which were made on the spleens of frogs, pigeons, rabbits, mice, rats, and various other animals, as well as of the human subject, were carried on in Dr. Frey's laboratory. They have published an account of their examination and its results in the "Centralblatt" for Nov. 9.

METALLURGY, MINERALOGY, AND MINING.

Didymium a Constituent of British Minerals.—Prof. A. H. Church, M.A., F.C.S., writes to the "Chemical News" (September) to say that Didymium was first discovered in a British mineral by Mr. C. Greville Williams, F.R.S., in the year 1865. This fact is recorded in the "Chemical News," vol. xii. p. 183. "The mineral containing this rare metal was described by me as 'a new British mineral containing cerium.' Analyses proved it to be a hydrated phosphate of the cerium metals, the latter, calculated as cerous oxide, constituting no less than 51·9 per cent. of the mineral. Specimens of this mineral may be seen in the British Museum, Mineral Case, No. 57. It is, however, very rare, and I hesitated to sacrifice the specimens which I possess in order to attempt a precise estimation of each of the cerium metals present. It occurred in a Cornish copper lode on quartz and killas. A concise description of the species will be found in Dana's 'Mineralogy,' p. 555 (5th edition, 1868)." The above remarks were suggested by Mr. C. Horner's note on the presence of didymium in pyromorphite ("Chemical News," vol. xxvi.) The occurrence of cryptolite in certain British, as well as foreign specimens of apatite has been ascertained. Now as cryptolite is an anhydrous phosphate of the cerium metals, it may be considered that the discovery of this species in apatite is equivalent to the detection of didymium in that mineral. I must say I have failed to find even a trace of cryptolite in the true asparagus-stone, the beautiful greenish-yellow crystals of apatite, from Juniella, in Murcia, Spain. Mr. Horner's discovery of didymium in pyromorphite will naturally lead to the search for the other cerium metals in that mineral.

What is American Sterling?—This is the name which the manufacturers have given to a new alloy whose construction is at present a secret. The "Scientific American" (October 26) says that a company has been recently formed in the United States for the introduction of this alloy, termed "American sterling." The composition is as yet unpatented, but results, drawn from a series of careful tests and experiments, point plainly to the fact that the new metal is not only a discovery of great importance, but to all appearances calculated to revolutionise a large and flourishing branch of industry. In its crude state, this new alloy resembles nickel; but after being worked up, it is almost undistinguishable from silver. Unlike the latter metal, it does not tarnish and is unaffected by sulphurous vapours, so that it is eminently adapted to replace silver, Britannia, or the ordinary alloys in the manufacture of table ware. Articles of food have no action upon it; alkalies produce a temporary tarnishing, which may be immediately removed by a slight rubbing with the hand. Made in the form of cutlery, the alloy possesses none of the disadvantages of steel or plate; it takes a keen cutting edge, requires little or no cleaning, and is unaffected by ordinary organic acids. Knives made from it show no black edges after short usage, as is the case with plate, while they can be ground or sharpened whenever necessary. The metal is unusually flexible and tenacious; a table fork made from it was, in our presence, twisted into a perfect knot, without showing the least flaw or intimation of breakage.

Belgian Coal in Britain.—Unquestionably a large amount of Belgian coal is being introduced here, owing to the extravagant prices demanded by English coal-masters, who have raised the prices entirely independent of the cost of the men whom they employ. The Belgian industrial journals are jubilant over the astonishing demand for coal which, in consequence of the great rise in the British prices, is now shipped in large quantities to England. They state that the prices given are so great that it is impossible to trace the course of the market. The proprietors of mines not only sell the coal as fast as it is extracted, but are actually obliged to refuse large numbers of foreign orders on account of being unable to fulfil them.

Italian Mining Progress.—The reports do not appear very extraordinary which reach us. With the exception of 10,000 tons of refined sulphur derived from the Roman mines, all of that material obtained from Italy comes from Sicily, and is exported in a crude state. The total value of the sulphur is nearly 1,040,000*l.*, not including the export duty of eight shillings per ton, which is paid by foreign buyers. There are about 19,000 workmen engaged in this industry, 5,000 miners and 14,000 operatives employed in transportation, refining, &c. The carrying of the sulphur from the mines to ports of embarkation furnishes labour for 20,000 additional workmen. The iron drawn from Italy and the articles made therefrom represent annually a value of 800,000*l.* The production of the foundries does not exceed 22,000 tons. The total product is but one-fifth of the entire amount consumed in the country. Lead and zinc are derived almost exclusively from Sardinia. Their extraction requires 10,000 workmen, and quantities to the value of 480,000*l.* are produced. The lead ore is argentiferous, but the silver is found in extremely small amounts. The zinc is exported to Belgium and this country. The quantity obtained yearly reaches 60,000 tons.

Examination of the Crystals of Leucite.—Professor Von Rath, the distinguished crystallographer of Bonn, is said to have found, through the examination of a twin crystal, as well as by measurements, that the crystals of leucite, instead of being isometric trapezohedrons, are really tetragonal.

MICROSCOPY.

The Histological Structure of Nematophycus Logani.—We merely refer to the paper, for it is too long for an abstract. It is by Mr. W. Carruthers, F.R.S., and is of importance, from the circumstance that it goes fully into the discussion of the literature and anatomy of this remarkable plant, and lays clear Dr. Dawson's position in the discussion that it has given rise to —*Monthly Microscopical Journal* (October).

The Structure of Diatoms.—This subject is referred to in a number of the "Monthly Micoscopical Journal" (October). That journal refers to the researches lately carried out by Professor Weiss, which appear of import. Mr. Stephenson's recent experiment of mounting diatoms in a very dense fluid, such as bisulphide of carbon, is also of equal interest. We may expect a paper on the subject soon from some member of the Royal Microscopical Society.

Eupodiscus Argus Properly Examined.—Mr. Slack says that when Mr. Wenham's reflex Illuminator is successfully employed upon *Eupodiscus Argus* a considerable portion of the circular valve will become clear and plain, and it will be seen that it is entirely composed of spherules of different sizes and varied aggregation. Radiating from a central portion, occupied by minute and closely-packed spherules, bands will be seen proceeding to the circumference each one composed of minute spherules, that appear in close contact under an $\frac{1}{8}$, with eye-pieces up to D of Ross' system. Between these bands are larger spherules, frequently, but by no means universally, arranged in *fours*, so that when seen with powers too low for their distinct separation, they appear to form patterns like the Gothic quatrefoils, and look like holes when the light passes straight through them.—*Monthly Microscopical Journal* (Dec. 1872).

Tolles' New Wet-Objective $\frac{1}{18}$th.—On this Dr. Woodward speaks most favourably. For instance, with regard to the performance of the dry combinations of this objective, he merely says that they gave him the striæ of *Amphipleura pellucida* rather better than any dry objective he has ever tried. He has not tested them as yet to any extent on other objects, because of the manifest superiority of the immersion work. The behaviour of the objective, when used wet, is certainly admirable. In illustration, he forwarded to the Society a new series of views of Nobert's plate from the lowest to the highest bands taken by it. These pictures, which certainly excelled all his former work on the plate, were purposely taken from the ordinary thick-bottomed plate, accessible to most microscopists, in order that those interested might compare what they can see by their objectives with the work then submitted. Most of the negatives were made with a power of about 1,200 diameters; but as paper prints of the 19th band, with this power, are so indistinct as to be practically valueless, he has added one of the 19th band from a negative taken with about 1,800 diameters, one of the 15th, for comparison, taken at the same distance, with the same cover correction; and lastly, an enlargement of the 19th band picture, which he hoped would serve to illustrate the subject of spurious lines on the edges of the band, as well as to display the fine resolution of the real lines obtained by the objective employed. "It will, of course," he says, "be expected that I should say something of the comparative merits of this new objective of Mr. Tolles, and the immersion front of the Powell and Lealand $\frac{1}{16}$th, which has done so much good work for me since 1869. Certainly, I must give the new Tolles' objective the preference on the plate, and on *Amphipleura pellucida*, both by sun and lamplight. On other tests, I have not as yet done enough work to particularize."—*Monthly Microscopical Journal* (Nov.)

The "Miniature Method" of Estimating Objectives.—This mode has been well described by Dr. Pigott at the last meeting of the Royal Microscopical Society. The method which he calls the miniature method is as follows:—Place the object-glass in the position of a condenser. At exactly ten inches from the stage, adjust a scale of inches and tenths. Bring the image of the scale upon ground-glass slide, with its ground surface downwards. The ground-glass now shows a miniature of the scale. Now replace it by a micrometer slide, and viewing it *with a low power*, readjust the condensing object-glass, so as to bring the image of the scale into a focus accurately coincident with the divisions of the stage micrometer. The actual size of the miniature scale can be read off upon the stage micrometer, which immediately gives the amount of diminution, and therefore of the enlargement.

Microscopical Papers of the Quarter.—The following is a list of all the papers on microscopic matters which have appeared in the "Monthly Microscopical Journal" during the past three months, October, November, and December:—"On Bog Mosses." By R. Braithwaite, M.D., F.L.S. "Reply to 'Further Remarks on Tolles' $\frac{1}{5}$th and Powell and Lealand's Immersion $\frac{1}{16}$th.'" By Dr. J. J. Woodward, U.S. Army. "On the History, Histological Structure and Affinities of *Nematophycus Logani*, Carr. (*Prototaxites Logani*, Dawson), an Alga of Devonian Age." By Wm. Carruthers, F.R.S., &c. "On the Active Part of the Nerve Fibre, and on the Probable Nature of the Nerve Current." By Lionel S. Beale, Fellow of the Royal Society, and of the Royal College of Physicians, Physician to King's College Hospital. "On the Regeneration Hypothesis." By Dr. Louis Elsberg, of New York. "On the Use of Monochromatic Sunlight, as an aid to High-power Definition." By Dr. J. J. Woodward, U. S. Army. "One of our Common Monads." By Professor Albert H. Tuttle. "Is Pedalion a Rotifer?" By C. T. Hudson, LL.D. "On the Structure and Development of the Crow's Skull." By W. K. Parker, F.R.S. "Remarks on the Resolution of the Nineteenth Band of Nobert's Plate, by certain Objectives, especially by a new Tolles' Immersion $\frac{1}{13}$th." By Dr. J. J. Woodward, U. S. Army. "Aperture of Object-glasses." By F. H. Wenham. "Description of the Plates Illustrating Mr. W. K. Parker's Paper on the Development of the Crow's Skull." "Proposal for a Standard of Comparison of the Magnifying Powers of Compound Microscopes." By J. E. Ingpen, Esq. "On the Structure of the Valves of *Eupodiscus Argus* and *Isthmia Enervis*, showing that their Silicious Deposit conforms to the General Plan of Deposition in Simpler Forms." By Henry J. Slack, F.G.S., Sec. R.M.S. "Notes on the Development of the Nervous System of the Annulosa." By B. T. Lowne, M.R.C.S., F.L.S., Lecturer on Physiology at Middlesex Hospital Medical School. "Notes on New Acarelli." By J. G. Tatem. "On a Proposed Standard Micrometer Eye-piece, or Eidometer; and on a Uniform and Easily Applied Method of Naming Microscopic Objectives." By George Findley. "On a Method of Ascertaining Magnifying Power and Minute Magnitudes by Miniatures. By Dr. Royston-Pigott, M.A., M.D. Cantab., M.R.C.P., F.C.P.S., F.R.A.S., M.R.I., F.R.M.S., late Fellow of St. Peter's College, Cambridge. "On a Method of Estimating the Optical and Actual Thickness of Microscopic Covering Glass." By G. W Royston-Pigott, M.A., &c.

PHYSICS.

Passage of Heat-rays through Inclined Diathermanous Plates.—This is the title of a valuable physical paper, by Professor Knoblauch, in a late number of "Poggendorff's Annalen." It is, however, abstracted in the "Chemical

News," December 6, 1872. We may mention that the first part of this paper treats cf the influence of polarisation on the phenomenon; the second, that of the nature of the plate as regards absorption.

A New Economic Galvanic Pile.—This, which is the invention of M. Gaiffe, is described in "Silliman's Journal of Science," November. He says, the "high price of galvanic piles and the difficulty of procuring them, being often an obstacle to the applications which might be made of them, I essayed the possibility of devising an apparatus that one could make anywhere without the aid of the professional workman, with substantives of little value, widely spread in commerce, and possessing the essential quality of constancy in the effects. The pair which, after some trials, I have adopted, resembles Callaud's in its form, used some years since on telegraphic lines; but its elements are different. It consists of a vessel into which dip two rods—one of lead the other of zinc. The leaden one descends to the bottom; the zinc is one-half shorter. The bottom of the vessel is coated with red oxide of lead (minium), and the exciting liquid is water containing 10 per cent. of chlorhydrate of ammonia. The electromotive force of this pile is about one-third of that of a Bunsen's pair; its internal resistance is slight, and varies little; the chloride of zinc formed does not sensibly alter the conductivity of the exciting liquid; its constancy is great; finally, the expense is almost nothing when the circuit is open."

A New Pocket Spectroscope, for which many advantages are claimed, is stated to have been invented by M. Hoffmann. It seems to be a very convenient form of spectroscope, that can be carried in the waistcoat pocket, and is yet capable of really wonderful effects, considering its diminutive size, producing a large and brilliant spectrum, the violet rays of which extend far beyond the line G. It has a lens of rock crystal, with perfectly flat parallel faces at each end to keep out all particles of dust, &c. The organ of dispersion and analysis is a compound prismoid formed of three alternating prisms, one, of the most powerful dispersive flint glass that can be procured, between two reversed prisms of crown, the angles being specially and skilfully arranged. The combination is completed by an ordinary compound doublet lens, of suitable focal length.

A House Fire caused by Electrical Apparatus.—It is stated that a fire recently broke out in the flooring of one of the offices of the Western Union Telegraph Company in New York, which was found to have originated in a cable of cotton covered wire saturated with paraffin, through which the lines entered the office beneath the floor. From some cause, probably lightning, a connection had been formed between two through wires attached to large main batteries at the general office, and which were connected with opposite poles to the ground. Two large batteries were thus connected and thrown into short circuit, developing an intense heat and setting fire to the inflammable paraffin covering of the wire. If this singular occurrence had happened after the closing of the office at night, it might have resulted in the destruction of the building, and the cause of the fire would have remained a mystery. Of course an accident of this kind could hardly have been foreseen, but it serves to point out the necessity of caution in running wires under the peculiar conditions described.

A Novel and Peculiar mode of Telegraphing, according to a patent recently taken out in America, is described in the "Scientific American" for November. The inventors provide a thin and narrow conducting tape or strip of metal, on which they emboss the message in the Morse characters, and this strip they draw through a transmitting instrument, which is so arranged that a metallic pen, or *stylus*, which is in communication with one pole of the battery, will only touch the upper surface of the characters, as the strip passes along through the machine. The under surface of the strip or tape is in communication with the other pole of the battery; consequently whenever the *stylus* comes in contact with an embossed character or signal, the electrical circuit is closed and a signal, corresponding to the embossed signal, is transmitted over the line wire, to the receiving instrument at the opposite end. The receiving instrument may be made on the plan of the Morse instrument, and is intended to be so arranged that it will indent or emboss the signals, as fast as received, upon a metallic strip like that used in first sending the message. Several advantages attend this method of telegraphing and recording. The transmission of messages once formed can be much more rapidly effected than heretofore.

Measuring Temperatures by Electricity.—The apparatus for this purpose and the method of using it are described very fully in the "Chemical News" for October 4, and following numbers, by Dr. C. W. Siemens, F.R.S. The paper is very long, and too technical for a brief abstract.

Meteorites in Vienna.—The "Academy," a journal which unfortunately we rarely see, says that Professor Tschermak has published a new catalogue of the meteorites in the Vienna collection. At the date of issue (October 1, 1872) the mineralogical museum contained specimens representing 182 falls of meteoric stones, and 103 falls of meteoric iron. Letters appended to the name of each aërolite in the list indicate its position in a classification which has been based chiefly on the constituent minerals, certain distinctive physical characters of these minerals also being used in arranging them in subdivisions.

The Disaggregation of Metallic Tin.—In the "Revue hebdomedaire de Chimie" Dr. Oudemans states that a quantity of Banca tin was sent last winter rail from Rotterdam to Moscow; on its arrival the metal was all converted into a powder, which, on being submitted to heat (somewhat above the fusion-point of the metal), did not become molten and re-converted to its pristine state, owing to the formation of a large quantity of oxide. Analysis proved the powder to be pure tin containing only 0.3 per cent. of foreign metals (lead and iron). The author is of opinion that the blocks of tin were converted into powder by the combined action of cold and vibration during the journey by rail.—*Chemical News.*

The Spectrum of the Aurora.—A note appears in "Silliman's American Journal" (November) written by Lieutenant E. L. Holden, in which he says, "I have this evening succeeded in observing the spectrum of a very fine aurora, which appeared about 7 P.M., and lasted perhaps twenty minutes. It first appeared as a rosy cloud about 15° wide, and perhaps 30° high, bearing N. 30° W. by compass. Afterward it spread to the zenith, and was principally in the shape of a band, of (say) 15° wide extending from the N.W. to the E. No pulsations of any magnitude were evident, but a radiated structure was manifest. The spectroscope (pocket, by Hawkins and Wales) was first turned on the full moon, and an idea of the length of the spectrum obtained; then with a wide slit it was turned on the aurora, and the following sketch made, which was *carefully verified*, so that it represents exactly what I saw. The violet (extreme) rays seemed cut off; and I saw 1st, a broad and bright *red* band; 2nd, a black space equal in width to it; 3rd, a green and bright band nearly as wide; then a faint spectrum of diffused light, and a bright line in the blue; then a bright line more refrangible, but whose colour could not be definitely *seen*. I then opened Angström's "Spectre Normal," and saw that he gave the auroral line as in the yellow. I observed this green line again, and cannot persuade myself that it was yellow. The black space I am *sure* of; and it was also seen plainly by an inexperienced person, into whose hands I put the instrument. The slit was then narrowed and turned on the moon, and adjusted to give the Fraunhofer lines most clearly. The aurora by this time was fainter, and I can only be sure of a bright line (green), with a suspicion of my former blue line. Opening the slit again, the red band of the diffused light spectrum was *close* against the green bright line. The aurora then faded. I mention this black space, as it is not what I expected to see from my reading of Angström and Winlock.

The Physics of a Fog.—At the meeting of the Manchester Philosophical Society October 29, 1872, Dr. R. Angus Smith, F.R.S., described a remarkable fog which he saw in Iceland. It appeared to rise from a small lake and from the sea at about the same time, when it rolled from both places, and the two streams met in the town of Reykjavik. It had the appearance of dust, and was called dust by some persons there at first sight. This arose from the great size of the particles of which it was composed. They were believed to be from $\frac{1}{400}$ to $\frac{1}{300}$ of an inch in diameter. They did not show any signs of being vesicular, but through a small magnifier looked like transparent concrete globules of water. They were continually tending downwards, and their place was supplied by others that rolled over.

Currents of Electricity in Plants.—Some curious experiments have been recently made on this subject by Herr Dr. Ranke, who has published his results at considerable length, in the "Sitzungsbericht" of the Bavarian Academy. Among other remarkable facts noticed by the author, was the fact that, as in the electricity of animals, the electromotive action was observed where the fibres did not lie parallel to the longitudinal axis. The pieces experimented with, then, were cylindrical pieces from the petioles of the Rheum undulatum, their longitudinal axis corresponding with the axis of the petiole, and they were terminated by two cross sections perpendicular to this axis. They were two to three c.m. in length, and 0·5 to 1·5 c.m. diameter of section. The apparatus for measuring the currents was similar to that used by Du Bois Reymond in his experiments. If a piece of the kind described was taken, and one electrode applied to the cross section, the other to any point of the uncut epidermis, the false current appeared, the cross section being negative to the other surface. If now the outer surface of the piece was removed by cutting parallel to the axis, and the electrodes were applied, one to the cross section, the other to the surface laid bare as described, there was in every case a current observed, the direction of which was from the surface of cross section to the other (through the wire); hence the reverse of the false current, and of the currents in muscles and nerves. This is the true plant current, the expression of the real electricity of plants. Dr. Ranke styles it the strong current, using in this and in other cases a terminology corresponding to that of Du Bois Reymond. By a further cutting of the piece, either perpendicular or parallel to the axis, the current at first sometimes increases, but it gradually becomes weaker as the process is continued.—See also *Chemical News*, Nov. 29, 1872.

ZOOLOGY.

A young Hippopotamus born in London.—On November 5, 1872, at seven A.M., the female hippopotamus gave birth to a young one, which, in honour of the day, has been called "Guy Fawkes." Guy has since got on very well, owing to the great care which has been taken of him. In fact it reflects great credit on both Dr. Sclater and Mr. Bartlett; and we trust that the fellows will show the secretary and his "sub." that they feel so.

The Animals of the Mammoth Cave, America.—Some time since we gave an account of Dr. Packard's researches in this remarkable cavern. We now beg to lay before our readers some further remarks, which were made by Professor Silliman some time ago, and which are quoted in the "American Naturalist," September, 1872. Of the fish there are two species, one of which has been described by Dr. Wyman, in the "American Journal of Science," and which is entirely eyeless; some ten or twelve specimens of the species were obtained. The second species of fish is not colourless like the first, and it has external eyes, which however are found to be quite blind. The craw-fish or small crustacea inhabiting the rivers with the fish are also eyeless and uncoloured; but the larger-eyed and coloured craw-fish, which are abundant without the cave, are also common at some seasons in the subterranean rivers, and so also it is said the fish of Green river are to be found in times of flood in the rivers of the cave. Among the collections are some of the larger-eyed craw-fish which were caught in the cave. The only mammal, except the bats, observed in the cave, is a rat which is very abundant, judging from the tracks which they make; but so shy and secluded in their habits that they are seldom seen. We caught two of them, and fortunately male and female. The chief points of difference from the common rat in external characters are in the colour, which is blueish, the feet and belly and throat white, the coat which is of soft *fur*, and the tail also thinly furred; while the common or Norway rat is grey or brown, and covered with rough hair. The cave-rat is possessed of dark black eyes, of the size of a rabbit's eye, and entirely without iris; the feelers also are uncommonly long. We have satisfied ourselves that he is entirely blind when first caught, although his eyes are so large and lustrous. By keeping them, however, in captivity and diffuse light, they gradually appeared to attain some power of vision. They feed on apples and bread, but will not at present touch animal food. There is no evidence that the cave-rats ever visit the upper air, and there was no one who could tell me whether they were or were not found there by the persons who first entered this place in 1802. Bats are numerous in the avenues within a mile or two of the mouth of the cave, and Mr. Mansell thinks he has secured at least two species.

The Species of Cottus Grœnlandicus.—Dr. Gill has lately communicated to the Academy of the Natural Sciences of Philadelphia a paper of some importance on the apparently different forms of the species. Descriptions in several works have been based on only one of these forms, but in Günther's "Catalogue of the Acanthopterygian Fishes" (II. p. 161), under the general term *Cottus Grœnlandicus*, the two forms are mentioned, one being, "Var. *α*. Sides of the belly with large white spots;" the other, "Var. *β*. Sides irregularly marbled;" each was represented in the British Museum by four specimens. No suspicion of any sexual relation of those forms was expressed. The universal occurrence of these two forms together and in approximately equal numbers led Dr. Gill to suspect that they really represented sexual conditions of the same species. Dissection confirmed the suspicion, and it was found that all individuals with white spots on the abdomen were males, and all without females.

The Fertilization of the Yucca Plant.—Professor C. V. Riley, of St. Louis, U.S., has lately discovered that the fertilization in this plant is performed by a small white moth which he calls *pronuba Yuccasella*, and which forms the type of a new genus. It is most anomalous from the fact that the female only has the basal joint of the maxillary palpus wonderfully modified into a long prehensile spined tentacle. With this tentacle she collects the pollen and thrusts it into the stigmatic tube, and after having thus fertilized the flowers she consigns a few eggs to the young fruit, the seeds of which her larvæ feed upon. The Yucca is the only entomophilous plant known which absolutely depends for fertilization on a single species of insect, and that insect is remarkably modified for the purpose. The plant and its fructifier are inseparable under natural conditions, and the latter occurs throughout the native home of the former. In the more northern portions of the United States, and in Europe, where our Yuccas have been introduced and are cultivated for their showy blossoms, the insect does not exist, and consequently the Yuccas never produce seed there. The larva of the *pronuba* eats through the Yucca capsule in which it fed, enters the ground and hibernates there in an oval silken cocoon. In this stage the insect may be sent by mail to this country, and our English botanists may, by introducing it, soon have the American Yucca produce seed without any personal effort.

The Thread Hilaria Anhinga Worm in Brain of Snake Bird.—Mr. J. Wyman states that during last winter he had the opportunity of examining ten of these birds, in addition to those of which he speaks in a report to the Boston Society of Natural History in 1868. He says that the proportion of the infected ones was less than in the previous examinations, no worms being found in four. Two of these were not mature birds, but of the age of the other two he has no record. Of the six in which worms were found four had both male and female Filariæ, while two had only females, viz. one had one and the other three In the instances where both sexes were present, the eggs were found, as before, in various stages of development, hile in the others, where females only existed, the oviducts were full of eggs and in the same numbers as in the others, but there were no signs of impregnation and consequently no developmental changes. From these facts it seems almost certain that impregnation takes place in the head, and, unless both sexes are present there, the brood fails. It is also probable, on the supposition that these worms are migratory, that it is in the head of the Anhinga the sexual organs are developed, the young arriving there in an immature state.

The Development of the Nervous System in the Annulosa.—A very valuable paper on this subject appears from the pen of Mr. B. T. Lowne (of Middlesex Hospital), in the "Monthly Microscopical Journal" (December, 1872). Before passing in review the various facts and arguments which he advances, he gives a brief account of what Dr. Metschnikoff has done. According to the observations of that author, the first trace of the embryo scorpion is a longitudinal groove in the blastoderm: this groove afterwards disappears for a time, but subsequently becomes visible again as a deep groove, on either side of which the nerve ganglia of the ventral chain appear as thickenings of the external layer of the blastoderm. Nerve fibres are next seen penetrating the median layer, or mesoblast. The mesoblast splits, as in vertebrates, to form the body cavity, its inner layer becoming incorporated with the inner or visceral layer to form the alimentary canal. In connection with these observations, the remarkable internal skin growths which support the principal nerve centres of insects and crustaceans are of the highest significance, as it is quite clear that they are the highly-developed remains of the primitive fold in which the nervous system is formed. One of the most striking circumstances in the development of the nervous system is the bifurcation of the neural groove and chain at its anterior or cephalic end, so that it embraces the mouth and pharynx in a kind of fork, the anterior extremity of which gives origin to the great preœsophageal or prestoma ganglia.

Liquid Emitted by the Larva of a Species of Cimbex.—In the "Archives Neerlandaises des Sciences," November 4, 1872, M. A. J. Van Rossum, in the beginning of a paper on the above, communicates some entomological particulars relating to the larvæ of the *Tenthredinæ*, genus *Cimbex*, which, provided with small lateral apertures, emit through these, with comparatively great force, a coloured fluid to protect themselves from the attacks of ichneumons, birds, &c. This fluid, collected by the author from the living larvæ, has been chemically investigated, and found, while exhibiting a distinctly alkaline reaction, to be mainly a protein or albumenoid compound, which behaves with reagents very much like white of egg. As regards the nature of the colouring matter, it is probably chlorophyll, or some modification thereof. The liquid experimented with was that from the larvæ of *Cimbex connata* and *Cimbex sylvarum*. The author thinks that the fluid acts as a means of defence more by reason of its viscosity than by reason of its weak alkalinity.

The Death of M. Pouchet.—The "Evening Standard" of Saturday, December 21, 1872, announces the death, at Rouen, of Dr. Pouchet, aged 72, after a severe illness. He was the author of numerous scientific works. His "Théorie de l'Ovulation Spontanée" obtained in 1845 the great prize of experimental physiology, viz. 10,000f., awarded by the Academy of Sciences. He had lived just long enough to complete an important treatise on birds, which had occupied him several years.

The Voyage of the Challenger.—Government has just fitted out a ship for exploration, and attached to her distinguished naturalist and other observers, some of whom are from Munich and other parts of Germany. She will cruise nearly around the world, and is to be out for nearly three and a half years. Doubtless her discoveries will be vast and proportional to the extent of preparation which has been made. She left Portsmouth in charge of Captain Nares at 11·30 on Saturday morning, December 21, 1872. As the weather was bad, she was expected to remain for a few days in Yarmouth Roads.

Dr. Dohrn's Aquarium at Naples.—A writer, signing himself E. R. L., whom we believe to be Mr. E. Ray Lankester, has sent an account of this splendid Aquarium to "Science Gossip" (October). He says, after giving a most interesting description of the whole institution, that it is more than doubtful whether all these rich and expensive conveniences can be furnished to zoological visitors without any pecuniary compensation; but he hears that Dr. Dohrn has drawn up a plan which will enable even naturalists of limited means to enjoy the advantages of the station. He proposes to offer one or more tables to various Governments and scientific societies for a fixed annual sum. These tables, and all the scientific resources of the station, will at once be placed at the disposal of any naturalist who brings a certificate from the Government, university, or scientific body to which the table has been let. This plan, among its many other advantages, seems to be a successful attempt to solve the difficult question as to how it is possible to unite a complete self-administration on the part of scientific bodies with the reception of pecuniary assistance from their Governments. Dr. Dohrn speaks in the most grateful manner of the assistance rendered him by the German authorities in Italy, especially by Mr. Stolte, the consul-general at Naples, while at the same time he warmly acknowledges the interest in his undertaking displayed by the Government of Italy, more particularly Signor Correnti and Signor Sella, the late and the present Ministers of Public Instruction.

Can the Arms of Rhynchonella be protruded.—Mr. Edward Morse states ("Silliman's American Journal," October), that he has lately had the opportunity of studying *Rhynchonella alive*, to note the ciliary action in the oviducts driving currents outward, and to establish the correctness of Owen's supposition that the arms of *Rhynchonella* can be protruded. A jar of specimens dredged by Dr. P. P. Carpenter, who had accompanied him from Montreal, was left standing undisturbed for twenty-four hours when one of the specimens protruded its arms their entire length from the partially opened shells. He poured the sea water carefully out, and suddenly poured in the strongest alcohol, and the specimen is now preserved in this exerted position. In the forthcoming memoir of the Boston Society of Natural History all the details of these examinations will be given.

The Physometer Applied to the Swim-bladder of Fishes.—M. P. Harting gives an elaborate paper in the "Archives Neerlandaises des Sciences Exactes et Naturelles," Nov. 4, 1872, illustrated by several engravings which not only detail the description of the physometer invented by the author, but also the history of the various opinions held by scientific men on the functions of the swimming-bladder of the fishes, and further, a series of minute experiments to illustrate the action of this organ, and of exhibiting to what applications the physometer may be employed.

Hybridism between Macacus nemestrinus, and M. cynomolgus.—At a late meeting of one of the American Academies Mr. Gentry called attention to what he regarded as a rare and remarkable case of hybridism, which occurred between *Macacus nemestrinus*, male, and *Macacus cynomolgus*, female. After exhibiting an alcoholic specimen of the young, and a stuffed specimen of the mother; which was clearly identified as *Macacus cynomolgus*, he detailed the leading characters of the two parents. He stated that the male differed from the female in being more robust and of greater dimensions, in the almost perfect smoothness of the face, which is of a pale flesh colour, while in the female it is black and invested with a close growth of short black hairs; in the absence of a crest upon the head of the male, which is a prevailing characteristic of the species (*M. nemestrinus*), and its presence in the female, which is a prominent feature of the species to which she belongs ; in colour; and, lastly, in the unequal development of the caudal appendage, which in the male is about seven inches in length, and densely clothed with long hairs, while in the female it is twice the length, and nearly naked for more than two-thirds of its extent.

Zoological Definition.—Dr. Hudson, in reading a paper on the question, whether *Pedalion* was a Rotifer, made the following interesting observations on the above subject:—" It is easy enough to define the typical form of a natural group of animals, or even to include in the definition forms that must be placed pretty near the central one; but in the ambitious search for a definition which shall include many families, as we get further away from the typical form, we find that one by one all the positive statements are disappearing from our definition, till at last we have nothing left but the mere shuck of a proposition, shelled of everything worth the stating. Take the definition of one of the zoological manuals:—' Rotifers are microscopic animals, contractile, with vibratile cilia at the anterior part of the body, which by their motion often resemble a wheel moving rapidly. Intestine distinct; terminated at one extremity by a mouth, at another by an anus; generation oviparous, sometimes viviparous.' Now there are Rotifers that have no ' vibratile cilia at the anterior part of their bodies,' others that have no intestines or anus, so that including these the above definition must shrink down into ' Rotifers are very small animals that lay eggs.' "—*Monthly Microscopical Journal, Nov.*, 1872.

Royal Institution.—The two Actonian Prizes of 105*l.* have been awarded by the Managers of the Royal Institution to the Rev. George Henslow and to B. Thomson Lowne, M.D., for Essays " On the Theory of the Evolution of Living Things."

Apes. and Half-Apes.

W. West & Co imp.

MAN AND APES.

By ST. GEORGE MIVART, F.R.S.

[PLATE XCV.]

The too frequent injustice of popular awards is a trite subject of remark. Christopher Columbus, with a hardihood now somewhat difficult to realize, sailed across an utterly unknown ocean to the discovery of a New World which nevertheless has not received its appellation from him, but from his imitator, Amerigo Vespucci.

As with the new geographical region so with the new force "galvanism." It received its name from Galvani, who called attention to it in 1789; but Swammerdamm had none the less discovered it more than a hundred and thirty years earlier.

Again, the doctrine of evolution as applied to organic life—the doctrine, that is, which teaches that the various new species of animals and plants have manifested themselves through a purely natural process of hereditary succession—is widely spoken of by the term "Darwinism." Yet this doctrine is far older than Mr. Darwin, and is held by many who deem that which is *truly* "Darwinism" (namely, a belief in the origin of species by natural selection) to be a crude and utterly untenable hypothesis.

We find yet another and parallel example of popular misapprehension in the opinion widely prevalent respecting one species of those animals—the apes—which most nearly resemble us in bodily structure.

The species referred to is the much-talked-of Gorilla, and the popular misapprehension concerning it is twofold; first as to its discovery, and secondly as to its nature.

The Gorilla is very generally supposed to have been first discovered and made known to science by M. de Chaillu, whereas, in truth, it was both discovered and described years before M. de Chaillu's name was heard of in connexion with it.

It was discovered by Dr. Thomas Savage, who, with the assistance of an American missionary, the Rev. Mr. Wilson, procured enough anatomical materials to enable Professor

Jeffries Wyman (in the United States) to describe* important parts of its anatomy.

Other specimens were soon afterwards procured, and were described in our own country by Professor Owen† more than twenty years ago.

The misconception as to the discovery of the Gorilla, however, is but a trifling matter; that as to its nature and rank is of far greater importance.

The lively interest which was been awakened by recent assertions respecting what is called "the descent of man," manifests itself far and wide in the daily press—in popular caricatures—on the theatrical stage, and in the Houses of our own Legislature as in the French Assembly.

It is interesting also to note that whereas a few years ago the notion of the brute origin of man was vehemently and all but universally scouted, the public are now carried by a wave of sentiment in a diametrically opposite direction, and there is even a widely diffused sympathy with notions which but lately were found so unpalatable. *Then* there was not tolerance to listen to, far less to fairly appreciate, the arguments advanced by certain men of science in support of their views. *Now* there is as little disposition as ever to weigh evidence, but the tendency is to accept without examination and without criticism the statements of every advocate of the essential unity of man and beasts.

Concomitantly with this change of sentiment there has also arisen a popular belief in the semi-humanity of the Gorilla, or at least an impression that the Gorilla possesses a very special and exceptional affinity to man. This animal is now popularly supposed to be closely connected with that "missing link" which, as is asserted, once bridged over the gulf separating man from the apes. The Gorilla, if not the direct ancestor of man, is yet generally thought to be related with exceptional closeness to such direct ancestor, and so to constitute the one existing and visible bond between ourselves and the lower animals. Highest of apes—close ally of the Negro—the Gorilla is by some supposed to surpass and excel the humbler and commoner apes as man surpasses and excels the Gorilla.

It is proposed here, putting aside all prejudice, to investigate by the unimpassioned process of enumerating and weighing facts of structure, what is the teaching of nature as to the affinities of various apes to man. It is not, therefore, proposed to touch directly upon the question of the ape origin of man

* See "Boston Journal of Natural History," vol. iv. 1843–4, and vol. v. 847.

† See "Pro. Zool. Soc." 1851, and "Trans. Zool. Soc." vol. iv. and v.

considered in the totality of his nature, because that is a matter not to be settled without the intervention of the philosopher and the psychologist. The anatomist—as such, however wide and detailed may be his acquaintance with different animals—is necessarily incompetent to offer a valid opinion as to that question.

The matters to be here investigated concern physical science only—facts of zoology and of anatomy, together with the inferences which may be drawn from them respecting man's bodily structure. The questions, then, which are to occupy us are the following: 1. What is the real zoological position and nature of the Gorilla? 2. What are the degrees of resemblance to man which the various kinds of apes exhibit? 3. What is the bearing of these facts upon the doctrine of evolution (or derivation), as applied to man's body, including the question as to the direction which the line of genetic affinity seems to take in passing from man through the apes to lower animals?

Whatever existing species is most nearly related to that extinct root-form which, according to Mr. Darwin's hypothesis, was the immediate ancestor of man—must exhibit a greater number of structural characters like those of man than any other existing species. The ape, next in affinity, must show the next degree of resemblance, and so on.

If the Gorilla really possesses that exceptional affinity to man with which it is popularly credited, it must exhibit a cluster of structural approximations to man such as are not to be found in any other animal. If, again, there should be reason to think that any anatomical peculiarities have special hereditary significance (either from their not being related to habit, or from the organ in which they are found), then such peculiarities should exist in the Gorilla if it deserves the pre-eminence so commonly attributed to it.

In order to understand the first point to be considered (the Gorilla's zoological position), a few words must be said as to the classification of animals generally.

All the higher animals (from beasts to fishes) are separated off from lower animals (such as insects, worms, and shell-fish), and form by themselves a great group (or sub-kingdom) called VERTEBRATA.* The Vertebrata are divided into five classes:—1. MAMMALIA (beasts). 2. AVES (birds). 3. REPTILIA (reptiles). 4. BATRACHIA (frogs and efts). 5. PISCES (fishes).

Each of these classes is subdivided into a number of subordinate groups termed *orders*, and the class MAMMALIA may be divided into about twelve of such groups.

* So called because the animals contained in it always possess a spinal column or back-bone, which (except in a few fishes) is made up of a series of separate bony pieces, each of which is called a vertebra.

These are (beginning with the lowest): 1. *Monotremata* (Duck-billed Platypus and Echidna). 2. *Marsupialia* (pouched beasts). 3. *Edentata* (sloths, ant-eaters, &c.). 4. *Ungulata* (hoofed beasts). 5. *Proboscidea* (elephants). 6. *Sirenia* (Dugong and Manatee). 7. *Cetacea* (whales, porpoises). 8. *Carnivora* (flesh-eating beasts). 9. *Rodentia* (mice, squirrels, hares, &c.). 10. *Insectivora* (moles, hedgehogs, shrews, &c.). 11. *Cheiroptera* (bats). 12. *Primates.*

The order PRIMATES contains man (zoologically considered) and all the apes and Lemurs; and it is subdivided into two great groups or sub-orders. The first of these contains man and the creatures most like him (the apes), on which account it has been called *Anthropoidea.* The second sub-order contains the Lemurs proper and the animals most like them, on which account it has been called *Lemuroidea*, the creatures contained in it when spoken of being generally also termed "Half-Apes" or "*Lemuroids.*"

The animals contained in these two sub-orders are exceedingly different, respectively, in structure, and there can be no question but that the anatomical differences between man and the lowest apes are very much less than those which distinguish the lowest apes from the highest of the half-apes.

The *Anthropoidea* may conveniently be spoken of as man and apes, but structurally the group is divisible into three *families*,* the first of which (*Hominidæ*) contains man only (*Homo*).

The apes may be classed in two families (which, however, scarcely differ so much from each other as do the apes, as a whole, from man), which are as neatly distinguished by geographical distribution as by structural differences.

The first of these two ape families is termed *Simiadæ*, and is made up of the apes of the Old World. These are, in fact, almost confined to Africa and Southern Asia, the Rock of Gibraltar and Japan being the northern limits of the group.

The second ape family is called *Cebidæ*, and is exclusively confined to Tropical America.

The *Simiadæ* are again subdivided into three smaller groups or sub-families: 1. the *Simiinæ;* 2. *Semnopithecinæ;* and 3, *Cynopithecinæ.* The first of these sub-families contains the Gorilla, the Chimpanzee, the Orang, and the Gibbons—or long-armed apes. These creatures are the apes which, on the whole, are most like man. They are often therefore emphatically spoken of as

* Orders (or sub-orders) are always in zoology subdivided into smaller groups, each of which is termed a *family*, and each family is again subdivided into smaller and more subordinate groups termed *genera*. Each genera finally is made up of one, few, or many *species*, as the case may be.

the "anthropoid apes," and they are also (on account of the bony structure of their chest) termed the "latisternal" or "broad-breast-boned" apes.

The Gorilla and the Chimpanzee together constitute the genus *Troglodytes*. They are both inhabitants of the warmest parts of Western Africa. The Gorilla is much the larger and more bulky animal of the two, but both kinds are vegetarians as to diet, and arboreal in habit. That the Gorilla in external appearance is

Fig. 1.

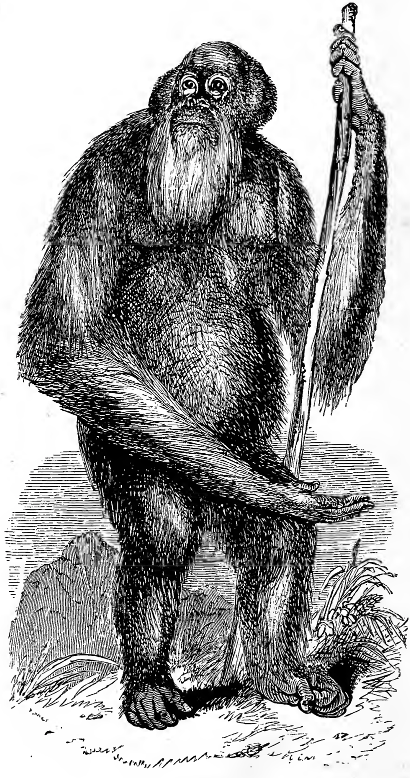
The Chimpanzee (*Troglodytes*).

not pre-eminently man-like may be seen by the plate herewith given (fig. 1), and a single visit to the British Museum will serve to convince any unprejudiced observer what a mere brute it is.

The Orang, which forms the genus *Simia*, is exclusively an inhabitant of Borneo and Sumatra, where it attains a considerable bulk, but not equal to that of the Gorilla. Slow, solitary, and peaceful in its habits, the Orang never voluntarily abandons the lowland forests, which supply it at once with shelter and with food.

The Gibbons (or long-armed apes) form the genus *Hylobates*, containing several distinct species, the largest and most interesting of which is called the Siamang.

Fig. 2.



The Orang (*Simia*).

In external appearance the Gibbons more nearly resemble the Orang than the African Troglodytes, on account of the length of the arms, which is even greater than in *Simia*. They are, however, much more active in their habits, though generally gentle in disposition. The power of voice possessed by some kinds is remarkable. The Gibbons, like the two preceding genera, have no vestige of a tail.

Fig. 3.

The Siamang Gibbon (*Hylobates*).

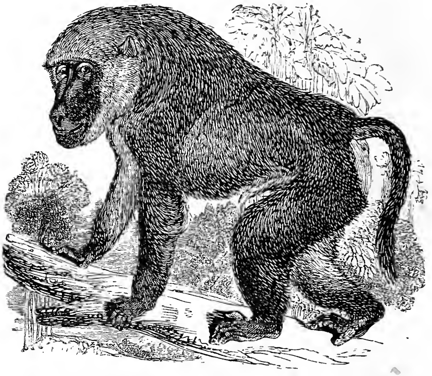
Fig. 4.

The Entellus Monkey (*Semnopithecus*).

The second sub-family embraces a number of large long-tailed species of monkeys, grouped into two genera. The first of these, *Semnopithecus*—of which the Entellus (or Sacred Monkey of the Hindoos) may serve as an example—is entirely confined to Southern Asia. The other genus, *Colobus* (remarkable for the absence of the thumb), is as exclusively African.

The third sub-family (*Cynopithecinæ*) contains three genera. The first of these, *Cercopithecus*, is made up of smaller, long-tailed African monkeys, some of which are very common in our menageries; as are also species of the second and Asiatic genus *Macacus*, in which the length of the tail is different in different kinds. The third genus, *Cynocephalus*, contains the great and brutal Baboons (such as the Mandrill and the Chacma), which

Fig. 5.



The Chacma Baboon (*Cynocephalus*).

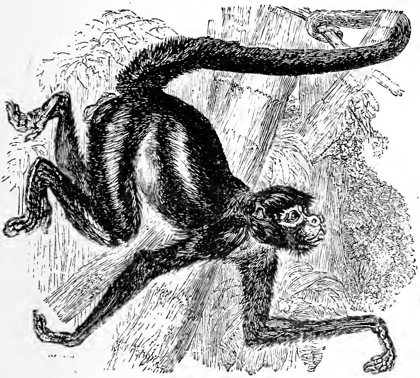
are entirely confined to Africa and that part of Asia which is zoologically African—namely, Arabia.

The second family of apes, the *Cebidæ*, or monkeys of the New World, need not be noticed here in much detail. Amongst them may be noted the Spider Monkeys, *Ateles*, with long prehensile tails, but as thumbless as the African kinds before noticed. The commonest American monkeys are the Sapajous (*Cebus*), which are those generally exhibited for their tricks by itinerant Italians. They have long tails curled at the end, but not capable of grasping with the power possessed by the tails of the Spider Monkeys.

The Howling Monkeys (*Mycetes*) are sluggish and apparently stupid animals. They have long and very prehensile tails; but, as their name implies, it is their power of voice which particularly distinguishes them.

Another group of monkeys, the *Sakis*, is interesting from peculiarities in the hairy clothing. The tail may be long or short, but is never prehensile. They form the genera *Pithecia and Brachyurus.*

Fig. 6.



A Spider Monkey (*Ateles*).

Fig. 7.

A bearded Saki (*Pithecia*).

The little Squirrel Monkey, (*Chrysothrix*) (Plate XCV. fig. 3), is a singularly attractive and beautiful little animal. Two allied genera are called respectively *Callithrix* and *Nyctipithecus.*

The last group of American monkeys comprises the delicate little Marmosets, or Ouistitis (*Hapale*), which differ notably from all the other apes, whether of the Old or New World; so that some authors have purposed to raise them to the rank of a distinct family. Passing now to the second sub-order of the Primates, *i.e.* to the Lemuroids, or Half-Apes, we find a geographical distribution of much interest.

The great bulk of the sub-order is exclusively confined to the Island of Madagascar, three genera only being found on the continent of Africa, and not elsewhere, and three others in South Eastern Asia only. In fact, the Lemuroids have a

Fig. 8.

A Marmoset (*Hapale*).

distribution on the earth's surface similar to that of the woolly-haired races of men.

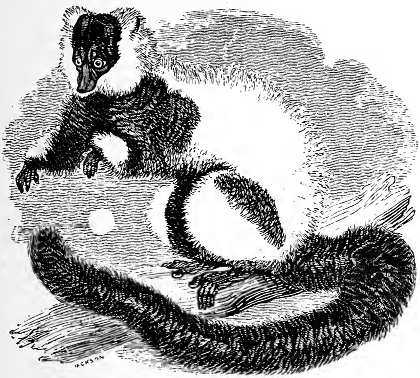
All the Half-Apes differ strikingly from the apes in external appearance, but there is much difference between the different kinds.

The typical Lemuroids, the true Lemurs (*Lemur*), are creatures with woolly fur, long tails, and pointed, fox-like muzzles. The allied genera, *Hapalemur*, *Cheirogaleus*, and *Lepilemur*, have snouts somewhat less elongated.

The genus *Indris* contains the largest forms of the sub-order. There is a short-tailed Indri, and there are long-tailed forms. All the Lemuroids above noticed are Madagascar forms.

There is a curious group of slow-paced, tailless, or short-tailed Lemuroids (*Nycticebinæ*), which contains two African and two Asiatic genera. The African genera are the Potto (Plate XCV. fig. 4) (*Perodicticus*), and the Angwántibo

Fig. 9.



The Macoco (*Lemur*).

Fig. 10.

The Short-tailed Indri (*Indris*).

(*Arctocebus*) (Plate XCV. fig. 5). The Asiatic genera are the Slender Lemur (*Loris*) and the Slow Lemur (*Nycticebus*).

Fig. 11.

The Slender Lemur (*Loris*).

Fig. 12.

The Maholi Galago (*Galago*).

A singular and beautiful genus, widely distributed over the continent of Africa, and containing many species, is called *Galago*. They have feet of very peculiar construction, are very active in their movements, and great leapers.

Another genus of Half-Apes is so exceptional as to form a family by itself. It is the Tarsier (*Tarsius*). These little animals inhabit the Islands of Celebes and Borneo, and have a foot of the Galago type, but still more exaggerated. (Plate XCV. fig. 6.)

The last genus of the sub-order, which also ranks as a family, is the Aye-Aye (*Cheiromys*). (Plate XCV. fig. 7). This very remarkable animal was discovered by Sonnerat in Madagascar, in 1780, and was never again seen till 1844, when a specimen was forwarded to Paris. It is now represented in our national collection by two stuffed specimens and by a skeleton; and there is also a skeleton in the Museum of the Royal College of Surgeons. The Tarsier and the Aye-Aye are the two animals which depart most widely from the general type of organization prevalent in the order Primates.

The groups of which this order consists may be tabulated as on p. 126.

Thus it becomes evident that the position of the Gorilla is in the African group, of the latisternal sub-family, of the Old World ape family, of the Anthropoid division of the order Primates. This is the answer to the first of the three questions proposed.

The second and more interesting question now follows: "What are the degrees of resemblance to man which the various kinds of apes exhibit?"

It may be well to begin with what is most manifest and external—the hair.

All the Apes and all the Half-Apes agree together, and differ from man in having the body almost entirely clothed with copious hair, and especially in never having the back naked.

The postero-inferior part of the body is indeed conspiciously naked, and the skin there thickened in the Baboons and long-tailed monkeys of the Old World. But the presence of these naked species (technically called ischial* callosities) can hardly be an approximation to the nakedness of man, since both in *Simia* and in *Troglodytes* they are wanting, while in *Hylobates* they are exceedingly small.

On the other hand, the *absence* of these dermal thickenings in the Orang, Chimpanzee and Gorilla, is no especial mark of affinity

* So called because they cover the lower part of that portion of the haunch-bone which is called the *ischium*.

SUB-ORDER I.—ANTHROPOIDEA.

Family I. HOMINIDÆ		Homo.
Family II.—SIMIADÆ . . . Sub-family	1. *Simiinæ*	Troglodytes. Simia. Hylobates.
	2. *Semnopithecinæ*	Semnopithecus. Colobus.
	3. *Cyncpithecinæ*	Cercopithecus. Macacus. Cynocephalus.
Family III.—CEBIDÆ . . . Sub-family	1. *Cebinæ*	Ateles. Cebus.
	2. *Mycitinæ*	Mycetes.
	3. *Pitheciinæ*	Pithecia Brachyurus.
	4. *Nyctipithecinæ*	Callithrix. Chrysothrix. Nyctipithecus.
	5. *Hapalinæ*	Hapale.

SUB-ORDER II.—LEMUROIDEA.

Family IV.—LEMURIDÆ . Sub-family	*Indrisinæ*	Indris.
	Lemurinæ	Lemur. Hapalemur. Lepilemur.
	Nycticebinæ	Nycticebus. Loris. Perodicticus. Arctocebus.
	Galagininæ	Cheirogaleus. Galago.
Family V.—TARSIIDÆ		Tarsius.
Family VI.—CHEIROMYIDÆ		Cheiromys.

to man, since they are equally absent in all the American apes, and in all the Lemuroids.

One of the most grotesque conceptions suggested by Mr. Darwin is that of the nakedness of man, and especially of woman, having been produced by the gradual extension over the body (through the persistent choice of more and more hairless spouses) of an incipient local nakedness like that now existing in certain apes.* No zoological facts known to the author afford the slightest basis for this bizarre hypothesis.

No single ape or Lemuroid has so exclusive and preponderate a development of hair on the head and face as exists in most men.

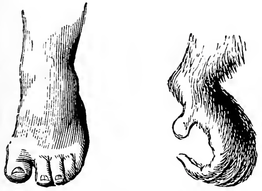
* See "Descent of Man," vol. ii. p. 377.

As to the head, long hair thereon is not a character found in the highest apes, but rather in the *Semnopitheci*, and in forms approaching the Baboons.

As to the face, a beard and copious whiskers are not unknown amongst apes. The male Orang has a beard, and certain *Cercopitheci* (*e.g.* the Diana Monkey) have long hair on the cheeks and chin. Nevertheless, it is not in the highest apes, nor even in the higher family, that we find a luxuriance in this respect like what we may often find in man. We must go for such luxuriance to the New World apes—to the Sakis (see fig. 7), which are certainly not the highest forms even of their own family, and which indeed show a certain resemblance (*e.g.* in their teeth) to the Lemuroid sub-order.

The opposed directions of the hair on the arm and forearm respectively (the apices converging to the elbow) is the same in most latisternal apes as in man. Nevertheless, in at least one such ape (*H. agilis*) the hair of the whole limb is directed uniformly towards the hand, as in most lower species. Yet we find it in some of the *Cebidæ* directed as in man.

Fig. 13.



Foot of Man and of the Orang.

Passing to the solid structures which the hair clothes, we come to one of the most characteristic peculiarities of the human body.

The whole of the Apes and the whole of the Half-Apes agree together, and differ from man in having the great toe, or (as it is called in anatomy) the hallux, so constructed as to be able to oppose the other toes (much as our thumb can oppose the fingers), instead of being parallel with the other toes, and exclusively adapted for supporting the body on the ground. The prehensile character of the hallux is fully maintained even in those forms which, like the baboons, are terrestrial rather than arboreal in their habits, and are quite quadrupedal in their mode of progression.

It was this circumstance that led Cuvier to give to that separate order in which he places man alone, the name

Bimana, while on the order of Apes and Lemurs he imposed the term *Quadrumana*.

The dispute as to whether the latter term is or is not applicable to the apes seems rather a dispute about words than about material objects.

If we accept, with Professor Owen, as the definition of the word "foot," "*an extremity in which the hallux forms the fulcrum in standing or walking*," then man alone has a pair of feet. But, anatomically, the foot of apes agrees far more with the foot of man than with his hand, and similarly the ape's hand resembles man's hand and differs from his foot. Even estimated physiologically, or according to use, the hand throughout the whole order remains the prehensile organ *par excellence*, while the predominant function of the foot, however prehensile it be, is constantly locomotive. Therefore the term *Quadrumana* is apt to be misleading, since anatomically as well as physiologically both apes and man have *two hands and a pair of feet.**

The thumb, in anatomy the pollex, shows no similar uniformity of condition. In the most man-like apes it is relatively much smaller than in man, and the Lemurs are more man-like than the apes in the development of this member.

As we have seen, the latisternal apes are, like man, devoid of a tail. A similar resemblance is, however, presented by much lower forms, as, *e.g.*, by the ape of Gibraltar, and even in the Slender Lemur (*Loris*).

As we descend from man, when we first encounter a tail at all, we find it at almost its maximum of development in the whole order, for such is its condition in the *Semnopithecinæ*. Short tails exist in the most varied forms from *Macacus* to *Arctocebus*; but a prehensile tail is found nowhere in the order *Primates*, save amongst the genera of the American continent.

The commoner monkeys of the Old World (the *Cynopithecinæ*) have the cheeks peculiarly distensible, serving as pockets. In so far as the higher apes resemble man in the absence of this condition, they share that resemblance with all the lower forms of the order, since no cheek-pouches exist in the *Cebidæ* or in any of the *Lemuroidea*.

Passing now to internal anatomy, it will be well to dwell with care on the characters presented by the skeleton. Without a patient consideration of many details, it will be impossible to arrive at any sure result as to the question under consideration, or as to that which is to follow. Hasty conclusions, derived from a few characters only, will be certain to mislead us in any investigation of the teaching of nature with respect to the affinities of organised beings.

* See "Phil. Trans." 1867, p. 362.

The back-bone of man exhibits a beautiful sigmoid curvature, and is strongly convex in front in the lumbar region. Now it is not in the latisternal apes, but in some of the Baboons, that we meet with the nearest resemblance to man in this particular.

The lumbar region of the back-bone exhibits in most apes certain bony prominences,* which are rudimentary in man. The three highest genera resemble man in this respect, but the same resemblance is found in the Slender Lemur (*Loris*) and in closely allied forms.

The sacrum † of man is also nearly as much resembled (size not being considered) by that of *Loris* as by those of the highest apes. Again, in the angle which this bone forms with the lumbar part of the back-bone, man is most resembled, not by the highest apes, but by some Baboons. The same may be said respecting the concavity of the anterior surface of the sacrum; and of the three highest genera it is not the Gorilla and Chimpanzee which resemble man most nearly, but the Orang.

The hinder aspect of the back-bone exhibits a number of prominences termed spinous processes. These, in most apes, are differently directed towards the two ends of the series, so that they tend to converge towards a single point in the back. They do *not* do so in man and the latisternal apes, but neither do they in *Loris* and its allies (*Nycticebinæ*). In that the breast-bone, or sternum, is relatively short, and composed but of two bones, man agrees not so much with *Troglodytes* and *Simia* as with the Gibbons, and in the Siamang the sternum is even shorter and broader relatively than in man.

The Orang exhibits a singular peculiarity in that the breast-bone long remains made up of ossifications arranged in pairs, side by side, successively. (Fig. 17.)

The normal number of ribs in the Gorilla and Chimpanzee is thirteen pairs; in the Orang and some Gibbons it is twelve, as in man.

In the Orang and Gibbons there are, as in man, five lumbar vertebræ; in the Gorilla and Chimpanzee there are but four, and sometimes only three.

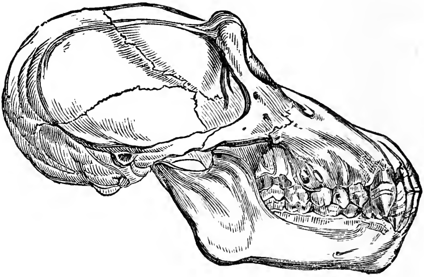
The bones of the neck (cervical vertebræ) in man have but short spinous processes, while in the Orang and Gorilla these are enormously elongated. It has been proposed to account for this latter condition by the great weight of the head and jaws in these apes. The little group *Nycticebinæ*, however, presents

* Termed "Metapophyses" and "Anapophyses." For details as to these see "Pro. Zool. Soc." 1854, pp. 571-576.

† The "sacrum" is the large and solid piece of the back-bone to which the haunch-bones are attached.

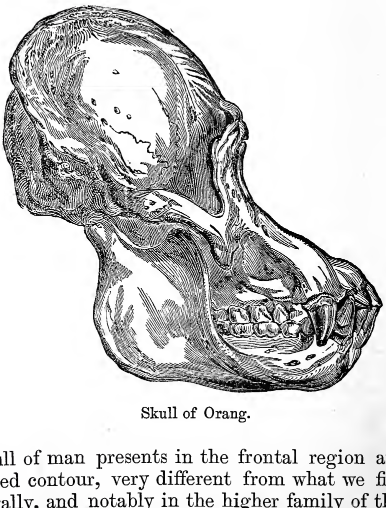
us with a parallel diversity, though the head and jaws are about equally developed in all of them. These spines are quite short in *Loris* and *Nycticebus*, while they are prodigiously long in *Perodicticus* and *Arctocebus*.

Fig. 14.



Skull of Chimpanzee.

Fig. 15.



Skull of Orang.

The skull of man presents in the frontal region an elevated and rounded contour, very different from what we find in the apes generally, and notably in the higher family of them. It is in the American forms—especially in *Callithrix* and *Pithecia*—

that we find the greatest resemblance to man in this respect. It is in the Gorilla that great bony crests (for muscular attachment), like those of a carnivorous animal, attain their maximum of development. (Plate XCV. fig. 2 *s.*)

The relation of the face to the brain-case is shown by what is called the cranio-facial angle. This angle is estimated by comparing the direction of a line drawn parallel to the base of the skull with another line drawn from the front end of that base to the middle of the lower margin of the upper jaw. Stress has been laid on the difference existing between man and the Gorilla as to this angle. But it does not appear to be a really important character, since much difference exists with regard to this character in forms admitted by all to be closely related, such as the two Baboons—the Mandrill and the Chacma.

There is one small cranial character, however, in which the Gorilla approaches man more nearly than does any other Primate. This is the existence of a certain ridge (termed *vaginal*) on the under surface of the bone which encloses the internal ear. Another process of the same bone (called *styloid*) is, however, developed more in accordance with man in one of the Baboons than in any other Primate, while of the latisternal apes it is not the Gorilla, but the Orang, which in this matter is the most human.

The Gibbons are more human than the Orang, Chimpanzee, or Gorilla, as to the preponderance of the brain-case of the skull over the bony face. But the smaller American monkeys exceed the Gibbons in this respect, while the Squirrel Monkey exceeds even man himself.

A striking feature in the human skull is the prominence of the inferior margin of the lower jaw in front; *i.e.* the presence of a "chin." The feature is quite wanting in the Gorilla, as also in the Orang and Chimpanzee. A more or less developed "chin," however, exists in the Siamang, although no other species of Gibbons, and indeed no other ape or Lemuroid, shows us a similar condition.

Another marked character of man's skull is the projection and transverse convexity of the bones of the nose. This convexity is quite absent in the Chimpanzee and in most Gibbons. In the Orang these bones are exceedingly small and flat, often even uniting into one bone, or with the adjoining jawbones, if indeed they are not altogether absent.

In the Gorilla, on the other hand, they are slightly convex transversely at their upper part, so that here we seem to have evidence of the predominant affinity of the Gorilla to man. Further examination, however, shows that this character can have no such meaning, since a still more decided convexity is found to exist in some *Semnopitheci*, and even in the lowest

Baboons. Moreover, in these Baboons the nasal bones only become convex towards maturity, being at first flat. This character therefore can hardly have been at one time a general one, now preserved only in a few scattered forms.

The relative length of the arm and hand, when compared with that of the spine, is very different in all the latisternal apes from what exists in man. In this respect the Gorilla is less like man than is the Chimpanzee, though both are less unlike him than are the Orang and Gibbons. In the Gibbons the arm and hand attain about twice the relative length attained in us.

The analogous proportions of the leg and foot show a near agreement between the Orang and man. While the Gibbons and Spider Monkeys have relatively longer legs than we have, the Gorilla and Chimpanzee have much shorter ones. If the foot be excluded from the calculation, then the Orang differs the most from man, while the Gibbons exhibit a remarkable conformity to him.

In shape the blade-bone of the Gorilla is singularly like that of man, but that of its congener the Chimpanzee differs more from man than does that of the Orang.

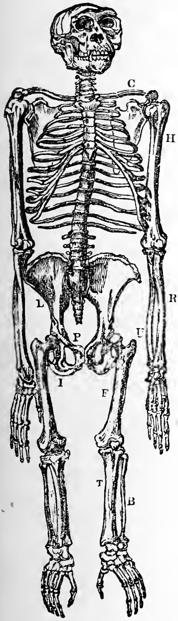
The collar-bone, in both the Chimpanzee and Gorilla, is much shorter when compared with the blade-bone than it is in man. In the Gibbons, however, it is still larger than in him; while in the Orang its relative length is much as in man.

Both the bone of the upper arm (*humerus*) and the bones of the fore-arm (*radius* and *ulna*) in the Chimpanzee, when compared in length with the spine, more resemble the same bones in man than do those of any other latisternal ape. In the length of the hand, so estimated, the Gorilla is the most human, and it is so in the relative length of the fore-arm bones to the humerus.

Much has been said of late as to a certain perforation (*supra condyloid foramen*) which has been found in a certain number of ancient human skeletons. Some have supposed this circumstance to indicate a transition in human structure from that of the higher apes. In fact, however, it is not in the Gorilla, not in any of the latisternal apes, not even in any of the apes of the Old World, that we find such a perforation developed. Such a condition is not met with till we descend to the lower *Cebidæ* (from *Cebus* downwards), though with the exception of *Arctocebus* it is constant in the Half-Apes.

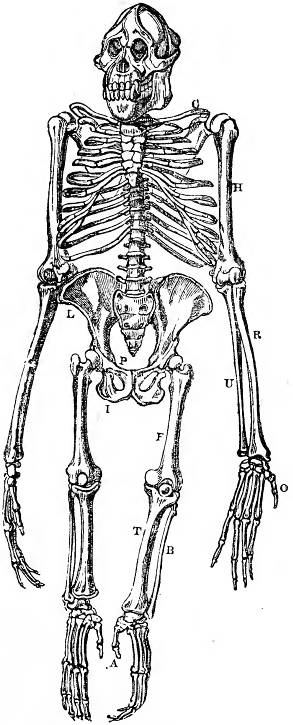
The little bones of the wrist are in man only eight in number, while in almost all the other Primates there are nine of such ossicles. In the Gorilla and Chimpanzee there are but eight, while the Orang and Gibbons have, like the other monkeys, nine. It is very remarkable that amongst the Lemuroidea there is a genus (*Indris*) which agrees with *Homo* and *Troglodytes* in having but eighi bones to the wrist. One of these wrist-bones (*the pisiforme*) is much smaller relatively in man and in the Orang than in almost any other species of

Fig. 16.



Skeleton of Chimpanzee.

Fig. 17.



Skeleton of Orang.

A. Hallux; B. Fibula; C. Clavicle; F. Femur; H. Humerus; I. Ischium; L. Haunch-bone or Ilium; O. Pollex; P. Pubis; R. Radius; T. Tibia; U. Ulna.

the order. Strange to say, however, we find in the little slender Lemur (*Loris*) an approximation in this respect to man much beyond that exhibited by the Gorilla.

The thumb, as to its relative length, taking again the back-bone as our standard of comparison, is in the Gorilla more like that of man than is the thumb of any other of the *Simiinæ*. But the same degree of resemblance to man exists in many lower forms; and in the short-tailed Indris the proportion is precisely the same as in ourselves.

The very same remarks may be applied to the index finger also.

The proportion borne by the thumb to the longest finger of the hand in the Gorilla is slightly more human than what we find in any other latisternal apes. Nevertheless the difference between these apes is trifling, and all differ greatly from man in this proportion; while in the Slender Lemur, and in the Marmoset, the proportion is nearly as it is in us, although in the Marmoset the thumb is not, as in us, opposable.

The pelvis, consisting of the two haunch-bones and sacrum, is one of the most characteristic parts of the human skeleton, closely connected as is its shape with the upright posture of man's body.

In the breadth of the pelvis, compared with the extreme length of each haunch-bone, man greatly exceeds every other Primate; he is most nearly approached, however, in this respect, not by the Gorilla, but by some of the Gibbons.

In the breadth of the pelvis, compared with its extent from before backwards, man is more nearly reached by some Baboons than by any latisternal ape.

The haunch-bone (*os innominatum*) is made up of three bones—1, the *ilium;* 2, the *pubis;* and 3, the *ischium*—which have coalesced into one mass.

In the length of the whole mass, compared with that of the spine, the Gorilla, Chimpanzee, and Orang, are considerably less human than are the Gibbons. In the relative length of the crest of the ilium, however, the Orang takes precedence.

Each ischium ends below in what is called its "tuberosity," on which the body is supported when in a sitting posture. Above this tuberosity is a prominence called the "spine of the ischium."

The shortness of the ischia, the smallness and the non-eversion of the tuberosities, and the prolongation of the latter upwards nearly to the spines of the ischia, are four characters almost peculiar to man. He is most nearly approached in these points, not by the Gorilla, nor by any of the *Simiinæ*, but by the Slender Lemur (*Loris*).

The development of the spine of the ischium is much more human in the Orang than either in the Chimpanzee or Gorilla.

The length of the thigh-bone (*femur*) compared with that of the back-bone, is greater in man than in any latisternal ape.

He is most nearly approached in this respect by the Spider Monkeys (*Ateles*), while in the Gibbons it is even longer than in man.

Comparing the length of the thigh-bone with that of the haunch-bone, we find the short-tailed Indris to be the most human, while *Hylobates* is more so than are the higher genera of *Simiinœ.*

In man the relative length of the thigh-bone to the humerus is enormously greater than in any latisternal ape. The Lemurs approach us most nearly in this proportion, while, as regards the slenderness of the thigh-bone, the Gibbons agree with us much more than do the thick thigh-boned Orang, Chimpanzee, and Gorilla.

The "neck" of the thigh-bone is especially long and well defined in man and in the latisternal apes, but the Gorilla in this respect is the least human of the latter.

The lower end of the thigh-bone of man is distinguished by the much greater projection downwards of its inner part (*inner condyle*). It is not, however, the *Simiinœ*, but the Spider Monkeys, and some Baboons, which in this character present the nearest resemblance to ourselves.

The length of the shin-bone, compared with that of the back-bone, is greater in man than in any of the Old World apes, except the Gibbons, in which its relative length is even a little greater than in man. Some of the Spider Monkeys resemble him in this, more than do any other Primates.

The length of the shin-bone compared with that of the thigh bone is much the same in the Gorilla and Chimpanzee as in man. In the Gibbons it is rather longer, relatively, and in the Orang considerably longer. In the Slow Lemur, however, the proportion is almost as human as in the Gorilla.

When the length of the entire foot is compared with that of the back-bone, the Orang appears at much disadvantage (as to resemblance to man) in comparison with all the other latisternal apes; the baboons, however, excel the last-named animals in this respect.

When the length of the foot is compared with that of the entire leg without it, the Gibbons are seen to take precedence (as to human likeness) not only of all the other latisternal apes, but of all other Primates whatever, except the *Nycticebinœ.*

If the length of the foot be compared with that of the shin-bone, the Gibbons come absolutely to the front rank of the whole order, while the Orang is seen to be, in this respect, the most inhuman of all Primates. The proportion as to length borne by the foot to the hand is more human in the short-tailed Indris than in any other Primate; while, of the latisternal apes, the Gibbons are the least human, and the Orang the most so; the last named, however, not being nearly so human as is the short-tailed Indris.

In man the ankle-bones form a larger proportion of the entire foot than in any other Primates except the Galagos. In this point the Gorilla and Chimpanzee are considerably more human than are the Gibbons and Orang. In the man-like slenderness of the ankle, however, some Gibbons much more approximate to man than do the other latisternal apes.

In the relative length of the great toe (*hallux*), compared with that of the back-bone, man is very closely approximated by the Gorilla, while the Orang falls off greatly. In this pre-eminence, however, the Gorilla is about equalled by some of the Sakis of America.

In the proportional length of the longest toe to the back-bone, Man is most nearly approached by the Gorilla and Chimpanzee amongst the latisternal apes. He is, however, much *more* nearly approached by the Lemurs. In man the great toe much more nearly equals the longest toe in length than in any other Primate. The Chimpanzee is the most human in this matter, but the short-tailed Indris is almost as much so, and excels the Gorilla and all other latisternal apes. The great toe of the Orang differs from that of every other Primate in that the terminal joint is often absent.

In the proportion borne in length by the great toe to the entire foot, man is most closely resembled by the Gibbons and Chimpanzee, while the Orang is the least human of all Primates. In the diminutive development of the hallux, as compared with the pollex, the Orang is even more exceptional, though an approximation to this is found in the lowest of apes—the Marmosets. In the proportion borne by the hallux to the pollex, man and the Gorilla agree; then comes the Chimpanzee; then the Gibbons, and last of all the Orang. The Little Squirrel Monkey, however, is almost as human as the Gorilla in this proportion.

Such are the main affinities towards man's structure exhibited by the different kinds of the higher apes as regards the skeleton. They show that the various species approximate to man not only in different degrees, but also in different modes. The Orang certainly diverges more, as regards the skeleton, from man, than does any other latisternal ape.

Thus it has the shortest leg, compared with the arm, of all Primates (hand and foot not being counted), while man has the longest. It has the absolutely longest hand, and the shortest thumb as compared with the forefinger; and it has the shortest thigh-bone, compared with the upper arm-bone, of all Primates.

The pit for the ligamentum teres * is almost constantly absent, while in man, Gibbons, and the Chimpanzee, it is constantly present. The Gorilla alone sometimes shares with the Orang the condition of having no such pit.

The Orang has the shortest shin-bone, compared with the upper arm-bone, and the longest foot compared with the leg, in the whole order. It has the relatively shortest and most imperfect hallux of any Primate, while in no other Ape or Half-Ape does the length of the second toe so closely approach that of the forefinger of the same individual.

Estimated by the skeleton only, the Orang cannot be said to approximate to man in any supreme degree, although, as may be remembered, several points have been mentioned in which it is more human than in any other latisternal ape.

The Gorilla and Chimpanzee have been seen to show many approximations to man as regards the skeleton. In some respects one species has been found to be the more man-like; in other points the other species has been so found.

We have found that the Gibbons, one or other of them, exhibit various skeletal characters more human than those presented by any other members of the order. Finally, we have seen that even some of the Half-Apes present most remarkable resemblances to man. The teaching, then, of the skeleton, as also of the other parts we have as yet reviewed, seems to be that resemblance to man is shared in different and not very unequal degrees by divers species of the order, rather than that any one kind is plainly and unquestionably much more human than any of the others.

Affinities seem rather to radiate from man in various directions than to follow one special route. At present, however, the facts presented are not sufficient to warrant the expression of a confident judgment. In order to arrive at such a judgment it will be necessary to survey the other organs of the body; and then, summarizing the results, we shall have material sufficient to examine the third question proposed, namely, the bearing of the facts upon the theory of evolution as applied to man.

(*To be continued.*)

* This is a ligament which holds the thigh-bone in its place, passing as it does, like a round cord, from the head of the thigh-bone to the inside of the socket of the haunch-bone, into which the thigh-bone fits.

EXPLANATION OF PLATE XCV.

Fig. 1. The Gorilla (*Troglodytes gorilla*).

„ 2. Skull of the Gorilla vertically and antero-posteriorly bisected, to show the great sagittal crest (*s*) rising above the brain cavity, and the supra-orbital crest (*o*) above the orbit.

„ 3. The Squirrel Monkey (*chrysothrix sciurea*).

„ 4. The Potto (*Perodicticus Potto*), showing the rudimentary condition of the index finger.

„ 5. The Angwântibo (*Arctocebus calabarensis*).

„ 6. The Tarsier (*Tarsius spectrum*), showing the foot at its maximum of elongation, relatively, in the whole order Primates.

„ 7. The Aye-Aye (*Cheiromys madagascariensis*).

THE LOST COMET AND ITS METEOR-TRAIN.

By RICHARD A. PROCTOR, B.A. (Cambridge).

Honorary Secretary of the Royal Astronomical Society; Author of "Other Worlds than Ours," "The Sun," &c.

THE meteor-shower which occurred on November 27 last, and the circumstances connected with that event, have not only attracted a fresh interest to the subject of meteoric astronomy, but have afforded important evidence respecting the connection which undoubtedly exists between meteors and comets. I propose in this paper to consider more particularly the events referred to; for, although I have not hitherto in these pages dealt with the progress of cometic and meteoric astronomy, yet it is known to the majority of my readers that elsewhere this subject has been somewhat fully discussed by me.

It has been shown by the labours of Schiaparelli, Adams, Peters, Tempel, and other astronomers, that the meteors of November 13–14 (called the Leonides) travel in the track of Tempel's comet. The meteors of August 10-11, or Perseides, have also been shown to travel in the track of a comet. Other such instances of association have been more or less fully recognised; and now the conclusion has been generally accepted, that in the train or path of comets bodies travel in scattered flights, which, if they fall on the atmosphere of the earth, appear as shooting-stars or meteors.

Until the recent shower, however, the inquiries made in this branch of research has been limited to cases of recognised meteor-systems whose orbits have been found to agree with those of comets. It was a new circumstance in the history of meteoric research when Weiss in Germany, and Alexander Herschel in England, ventured to predict a meteoric display because the earth was about to pass through the orbit of a known comet. It is true that there were some reasons for believing that meteors which had fallen in various years between November 25 and December 7 were attendants upon the comet in question—Biela's or Gambart's. But the evidence was slight, and in some respects unsatisfactory; so that it may be said that in reality the astronomers just named had no other grounds for their anticipations than first the fact that Biela's comet was known to have recently passed the descending node of its orbit (or the place where it passes nearest to the earth's orbit), and secondly their confidence in the theory that meteors and comets are in some way associated. A prediction such as this became therefore in some sense a crucial test of this theory—not indeed that the failure of the prediction would have disproved the theory (because negative evidence counts for little in this matter), but that its fulfilment would supply the only form of positive evidence yet wanting to that theory.

I do not here enter at length on the remarkable circumstances connected with Biela's comet, because they have been elsewhere stated at considerable length, and are probably known to the majority of those who will read these lines. Let it suffice to say that the comet was one of short period, returning at mean intervals of 6·635 years; that in 1837 it was observed to be divided into two distinct comets; that it returned in 1852, and both the comets were then still in existence; that whether it returned (unchanged in general aspect) in 1858-59 or not, is unknown, because its calculated course was such as to render observation impossible; and lastly that in 1866, and again last year, it was searched for in vain with telescopes of great power.

Now it crossed the earth's path last year nearly twelve weeks before November 27, when the earth herself traversed the place at which the comet crosses her orbit. And since the meteors of November 13-14 have been seen, not merely a few months, but several years after the nodal passage of their comet, it seemed not unreasonable to expect a considerable meteoric display on or about November 27. The exact date was not indeed very accurately determined, and the reason is readily seen. I invite the reader's special attention to the point, because it has been somewhat singularly overlooked even by astronomers of great mathematical attainments. The comet itself had its place of passage readily calculated, and it might seem at first sight that whenever the earth came to that place the display should occur. But manifestly the position of the cometic orbit for November 27, when the earth crossed that orbit's node, would not be identical with the position of that orbit three months or so before, when the comet passed its node. It might then seem that this latter position was what astronomers should calculate, and as a matter of fact this is what was commonly done. We find the position of the node of the orbit for the end of November assigned as the place where the encounter of the earth with the meteoric flight was to take place. But this view is as incorrect as the former.

Those particular meteors which were travelling twelve weeks behind the head of the comet, although, speaking generally, they would follow the comet's track, would nevertheless not be found travelling in precisely the same orbit, nor would they cross the earth's orbit precisely where the comet's orbit did at the time. For they would have been subjected to perturbations differing notably in character from those which had affected the comet itself. It must be remembered that the circumstances which separated such meteors by so great a distance from the head have not taken place in a few years, in a few revolutions of the comet, or even in a few centuries. But even if we take only the last half century or so, and consider the history of those meteors during that time, it will be manifest that their perturbations have differed considerably from those which have affected their leader, so to term the comet in whose track they follow. In the course of those years the comet has made seven or eight revolutions, and so have the meteors, while Jupiter, the chief disturber of Biela's comet, has made four or five revolutions. In the course of this period the comet must have been more than once so placed as to be very considerably disturbed by Jupiter, because as a matter of fact the path of the comet passes not very far (near its aphelion) from the path of Jupiter. The same general statement is true, of course, of the meteors twelve weeks behind. Now, whenever it happened that the comet was at its nearest to Jupiter, when passing that critical portion of its orbit, the meteors twelve weeks behind were either not brought so fully under the influence of Jupiter's attraction, or if they were, they were perturbed by him in a different manner. This is manifest if we consider how enormous is the real distance corresponding to the twelve weeks or so by which the meteors are behind the comet. And again, when the meteors chanced to be at their nearest to Jupiter when passing the critical part of their orbit, the comet, twelve weeks in front, was either not brought so fully under Jupiter's influence, or was perturbed in a different way.

Now whenever a perturbation has been produced, it affects the orbit of the perturbed body. Supposing the comet and meteors moving in precisely the same orbit at a particular moment, when Jupiter is pulling the comet in a certain way and the meteors in a different way, then forthwith the comet and meteors travel in different orbits. The difference may be slight, close by the place where such perturbations are produced, but it may nevertheless appreciably affect the positions which will be occupied by the comet and meteors when severally traversing some other and distant part of their orbit (as for instance when they are at their descending node close by the earth's track). And again, although in the long run there are compensatory effects—the comets and the bodies travelling twelve weeks behind being in the course of many years subjected to every variety of perturbative effect in the same respective proportions—yet such cycles of compensation are enormously long in the case of bodies moving in an orbit like that of Biela's comet; and practically it may be said that compensation is never effected.*

So that unless calculations could be made of the perturbations affecting those meteors themselves which are travelling twelve weeks behind the comet, we could not possibly be certain as to the place where the earth would actually encounter the meteor flight, or whether such an encounter would take place at all. The calculation would be one of immense difficulty, even if we knew where and how the meteors had been moving at some particular date; but as we know nothing on either point, it is simply impossible to enter upon the calculation.

It will presently be seen that these considerations bear importantly on the opinion we are to form respecting the events which have recently occurred.

It is in the knowledge of all our readers that on November 27th last, the anticipated display of meteors did actually occur. It was a display very remarkable in character. The meteors were even more numerous, in fact they were far more numerous than during the memorable shower of the night between November 13–14, 1866; though the meteors were not so large on the average as those seen on the latter occasion. I select from among many accounts the excellent description given by Professor Grant, because his skill and practice as an observer gives

* One may reason thus: Given a body travelling in the orbit of Biela's comet; then the orbit of this body will pass through endless changes. Its eccentricity will wax and wane; its inclination will increase and diminish; its line of apsides will advance and regrede, advancing on the whole; its line of modes will advance and regrede, regreding on the whole; and countless ages must elapse before its orbit resumes its original figure, for the four kinds of change will not have synchronous periods. Now the same is true of another body, having at the beginning the same orbit but twelve weeks in front or behind. This body will have its orbit passing through endless changes, and will only after countless ages be found travelling in the same orbit as at first. But the period in which this will happen is not the same period in which the former will happen. Each period is enormously long; but after the lapse of either the bodies are not travelling in the same orbit. When one period has elapsed, the other is far from being completed; when the latter is completed, the former is far past. Nor does it follow that the perturbing planets are in the same position as when the changes began. Many thousands of such periods must pass for both bodies before there is a near approach to the original state of things in all respects.

great value to his statements. "In their general features," he says, "the meteors did not differ from those of the great display of November 13–14, 1866. They were, however, obviously less brilliant. Their normal colour was white, with a pale train tinged now and then with a very faint greenish hue. The head seldom equalled in brightness a star of the first magnitude. From time to time, however, a meteor of unusual splendour would appear, nearly rivalling Jupiter in brightness. In such cases the train, especially when breaking up, exhibited a reddish tinge. In two instances of large meteors (those of 8h. 13m. and 9h. 33m.) the colour of the train was conspicuously green. In general, however, there was an absence of the brilliant emerald hue which formed so conspicuous a feature of many of the larger meteors of November 1866. The time of visibility of a meteor did not exceed two or three seconds. In two or three instances of bright meteors, however, the *dêbris* of the train continued visible for about thirty seconds. The arc described varied as usual from zero to forty or fifty degrees. I was unable to detect any pronounced difference in the angular velocity of the meteors as compared with the meteors of November 1866. During the whole time of the occurrence of the shower I directed especial attention to the region of the heavens from which the meteors were issuing, with the view of detecting stationary or nearly stationary meteors, having been convinced, from my experience of the meteoric shower of November 1866, of the facility with which such meteors indicate the position of the radiant point. Several meteors of this class were seen during the progress of the shower. At 8h. 43m., at 9h. 23m., and at 9h. 35m., absolutely stationary meteors were perceived. They rapidly swelled out, without any vestige of a train, and then suddenly collapsed. They all concurred in placing the radiant point in a position midway between γ *Andromedæ* and 51 *Andromedæ*, perhaps a little nearer to the former star than to the latter. Assuming the position of the radiant point to be midway between the two stars just mentioned, it would thus be situated in R.A. 26°, Decl. N. 44°. This conclusion was supported by the observations of nearly stationary meteors in the vicinity of the radiant point. On the other hand the courses of the more distant meteors when traced back, although in general assigning the same position to the radiant, appeared in many instances to come from a higher region situated in *Cassiopiea*. Of this fact (which is otherwise indicated by the projection of the observations) I do not entertain the slightest doubt, my attention having been directed to it early in the evening. In order to ascertain the time of occurrence of the maximum of the shower, it was necessary to count the number of meteors visible. At first it occurred to me to place two observers, one looking towards the region of the radiant point, and the other towards the opposite region, but I found that the attempt to carry into effect this arrangement introduced confusion. I therefore directed the observer always to keep the star γ *Andromedæ* as the centre of vision, and to continue counting as many meteors as he could without turning round. The counting of the meteors commenced at 5h. 30m., and was prosecuted without intermission until 11h. 50m.; it consequently embraced an interval of 6h. 20m. The operation was effected by counting the number of meteors visible in each successive interval of five minutes. The meteors counted were thus parcelled out into seventy-six groups, each group extending over five minutes. The number of meteors counted in the first group (5h. 30m. to 5h. 35m.) amounted to 40. The number of meteors in the maximum group (8h. 10m. to 8h. 15m.) was 367. The number of meteors in the last group (11h. 45m. to 11h. 50m.) fell to 6. Taking the first seventy-two groups, and forming them into twenty-four groups of fifteen minutes each, we have the following results:—

Quarter of Hour ending	No. of Meteors Counted	Quarter of Hour ending	No. of Meteors Counted	Quarter of Hour ending	of No. Meteors Counted
h. m.		h. m.		h. m.	
5 45	150	7 45	881	9 45	233
6 0	174	8 0	930	10 0	246
6 15	292	8 15	1070	10 15	190
6 30	507	8 30	777	10 30	116
6 45	643	8 45	599	10 45	111
7 0	840	9 0	413	11 0	74
7 15	721	9 15	418	11 15	48
7 30	890	9 30	213	11 30	22

"It is clear that the maximum of the shower occurred about 8h. 10m. The aggregate number of meteors counted from 5h. 30m. to 11h. 50m. (by one observer) amounted to 10,579."

To this it may be added that in Italy the shower was even richer, for Signor Denza states that in 6½ hours no less than 33,400 meteors were counted by four observers. "The meteors were very brilliant," he adds, "and were noticed in every part of the sky. The number recorded above is far less than the truth, for we found it frequently impossible to count them. The maximum display took place between 7h. and 9h., and for 21 minutes, between 6h. 35m. and 6h. 56m., *the appearance in the sky was that of a meteoric cloud.* The radiant point was very clearly indicated near γ *Andromedæ.*

Now in the first place it is to be noticed that there can be no question whatever as to the meteoric display having been produced by bodies which were travelling in the track (speaking generally, *bien entendu*) of Biela's comet. It is sufficient to compare the position of the radiant point with that which would have been due to meteors following precisely in the orbit of Biela's comet, as calculated for the last perturbed epoch, 1866. Mr. Hind, the superintendent of the "Nautical Almanac," has calculated for the radiant point due to the comet a place in R. A. $1^h. 41^m.$, and N. P. D. 48°. We have seen that Professor Grant gives for the observed radiant point a position in R. A. 26° (or $1^h. 44^m.$), and N. P D. 44°, a singularly close agreement under the circumstances.*

But now comes the most singular part of the whole affair. It occurred to the German astronomer Klinkerfues that if search could be made in the part of the heavens directly opposite to that whence the meteor-shower had appeared to radiate, the cluster of meteoric bodies which had produced the display might be detected. In fact, Klinkerfues appears to have supposed that Biela's comet had itself touched the earth on the evening of November 27, for he telegraphed to Mr. Pogson (the Government astronomer at Madras) in the following terms: "*Biela touched earth on 27th; search near Theta*

* In passing I would venture to touch on what I cannot but regard as an error in the treatment of this subject by Professor Newton of America, and some other astronomers. They attribute to the indications of the meteoric paths a degree of accuracy which cannot, I conceive, be regarded as to be depended upon. And where, judging from the meteoric motions, the radiant seems to shift in position, or to occupy an area rather than to be a mere point, they deduce such and such inferences from one or other circumstance. But it must be remembered that apart from those causes which would tend to spread the radiant region, the meteors must by the action of the atmosphere be very often, if not always, caused to deviate from the direction in which they had been moving before they reached the upper limits of the atmosphere. We cannot assume that because the air is very rare where the meteors first become visible, they therefore encounter an inappreciable resistance. The very fact of a meteor becoming visible shows, on the contrary, that there has been a degree of compression of the atmosphere in front of the meteor, which must necessarily involve a considerable resistance. And it is utterly unlikely that this resistance should take place without to some degree affecting the direction in which the meteor travels. Nor will all meteors be alike affected. For it is to be remembered that of the meteors seen from any given station some strike the atmosphere in a very different way than others. Some impinge almost squarely upon the upper atmospheric layers, while others fall much more aslant. Then there must often be a difference of density and of arrangement in the upper strata of our atmosphere. These and other causes which may be pointed out, as well as differences in the size, weight, and density of the individual meteors, must lead to appreciable changes in the direction of motion.

Centauri." And Pogson understood that it was the comet itself that he was searching for, since he wrote as follows, in describing the results of his search:—"I was on the look out from Comet-rise (16^h.) to Sun-rise the next two mornings, but clouds and rain disappointed me. On the third attempt, however, I had better luck. Just about $17\frac{1}{4}^h$. mean time a brief blue space enabled me to find Biela, and though I could only get four comparisons with an anonymous star, it had moved forward 2·5 s. in four minutes, and that *settled* its being the right object. I recorded it as 'Circular; bright, with a decided nucelus, but no tail, and about 45″ in diameter.' This was in strong twilight. Next morning, December 3, I got a much better observation of it; seven comparisons with another anonymous star; two with one of our current Madras Catalogue Stars, and two with 7734 Taylor. This time my notes were: 'Circular, diameter 75″, bright nucleus, a faint but distinct tail, 8′ in length and spreading, position angle from nucleus about 280°.' I had no time to spare to look for the other comet, and the next morning the clouds and rain had returned. The positions, the first rough, the second pretty fair, from the two known stars, are:—

	Madras M. T.			R. A.			Apparent N. P. D.		
	h.	m.	s.	h.	m.	s.	°	′	″
Dec. 2.	17	33	21	14	7	27	124	46	
„ 3.	17	25	17	14	22	2·9	125	4	28

It is manifest, however, that whatever the object seen by Pogson may have been, it was not Biela's comet; for the comet was due in that part of its orbit no less than twelve weeks earlier, and any retardation which could have produced so great a delay would have altogether changed the character of the comet's path.

Still it might be supposed that certainly what Pogson saw was on the track of Biela's comet, was in fact the cluster of bodies which produced the meteor-shower of November 27. Even this, however, is so far from being demonstrated that skilful mathematicians consider the object seen by Pogson to have had no connection whatever either with Biela itself or its meteoric train.

This at any rate is certain—a flight of bodies travelling on the track of Biela's comet, and crossing the earth's orbit on November 27, could not possibly have been seen in the positions in which Pogson saw a cometic or cloud-like object. We have, Professor A. S. Herschel has pointed out, unmistakable evidence that Pogson saw one and the same object. For he rated the motion of the object on the first morning, and the observed rate accords perfectly with the position occupied by the object on the second morning.

Two observations of a comet do not afford the means of determining the paths in which the comet is travelling. But if we combine Pogson's observations with some other assumption, as that the object he saw had crossed the earth's orbit on November 27 at a given hour, or that the period of the object is identical with that of Biela's comet, or the like, then an orbit can be determined.

Now Capt. Tupman, in a paper recently read before the Royal Astronomical Society, after showing that the meteors seen on the night of Nov. 27 were running in an orbit sensibly the same as Biela's comet, proves conclusively that a body moving in the same orbit as those meteors, or in an orbit parallel to them, could not have been in the positions occupied by the object seen by Pogson. We must assume greater changes in the character of the orbit than appear admissible, in order to account for the observed positions; in particular since the object seen by Pogson had an apparent motion nearly parallel to the ecliptic, the inclination of its orbit cannot possibly be so great as 12° 34′, which is the inclination of Biela's comet.

On the other hand, Dr. J. Holetschek, in No. 1920 of the 'Astronomische Nachrichten,' combining Pogson's two observations, with Hubbard's values of (1) the longitude of the node, (2) the longitude of the perihelion, and (3) the inclination, deduces for the perihelion passage of Pogson's object the date December 23·368 (mean Berlin time) and the perihelion distance ·8339 (·8606 being Hubbard's value of the perihelion distance of Biela's orbit in 1872). It is noteworthy that Tupman obtains for the meteor-flights of last November and for Biela's comet the following elements respectively:—

	Meteors of Nov. 27.	Biela's Comet.
Perihelion passage	1872 Dec. 26·90	1872 Oct. 66·9 (?)
Longitude of perihelion. .	111° 48′	109° 24′
" " ascending mode	245° 57′	245° 54′
Inclination	13° 24′	12° 34′
Perihelion distance . .	·8265	·8718
Eccentricity	·7670	·7600
Motion	Direct	Direct

So that Holetschek's result would appear to indicate that the object seen by Pogson had been travelling about 3½ days behind the meteors observed on November 27 last.

Professor von Oppolzer of Vienna, the eminent orbit calculator, shows, in the same number of the "Astronomiche Nachrichten," that the same problem may be successfully treated in a totally different manner. He assumes the period (or which amounts to the same thing, the major axis) of the object's orbit to be the same as that of Biela's comet, and that the object was moving from the earth in the interval between December 2 and 3, deducing elements nearly resembling those of Biela's comet.

It appears to me that the discordances obtained by different astronomers depend largely on the assumption that the object seen by Pogson, if identifiable at all with Biela's meteor-train, must in a special manner be identified with the cloud of meteors through which the earth passed on the night of November 27. But is there any valid reason for this assumption? It may seem at first sight that there is; that a cloud of meteors sufficiently dense to produce so remarkable a display should be visible, when it had passed beyond the earth, as a cloud of light in the telescopic field. But if we consider the real distribution of those meteors in space, we shall find reason to conclude that they were far too sparsely distributed to be visible under any circumstances, by the light they were capable of reflecting. Let it be remembered that the display lasted about six hours, and that during that period about 50,000 meteors at the utmost appeared above the horizon of any given place. But let us set 100,000 as the number of meteors so appearing, and the time at only four hours. Now the region of meteor-traversed atmosphere above the horizon plane of any station may be taken as a plano-convex lens, its plane circular face having a diameter certainly not less than 1,000 miles; and as the radiant was high above the horizon, we shall be within the truth in concluding that such a plane on the average presented (as supposed to be seen from the advancing meteors) an area equalling the 100th part of the area presented by the whole disk of the earth. So that if we take 10,000,000 for the total number of meteors falling on the earth during four hours, we shall certainly not underestimate the number (referring always to meteors large enough to become visible to the naked eye). Now, the actual region of space traversed by the earth in four hours is a cylinder 260,000 miles long and having a cross section nearly 8,000 miles in diameter. Such a cylinder would have a volume of 12,500,000,000,000 cubic miles, and to each meteor of the 10,000,000 there would therefore correspond an average space of 1,250,000 cubic miles; that is, a space corresponding to a cube nearly 108 miles in length and breadth and height. Since such meteors as were seen on the night of November 27 have been estimated at less than an ounce in weight (in many cases only a few grains), it follows that their dimensions are inconsiderable. The largest can scarcely, when solid, be an inch in diameter. It will be conceived, therefore, how small must be the prospect of seeing a flight of bodies so exceedingly minute compared with the average space occupied by each. It is, indeed, easy to estimate the luminosity of such a flight regarded as a whole, if of given depth and at a given distance from the sun. Thus, suppose the flight of a million miles in depth, and at the earth's distance from the sun. Along a range of a million miles there would be less than 10,000 meteors. Now, granting each to have a disk one square inch in real area, we should have a total area of 10,000 square inches (that is, $8\frac{1}{3}$ feet square). And the ratio of this area to 108 miles square gives the ratio of the luminosity of the meteor-cloud (when of the given depth) to the luminosity of a surface illuminated by the sun at the earth's distance—(say, the moon, for example). Now 108 miles square, or 11,664 square miles, contain $11,664 \times (1,760)^2 \times (36)^2$ square inches, or roughly (for great nicety would be useless in such a problem) $10,000 \times (2,000)^2 \times (35)^2$ square inches; so that the ratio we require is 1 to $(70,000)^2$ or 1 to 4,900,000,000. That is, the luminosity of the meteor-cloud would be one-4,900,000,000th only of the moon's, and necessarily the meteor-cloud would be quite undiscernible. Hence we may be assured that if the object seen by Pogson was connected at all with the meteor-cloud through which the earth passed on November 27, he saw a very much denser part of the meteor-cloud; and there is no reason why this dense portion or nucleus of the meteor-cloud may not have been at a considerable distance from the earth on the 27th of last November. This consideration would serve to remove some of the more perplexing circumstances of the recent observations.

CURIOSITIES OF VEGETABLE MORPHOLOGY.

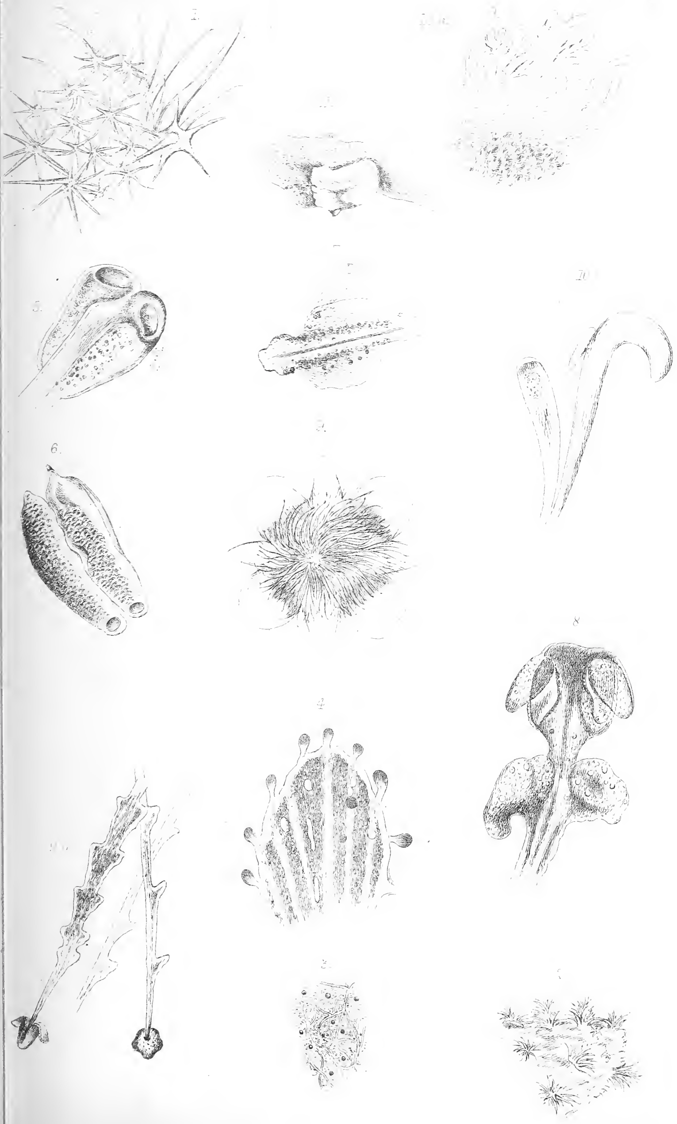
By HENRY J. SLACK, F.G.S., Sec. R.M.S.

[PLATE XCVI.]

ONE of the most important sciences of quite modern growth is that of *Morphology*, the object of which is to trace the series of growth and development processes by which organs or structures are brought to their final form. This is done in both the vegetable and the animal kingdoms, and also in that border-land to which no definite name can be given, and in which organization appears in its simplest forms. The morphology of plants and animals is intimately connected with the comparative anatomy of the two groups, and the investigator traces step by step the formation of particular structures, notes the points at which they diverge to carry out the plan on which different types are built up, and the extent as well as the direction to which development is carried. By researches of this description—lower groups and higher ones—are shown to be intimately connected, so that, as discovery follows discovery, the apparent gaps in the great scheme are gradually filled in, and little doubt left of the two great scientific doctrines—unity of design and gradual transformation of so-called species. The extinct forms preserved in a fossil state often help the morphologist as well as the comparative anatomist to a missing link, and no branch of enquiry is more intimately connected with speculative thought, or contributes more to a philosophical conception of Nature as a whole. As an illustration of the curious results arrived at, it may be mentioned that our great English morphologist, Mr. W. K. Parker, finds in the tadpole, in a rudimentary form, a structure belonging to the human ear.

There is of course very much in such a science as morphology that is beyond the reach of the student of popular science, but a good deal may be learned from plants, without much trouble, especially with the help of a microscope. The most agreeable and easy way of laying a foundation for further

Plate XXVI



West & Co. imp.

Hairs, Glands, & Anthers of Plants.

enquiry is to notice the growth and final condition of certain parts or organs of different species of plants. Take for example the *hairs* found on leaves or flowers. They are all appendages of the cuticle, and vary from single cells to structures of many cells, arranged in a straight line, or in star patterns, more or less complicated, in single layers or in many. We also find them branched and knobbed. When filled with thin fluids they are soft; but they are capable of being strengthened and thickened into *thorns*, which are distinguished from spines as being outgrowths of the epidermis, not of the wood. They also exhibit in some cases deposits of silica. Many of these plant hairs are well known as microscopic objects; those on the leaves of *Deutzia scabra*, for example, being frequently used for exhibition with the polariscope. It is not, however, common to find in popular collections the flower-buds of this plant, or of *D. gracilis*, both of which are exquisite objects, especially the former. The young flower-bud should be mounted in a cell with glycerine jelly, and viewed as an opaque object with a binocular instrument of 1½ or 1-inch objective. The stellate hairs (fig. 1) shine like silver, and their true form is much better seen than when they are compressed in the usual balsam mounting. Hairs of this description should be contrasted with simple tubular hairs, and also with those that branch, or terminate in knobs. The hair of the cabbage-leaf is a good illustration of the simplest form. Those on the calyx of Salvia have bulbous heads, and those on the stems of London Pride exhibit minute terminal bulbs, filled with a fine ruby fluid. Many of the *Cruciferæ* have branched hairs. On the stalk of the Deutzia flower-buds will be seen long hairs like thorns, but not so hard, and surrounded at their basis with lesser hairs in star patterns. The Deutzia hairs should not be dismissed without taking some leaves of the plant and calcining them over a spirit-lamp. Those who possess chemical apparatus will find a platina or small porcelain crucible convenient for this purpose; but it may be effected on a plate of brass or sheet iron. The black carbonaceous mass left when the process is finished is excessively brittle, but a few of the flattest pieces may be placed in a shallow cell, some with the upper and some with the lower side at top, covered with thin glass, and viewed as opaque objects. The hairs look like a lot of steel-gray star-fishes, and their minute tubercles, which are well preserved, add to the resemblance.

Amongst the hairs found on sepals, those of the Gum Cistus are particularly beautiful and curious (fig. 2). The cuticles of these sepals should be cut off in thin slices with a fine pair of sharp scissors, and mounted in glycerine jelly, without compression. They are then transparent enough to show in the usual way with the polariscope, lit up with rich colours; or they may be viewed with ordinary light, either as opaque or transparent objects. Each hair is simple, something like that of the cabbage, but a considerable number grow out from a common base, forming radiating tufts.

Having considered hairs in simple and compound forms, as soft structures and as hardened into thorns, the transitions from hairs to scales should be observed; and many ferns will supply good illustrations. The hairs on the stems of the large parti-coloured-leaved Begonias are thickly furnished with hairs, composed of a multitude of cells, looking somewhat like scales to the naked eye, but under the microscope they exhibit a complicated cell-structure, and show how easy it is to pass from simple hairs to higher forms.

Many hairs are glandular; that is, they act like glands, and secrete some peculiar material. The best known is that of the stinging-nettle, providing the acrid poison that escapes as soon as a slight touch breaks off the brittle point. Hairs that secrete and store up remarkable colouring matters will be readily found by examining plants on the roadside or in the garden. A common St. John's Wort (*Hypericum pulchrum*) has its leaves furnished with a fringe of club-shaped glands, similar in structure to many stumpy hairs, and filled with dark pigment (Fig. 4.) Interesting hairs with glandular tips will be found on the sepals of the American Currant (*Ribes sanguineosum*), common as an ornamental shrub.

The *surface* glands of leaves are essentially the same in construction as hairs, being expansions of the cuticle. They differ from the deeper glands (internal glands) below the cuticle, which can be well seen in a vertical section of orange-peel. The ornamental Coleus plants, common in every conservatory, afford interesting specimens of surface or cuticular glands. The under surface of the leaves should be examined as opaque objects with powers of from 60 to 100 or more, and numerous little balls, slightly indented with a cross, will be seen to shine like topaz gems. They may be found well developed in very young leaves; and such leaves, if also adorned with numerous hairs, filled with purple and white fluids, make splendid objects when well lit up. The little glands contain a fluid that seems to pass into a resinous state, changing to a redder tint when simply dried. A leaf flattened and dried in a book, then placed on a slide covered with thin glass, with paper pasted round the edges, or the edges cemented with varnish, keeps its colour sufficiently well to be worth preserving. In a specimen before the writer at this moment, put up a year ago, the glandular balls have retained their form and size very closely, changing to a darker tint, and the hairs with which the leaf is numerously beset, still show their purple hue at the spots where the cells join (fig. 3.)

Common garden Sage leaves, and many other plants of the same family, have similar glands; those of the Sage being white. In the Coleus glands there is a tendency to division into four parts; shown in fresh specimens by the cross-like depression. In a Digitalis (foxglove) from Calcutta, four-celled glands containing a white material are very conspicuous.

Let us now pass to another sort of structure, in which great variety of development may be easily seen—namely, anthers with their filaments or stalks. Everybody notices anthers like those of lilies, with their abundance of coloured pollen; but few think how the pollen is formed, and few investigate the structure of anthers that need the microscope for their elucidation. Pollen grains are formed in special cells in the substance of the anther, and they must, when ready for their work, be able to get out. This is usually accomplished by the bursting of the anther; but very interesting exceptions are found. Fig. 5 shows the anthers of an Azalea; twin bottles, with round mouths opening at the right time. From one of these bottles the pollen is in the act of escaping.

Anthers in this stage may be well preserved in cells with glycerine jelly. Each filament carries a pair of bottles, and the figure shows them in two positions—with their mouths upwards in one case, and downwards in the other. Both positions may be seen in the living plant.

Fig. 6 exhibits Rhododendron anthers. These, again, are pairs of long bottles composed of a very delicate membrane that splits lengthwise with great facility. The mouths of these bottles are less firm and regular than those of the Azalea, that are strengthened by a thick rim, and somewhat remind one of moss capsules.

In *Berberis Darwinii* * (fig. 7), the bottle form is abandoned for a sort of box with a lid, which opens when the pollen is ripe. In this case each anther cell splits twice lengthwise, and the lid is formed of a strip left in adhesion only at the top, and free to fall open.

In the Narrow Leaf Bay * (fig. 8), the box form again occurs, much like that of the Berberis; but the filament, or stalk of the anther, is furnished with two projecting wings, supposed to be glandular. We shall have more to say about these wings presently, but will now advise the student to examine the anthers of various plants in different stages of growth, making their sections in longitudinal and transverse directions, gently flattening them in a drop of water

* The peculiarity is not confined to this species or variety.

on a slide under a covering glass, and viewing with one-quarter or higher powers. The mode of growth of the pollen buds will then be seen, and it will be found that the cells below the epidermis often present curious and beautiful appearances of spiral or other fibres. The Siberian Squill, common in gardens (*Scilla Sibirica*), and as a pot plant, shows the spiral fibres something like those in the leaves of Sphagnum exceedingly well. The "Micrographic Dictionary" gives, amongst others, *Narcissus poeticus*, *Populus alba*, and *Datura Stramonium*, as having *spiral* fibres; *Iris florentina*, *Hyacinthus orientalis*, and *Convallaria*, as having *annular* fibres; *Tritillaria imperialis* (internal face), and *Viola odorata* as having *reticulated* fibres; *Nuphar lutea*, *Bryonia dioica*, *Primula sinensis*, and *Lupinus*, as having *arched* fibres, on three sides of the cells, the fourth free. Trumpet Lilies, Calceolarias, and Larkspurs, should also be examined, as their fibres stand upright. An investigation of a dozen or two of flowers easily found in a garden or conservatory would well repay the trouble.

Botanists regard all the outgrowths from the stems of plants as leaves of some kind, however they may be modified in form or colour. What are commonly known as "leaves" of course retain that appellation in scientific works; but sepals, petals, anthers, &c., are all morphologically considered as modified leaves. At first this sort of philosophy appears exceedingly far-fetched and difficult; but there are several easy modes of getting a sufficient insight into the matter to show that it is true in certain groups of cases; and when the student has got thus far, he need not be in a hurry to doubt that with greater knowledge he would find it true in others. In regarding various parts on modified leaves the notion must be avoided that a true leaf is made first, and the particular parts made out of it afterwards by modification. This would be quite wrong. What is considered is, that the various parts begin as leaves begin, and that their growth is modified as it goes on, the cells of which they are composed arranging themselves in given directions and quantities, according to the nature of the patterns ultimately required. Nothing can appear more different than the ordinary leaf of a plant and its stamens with their filaments. But in Buttercups, Bachelor's Buttons, &c., a quantity of stamens pass into the condition of flower-leaves or petals; and if a wild single Rose is compared with a full-leaved garden variety, it will be found that the "doubling" has consisted in the development of the anthers and filaments into floral leaves. The elegant double Cherry that flowers in Spring is another illustration of stamens taking the petal form.

Minor modifications of the filament are also common, and fig. 9 shows the number of ornamental expansions that grow down those of the *Sparmannia Africana*, a shrub belonging to the lime-tree family, coming from Africa, and not uncommon in greenhouses, or as an out-door plant in summer. The flower of Sparmannia owes much of its beauty to its modified filaments. It has four white petals, narrow at the base and broad at the rim, arranged in an open cross. Between these shine four white spear-shaped sepals, and the centre is occupied by an immense number of filaments, the outer golden yellow, and barren; the inner ones longer, rich red in colour and bearing purplish anthers, and both sets of filaments are provided with a series of expansions, as shown in fig. 9A, the whole effect being very pretty.

In this instance we find that the filaments, instead of being simple stalks, exhibit lateral growths; and having in this and in the case of the Berbery filaments witnessed such developments, we shall not be surprised in other plants to find much more accomplished in the way of modification.

If we look at the Cannas, now common as greenhouse plants, and planted out in summer to give sub-tropical effects, we notice at once a striking departure from ordinary flowers, and at first may not perceive in the narrow petal-like objects anything that will do for either stamen or pistil. We shall, however, on careful examination, see that some of the narrow petals have whitish tips and pollen masses upon them. These are the stigmas, as shown in fig. 10A. The anthers are of similar character, looking like leaves. Their filaments (stalks) are expanded on one side in a petal, and the actual anther, with a slight expansion on the other side, will be noticed arranged longitudinally near the top (see fig. 10).

The Cannas belong to the Marantaceæ, in which the plants yielding the true arrow-root are found, and botanists describe them as having "a calyx of three sepals, a corolla of six pieces, five of which are erect, the other reflexed; these may be considered rather as abortive stamens than petals; the one fertile stamen is petal-like, with an anther on the margin; the style is also petal-like, with a linear stigma." * The seed of these plants is very hard, and justifies the popular name of "Indian Shot."

My acquaintance with Cannas is confined to the greenhouse varieties, known as "Alexandra," &c., and they appear to conform very closely in structure to the figures of *C. Indicus* and others in Roscoe's great work on the *Scitamineæ*. When the flower has opened, any casual observer would at first be puzzled to find the reproductive organs. He would see a mass

* Treasury of Botany.

of pollen adhering to what looks like a slender leaf, and might detect no symptoms of a stigma. He would see an anther-like body attached to the margin of another leaf, but most likely without a trace of pollen upon it. These appearances would be puzzling, but easily explained by unrolling a few buds, just before their natural time of opening. It would then be seen that the *stigma* was a whitish body at the apex of the leaf (or petaloid expansion), and that it was soft and full of fluid. Thinly slicing it, and placing it under a ½-inch power, would show the structure exhibited in fig. 10—a multitude of fine tubes. The anther grows so as to touch the stigma-leaf; and frequently, if not always, transfers the whole of its pollen to that body before the bud opens. This had happened in every case I have examined. Soon after the opening of the flower the stigma shrivels, and often leaves scarcely a trace to be seen. The impregnation thus appears to occur in the bud, and unless insects have any action in carrying pollen from one plant to another, the greater part of the pollen-globules of any plant have no chance of performing their function, as they are deposited below the stigma, and cannot get at it by any movement of their own. The soft tubular filaments catch and entangle the pollen that is used.

The petaloid condition of styles and of stamens, which is normal in some plants, occurs in others as a monstrosity. For example, I noticed, in February, a Fuchsia (in a greenhouse) with a very strange-looking flower. Two of the sepals, instead of taking their usual appearance, resembling white petals, had grown into green leaves, and another had formed itself into a hollow slipper-like object, while some of the stamens had developed petaloid outgrowths, as shown in fig. 11, with rich red colours.

Facts of this kind are very instructive, because they indicate modes of transition by which one group of plants might give rise to varieties that would be classed in other genera, families, or orders. There is an obvious difference between variations from the parent type that are properly called deformities, and which involve some injury or infirmity, and those that are consistent with vigorous growth and reproduction under certain conditions. If means could be found of perpetuating such an abnormal Fuchsia as I have described, we should have a new garden flower. In this Fuchsia, the outgrowth was from the anther itself, not from the filament.

In Dr. Maxwell Masters' "Vegetable Teratology,"* a long list is given of plants subject to "petalody of the stamens;"

* Ray Soc. publication.

and amongst them it appears to occur most commonly in Ranunculus, Anemone, Poppy, Clematis, Hepatica, Geranium, Pelargonium, Camellia, Deutzia, Fuchsia, &c., those mentioned being within easy observation of frequenters of gardens or cultivators of flowers. Dr. Masters says: "When petalody specially affects the anther-lobes, as in Arbutus, Petunia, Fuchsia, &c., the venation of the petal-like portion is very frequently laminar, thus tending to show that the anther is in such cases really a modification of the blade of the leaf; but as, on the other hand, we often find petal-like filaments having pollen sacs on their sides, it is clear we must not attribute the formation of pollen to the blade of the leaf only, but we must admit that it may be formed by the filament as well." He also says that the "tendency to petalification is greater among those plants which have their floral elements arranged in a spiral series, than amongst those where the verticillate arrangement exists."

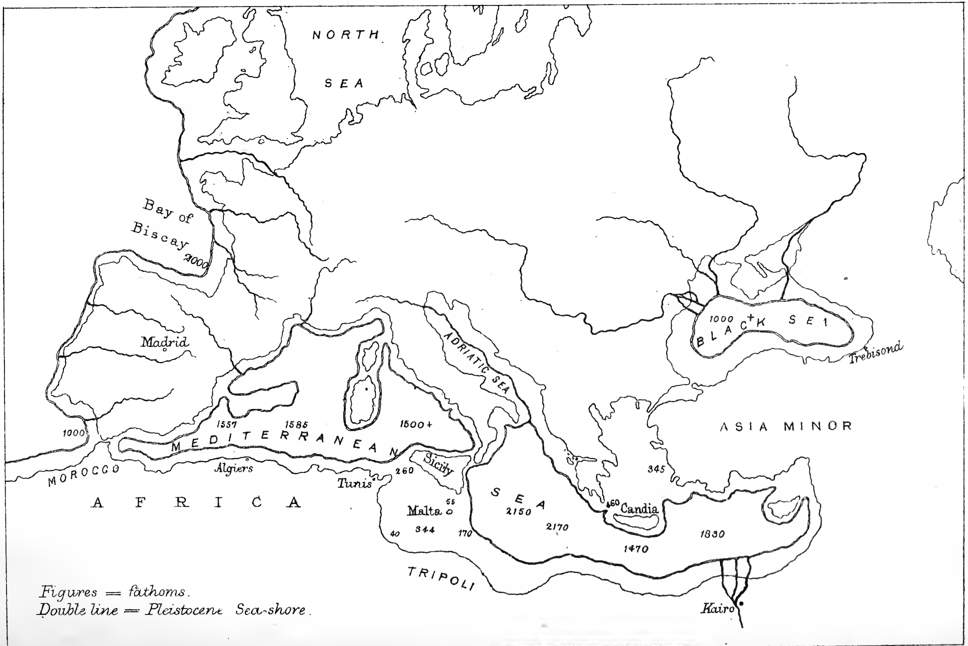
Doubtless the cultivators of "Popular Science" will look out for instances of these and other modifications; and they may be assisted by another quotation from Dr. Masters, who informs us that De Candolle observes that, in the Ranunculacæ, the species of Clematis become double by the expansion of the filament, those of Ranunculus by the dilatation of the anthers, and those of Helleborus by the petal-like development of both filament and anther."

It would have been easy to have thrown the matter of the preceding pages into a more regular form, but the one chosen has arisen out of accident that may happen to many observers. It occurred to the writer that remarks founded upon a few objects which he had collected and mounted during a few months of the past and present year might stimulate others to make observations and collections of this description, and would be more acceptable to many than a technical or formal essay. It is often necessary to study objects according to a logical or scientific arrangement of them into groups, but the microscopist who keeps his eyes open will find subjects of investigation presented to him in defiance of all rules. This is the case in reference to plants as much as to anything else; and the preceding illustrations may show how various species and parts may be studied, with the additional interest afforded by finding that the information they afford all tends to coalesce in certain broad philosophical ideas. Few persons can be botanists, in the sense of acquiring a complete knowledge of any considerable portion of the immense vegetable kingdom; but anyone in a few hours of recreation may acquire food for pleasant thought, and learn enough to appreciate many of the broad generalisations at which the greatest investigators arrive.

It is of course very necessary to learn the names of plants, and be able to describe them according to a system; but no one should be satisfied without employing the microscope to elucidate minute structures, and acquiring at least the rudiments of vegetable physiology and morphology.

EXPLANATION OF PLATE XCVI.

Fig. 1. Deutzia Scabra, stellate leaves on flower-bud. (Mag.)
,, 2. Gum Cistus, sepal hairs. (Mag.)
,, 3. Coleus leaf, hairs and glands. (Mag.)
,, 4. Hypericum pulchrum leaf, with marginal glands. (Mag.)
,, 5. Azalea anthers. (Mag.)
,, 6. Rhododendron anthers. (Mag.)
,, 7. Berberis Darwinii anthers, with lids. (Mag.)
,, 8. Narrow-leaf Bay anthers, with lids.
,, 9. Sparmannia Africana, flower. (N. S.)
,, 9 A. ,, ,, filaments and anthers. (Mag.)
,, 10. Canna anther and stigma, with petal-like expansions. (N. S.)
10 A. Portion of stigma in section. (× 200).
11. Fuchsia anther, with petal-like expansion. (N. S.)



W. West & Co. lith.

PLEISTOCENE GEOGRAPHY OF MEDITERRANEAN.

THE PHYSICAL GEOGRAPHY OF THE MEDITERRANEAN DURING THE PLEISTOCENE AGE.

By W. BOYD DAWKINS, M.A., F.R.S.

[PLATE XCVII.]

IN a preceding essay* we have seen that north-western Europe was elevated, during the Pleistocene Age, to an extent of at least 600 ft. above its present level, so that Ireland was united to Britain, and Britain was joined to the mainland of Europe, proof of this elevation being dependent upon the soundings on one hand and the distribution of the fossil mammalia on the other. Such a change must necessarily have affected the whole physical conditions of the area, since the substitution of a mass of land for a stretch of sea and the higher altitude of the land would tend to produce climatal extremes of considerable severity. It is indeed no wonder that, during this time of continental elevation, the hills of Wales, Yorkshire, Derbyshire, Cumbria, and Scotland should have been crowned with glaciers, or that there should have been a migration to and fro of animals, comparable to that which is now going on in Siberia and the northern portions of North America. I propose in the present essay to apply the same modes of investigation to the Mediterranean area. The condition of southern Europe at that time has a most important bearing on any conclusion which may be drawn as to the Pleistocene climate in France, Germany, or Britain. For if it be proved that a mass of land then extended where the Mediterranean sea now rolls, the extension would increase both the heat of the summer and the cold of the winter in central and north-western Europe.

The geological evidence that the Mediterranean region has

* "On the Pleistocene Climate and the Relation of the Pleistocene Mammalia to the Glacial Period."—*P. S. Review*, Oct. 1871.

been subjected to oscillations of level during the Tertiary period, is clear and decisive. Professor Gaudry has proved, in his work on the fossil remains found at Pikermi, that the plains of Marathon, now so restricted, must have extended, in the Meiocene Age, far south into the Mediterranean, to have supported the enormous troops of hipparions and herds of antelopes, the mastodons, and large edentata, revealed by his enterprise. The rocky area of Attica, as now constituted, could not have afforded sustenance for such a large and varied group of animals, nor would the broken hills and limestone plateaux have been inhabited by hipparions and antelopes, if their habits at all resembled those of their descendants living at the present time. It may, therefore, reasonably be concluded that Greece, in those times, was prolonged southwards, and united to the islands of the Archipelago by a stretch of land; and if Africa were then, as now, the head-quarters of the antelopes, it is very probable that one of the lines by which they passed over into Europe, and spread over France and Germany, was in this direction. Nevertheless, it must be admitted, that the changes of level, which have taken place since the Meiocene Age in those regions, are so complicated as to render it almost impossible to restore the Meiocene geography.

In the succeeding, or the Pleiocene Age, the presence of the African hippopotamus in Italy, France, and Germany, can only be accounted for by a more direct connection with the African mainland than is offered by a route through Asia Minor. It would seem, therefore, that then the Mediterranean Sea could not have formed the same barrier to the northern migration of the animal which it does now. In many regions, however, the present land has sunk beneath the sea; and marine strata, of Pleiocene Age, are accumulated in the Val d'Arno, Sicily, and southern France.

In treating of the physical conditions of the Mediterranean area in the Pleistocene age, I shall first of all take the evidence of the mammalia, and then compare it with that offered by the varying depth of the sea at the present time, following out an idea suggested by the late Dr. Falconer in a speech before the British Association in 1863. The mammalia of the Iberian peninsula will be taken first.

The researches of Captain Broome, Professor Busk, and of Dr. Falconer,* in the bone caves of Gibraltar, carried on through a long series of years, have established the fact, that African animals lived in considerable numbers on and around that

* "Falconer Palæont.Mem." vol. ii. Busk, "International Congress." "Prehistoric Archæol." Norwich.

barren rock, in the Pleistocene period. The animals found consist of the following species:—

Homo, man.	*Canis lupus*, wolf.
Lepus cuniculus, rabbit.	*Equus caballus*, horse.
Felis leo, lion.	*Rhinoceros hæmitoechus.*
F. pardus, panther.	*Capra ibex*, ibex.
F. caffer.	*Sus scrofa*, wild boar.
F. pardina, lynx.	*Cervus elaphus*, red deer.
F. serval, serval.	*C. capreolus*, roe.
Ursus ferox, grizzly bear.	*C. dama*, fallow deer.

The spotted hyæna, the serval, and *Felis caffer*, are species now peculiar to Africa, and it is obvious that they could not have found their way into Gibraltar under the present physical conditions of the Mediterranean. Such a varied group of animals could not have lived in Gibraltar as now constituted, and their very presence therefore implies the existence of land which has now been sunk beneath the waves.

To this list of African animals, which formerly lived in the Iberian peninsula, M. Lartet added the *Elephas Africanus* (the African elephant)* and the *Hyæna striata*, or striped hyæna, found in a stratum of gravel near Madrid.

The mammalia discovered in the bone-caves of Sicily afford the same kind of evidence as to the former extension of the African mammalia northwards, as those of the Iberian peninsula. Caves have been worked during many years in that island, for the sake of the bones, to be used in the manufacture of lamp-black, since the year 1829; and from one cave, that of San Ciro, many ship-loads were sent to Marseilles. Nearly all the bones were identified as belonging to the hippopotamus by M. de Christol. In 1859† Dr. Falconer examined the collections made from this cave, as well as those which remained *in situ*, and carried on further researches into a second in the neighbourhood, known as the Grotta di Maccagnone, and in the following year two others were discovered and explored in northern Sicily by Baron Anca. The species were as follows:—

Felis (leo?), lion.	*Elephas antiquus.*
Hyæna crocuta, spotted hyæna.	*Elephas Africanus*, African elephant.
Ursus ferox,‡ grizzly bear.	*Hippopotamus (major ?)*, hippopotamus.
Canis.	*Hippopotamus Pentlandi*, Pentland's hippopotamus.
Cervus, deer.	*Lepus.*
Bos, ox.	
Equus, horse.	
Sus scrofa ? boar.	

* "Comptes Rendus," xlvi. 1858.

† Falconer, "Palæontographical Memoirs," vol. ii. p. 543.

‡ The same as bear from Grays Thurrock, Essex, which is *U. ferox.*

The African elephant* was obtained from three caves: from that of San Theodora, by Baron Anca; from Grotta Santa, near Syracuse, by the Canon Alessi; and from a cave near Palermo, by M. Charles Gaudin. It is obvious that the presence of this animal, as well as of the spotted hyæna in Sicily, can only be accounted for on the hypothesis that a bridge of land formerly existed, by which they could pass from their head-quarters—that is to say, Africa. On the other hand, the presence of the grizzly bear and of the *Elephas antiquus* implies that they passed over into Sicily from their European head-quarters before the existence of the Straits of Messina. The larger species of hippopotamus, doubtfully referred by Dr. Falconer to the *H. major* (=*H. amphibius*), may have crossed over either from Italy—where its remains are very abundant in the Pleiocene and Pleistocene strata—or from Africa.

Nor are we without indications—from the distribution of one of the fossil mammals—of the position of the land that formerly connected Sicily with Africa. The small species of hippopotamus (*H. Pentlandi*), almost as small as the living *H. Liberiensis*, occurs in incredible abundance in the Sicilian caves; and it has also been discovered by Capt. Spratt and Dr. Leith Adams in the bone-caves of Malta, along with the pigmy elephant (*Elephas Falconeri*) and a gigantic dormouse (*Myoxus Melitensis*). A tooth belonging to the same animal, preserved in the British Museum, was obtained by Dr. Leith Adams from Candia. In 1872 I was enabled to extend its range to the mainland of Europe by the identification of a last lower true molar in the Oxford Museum, which was obtained by Dr. Rolleston from a Greek tomb at Megalopolis, in the Peloponese, and which was probably derived from some of the many caves in the limestone of the district.† For this extinct animal to have spread from Sicily to Malta, from Malta to Candia, and from Candia to the Peloponese, or *vice versâ*, these three islands must have been united together, and have formed the higher grounds of a land now submerged beneath the waves of the Mediterranean. We may therefore infer that Sicily was connected with Africa by a southern extension of the land, in the direction of Malta.

If the African mainland extended to Europe in the directions

* Falconer, Op. cit. ii. p. 283.

† It was very probably interred for some superstitious reason. It is by no means improbable that the Greeks used fossil bones and teeth as medicine, just as the Chinese do at the present time. In the Middle Ages they were eagerly sought for in the caves of the Hartz, and figure largely in all the old pharmacopœias.

of the Straits of Gibraltar and of Malta and Sicily, so as to afford passage for the African mammalia into Europe, it would afford equal passage for the southern advance into Africa of some of the European mammalia. Evidence of this we meet with in the bone-cave of Mansourah, near Constantine, in Algèria, described by M. Bayle in 1854.* The animals which he obtained, consisting of the horse, ox, antelope, hippopotamus, and elephant, have been described by Professor Gervais.† An examination of his figure of a fragment of a molar tooth leaves no room for doubt that the *Elephas meridionalis* was living in North Africa during the Pleistocene age; that is to say, an extinct animal, the head-quarters of which are to be found in Italy, ranged as far south as Northern Africa.

The former continuity of Africa by way of the Iberian peninsula and Sicily, may also be inferred by the distribution of the mammalia at the present time. Professor Gervais observes that most of the insectivora are the same in Europe and North Africa. The genette and *Fœtorius furo* (ferret), the *Mangousta Widdringtoni* (Gray), and the fallow-deer, are common to Spain and Africa. The porcupine of Algeria belongs to the same species as that of Italy and Sicily, and the wild boar does not present any characters of importance by which it can be separated from that of Europe. From the present range, therefore, of the mammalia the same conclusion may be drawn as to the continuity of Africa with Europe, as is afforded by their distribution in the Pleistocene Age.

These conclusions, derived from the study of the mammalia, are corroborated and supplemented by the evidence of the soundings. As we enter the Straits of Gibraltar (Pl. XCVII.) the Atlantic Ocean shallows, until between Tangiers and Tarifa it is not more than from 270 to 300 fathoms. Between Tarifa and Ceuta the sea measures from 300 to 400 f., and thence, in passing westwards, suddenly deepens to the extent of over 1,500 f. An elevation of 400 f. would be quite sufficient to raise a barrier of land between Morocco and Spain, and to insulate the deep Mediterranean basin from the Atlantic. The soundings between Sicily and Tunis are 260 fathoms, between the former place and Malta 55 f., between Malta and the African mainland 344 f. An elevation of 400 f. would suffice therefore to connect Africa with Sicily, and to insulate the eastern from the western deep Mediterranean areas. To the east of Sicily the soundings reveal a depth of over 2,000

* Bull. Soc. Geol. France, 2e Sér. t. xi. p. 340.

† Gervais, "Nouvelles Rechérches sur les Animaux vertébrés vivants et fossiles," 4to, Paris, 1867–9, p. 88.

fathoms, and this deep basin extends as far to the east as Cyprus and Asia Minor. Between Candia and the Peloponese the sea is 460 fathoms deep. An elevation therefore of 500f. would allow of the passage of *Hippopotamus Pentlandi* from Candia to the Peleponese, and it would moreover allow of the animal ranging thence by Southern Italy into Sicily and Malta. I have, therefore, represented in the map what would be the necessary result of the elevation of the bottom of the Mediterranean to that extent. Two great barriers of land would extend from Africa into Sicily and Italy, and enable the African mammalia to find their way into the regions north of the Mediterranean Sea. The shallowness of the sea at those two points indicates the existence of the sunken barriers, while the African elephant has been found only in the contiguous areas in Europe. Such a change as this would convert the Adriatic into dry land, and cause the islands of the Grecian Archipelago to rise high above the surrounding plains. The five hundred fathom line is therefore taken to represent the probable sea margin of the Pleistocene age, although in centres of volcanic activity, such as Sicily and the Archipelago, local changes of level, even of greater magnitude, may have taken place.

This view of the former physical condition of the Mediterranean area, by which the present shores stood at a height of about 3,000 feet above their present level, will go far to explain the very remarkable evidences of glaciers met with by Mr. Palgrave in Eastern Anatolia, and by Mr. Maw in Morocco.

In the central plateau of Asia Minor,* glacial action is strongly marked; and especially in the valley through which the Chorok flows, and in the mountainous country to the north-east, between Georgia and the Black Sea. The river Chorok runs about 120 miles, in a north-easterly direction, and is separated from the Euxine by a high mountain chain, forming a long strip of land which is called Lazistan, after its inhabitants, a tribe of Lazes. It then turns suddenly to the north, where it falls into the sea. The southern side is determined by mountains of Cretaceous, Jurassic, and Plutonic rocks, which are the watershed between the tributaries of the Black Sea and Persian Gulf. Three large moraines are to be found on the southern side of the valley, their lower extremity about 5,000 feet above the sea, their upper origin nearly 8,000 feet. No moraines are seen where the chain does not reach an altitude of 7,000 feet, though angular boulders are not uncommon. The upper mountain contours

* "Vestiges of Glacial action in north-eastern Anatolia," by Gifford Palgrave. "Nature," October 31, 1872.

are invariably rounded and smoothed off, and the sides are scooped too widely for the depressions to have been caused by water. "Low down in the valley the slopes terminate in rifted precipices."

That these moraines were posterior to the volcanic action in the district is evident from the examination of a broad stone ridge near the highest point, to the east of Erzeroum, where at a height of 7,000 feet the Jurassic limestone was interrupted by a volcanic outbreak of several miles in extent. Traces of a crater were visible. Above, the granite peaks rose to a height of 9,000 feet; below, a wide moraine crossed the road, composed of volcanic fragments mixed with granite. Consequently, it must have been formed after the volcano had become extinct. Similar traces are to be found at Keskeem Boughaz. Mr. Palgrave concludes that "the ice-cap of the north-easterly Anatolian watershed, in post-pliocene (Pleistocene) times, must have reached downwards, on the northern side of the range, to 7,000 feet above the present sea-level, while some of the glaciers issuing from it descended to about 4,500 of the same measurement." Striated and ice-worn boulders, and especially of granite, were very abundant. This region, it must be observed, is within sight of the lofty granite range of Tortoom, which is "streaked with perpetual snow."

On leaving the Chorok valley and getting on to the watershed, at a distance of fifty miles to the north-east comes the main ridge or backbone of the land. Here, among the limestone ledges, about 6,400 feet above the sea, is a colossal moraine, formed of worn granite blocks, partly overgrown with forest, and descending from a height of over 8,000 feet. It is divided by a valley from a lofty undulating granite plateau that is scooped out here and there into deep little oval lakes, always full of blue water. The sides of the plateau are strewn with boulders of granite, brought from the higher peaks about five miles off. These boulders occur in greater or less abundance down to the basin of the Ardahan, near the sources of the Kur or Cyras, which joins the Araxes before flowing into the Caspian. The height of this Ardahan basin is about 6,500 feet: it is, but for a slight easterly slope, a water-level. The bottom consists of deep alluvial soil mixed with detritus and boulders; the sides are rounded and smoothed, and bear every mark of long ice-covering. Plateaux stretch east to Russo-Georgia, all containing lakes, till their greatest height is gained at Kel Dagh, a mountain about 11,000 feet, then descending to the plains of Georgia and the Black Sea; but from this point the character changes, rifts, precipices, and narrow gorges taking the place of the rounded undulating outlines further inland. Nor is there any further trace of boulders or moraines.

With but one exception, there is no trace of glacial action along the coast between the river Rion and Trebizond. This exception is at Hamshun, high up in the Lazistan mountains. Here, at 6,900 feet, is a granite-strewn plateau, thinly green with grass, sheltered from the sea by lofty peaks on the north-west and backed to the south-east by tremendous jagged granite cliffs, the highest 12,500 feet above the sea. "The plateau itself was about forty miles in length, irregular in breadth, its surface rounded and jotted over with boulders. But just as my track led near under the base of Verehembek, at an altitude of 8,300 feet, it crossed a large broad moraine," descending from the higher slope, and having its base in a broad bare valley not far below; thus indicating that here, too, at the highest and widest part of the Lazistan chain, perpetual ice had once existed in sufficient quantity to furnish one glacier. But if warrantable conclusions can be drawn from a single instance, the limited ice-cap of the Hamshun highlands extended no further down than 8,500 or 9,000 feet, thus differing by a line of 1,000 to 2,000 feet from the glacial covering of the inland range.

My friend Mr. George Maw has lately proved that similar glaciers formerly existed in Morocco, since he met with unmistakable moraines in his interesting journey, along with Dr. Hooker and Mr. Ball, to the summit of the great Atlas in 1871. "After four hours continued ascent," he writes (p. 19), "the termination of the glen comes into full view, and we observe with great interest that it is closed by a group of moraines, proving the former existence of glaciers in the Atlas, and confirming my opinion that the great boulder beds flanking the chain are also of glacial origin. Two villages, probably the highest in the Atlas, are built on the principal moraine, Eitmasan at its base, at a height of 6,000 feet, and Arroond, near its summit, at a height of 6,800 feet; the terminal angle of the larger moraine having a vertical height of over 800 feet. It is composed of immense blocks of porphyry, lying at a steep angle of repose, up which it takes us nearly an hour to climb. The existence of these moraines in latitude 30½ (the latitude of Alexandria) is perhaps the most interesting fact we noticed during our journey, for this is the most southerly point at which the evidence of extinct glaciers has been observed, and tends to confirm the opinion entertained by many geologists, that the refrigeration during the glacial period was almost universal." *

* "A Journey to Morocco and the Ascent of the Great Atlas." A lecture delivered before the Birmingham and Midland Institute, Slater, Ironbridge, Salop.

The elevation of these African moraines above the sea is as nearly as possible the same as those of Asia Minor, about 6,000 feet and upwards. If the mountains of Atlas and Lazistan shared in the upward movement of the Mediterranean area, the addition of 3,000 feet to the height could not fail to leave marks behind of the low temperature thereby induced. It is very probable that during the time the Mediterranean was reduced to two land-locked seas, these mountains were covered with snow-fields, and constituted the ice-sheds of glaciers, just as we have reason for the belief that Wales, Ireland, Cumbria, and the Pennine chain and a great portion of Scotland were clad with ice at the time that Britain formed part of the European mainland.

From the range of the mammalia we have inferred the existence of land barriers extending across from Africa to Spain and Italy and from Candia to Greece, and their actual existence beneath the sea has been proved by soundings, which necessitate an elevation of about 500 fathoms to bring them above the sea level. We have also seen that the higher mountains, which most probably participated in this upward movement, bear traces of a lower temperature in the moraines of Atlas and Lazistan. The hypothesis of such an elevation during the Pleistocene Age may therefore be taken to be proved so far as it explains widely different classes of facts.

The substitution of land for a stretch of sea in the Mediterranean could not fail to cause the summer heat to be more intense in the region to the north than at the present time, while the increased elevation would produce a greater severity of winter cold, as Mr. Godwin Austen has pointed out in the case of the hills of Devonshire. When, indeed, we consider that the Pleistocene land surface extended from the snowy heights of Atlas as far north as the hundred fathom line off the coast of Ireland, we might expect to find that African animals, such as the spotted hyæna and *Felis caffer*, ranged as far north as Yorkshire, for the only barrier to their migration would be that offered by the severity of a Pleistocene winter.

The submergence of the barriers and the constitution of the Mediterranean as we find it now, have probably taken place but a short time ago, from the geological point of view, though we know that for the last three thousand years the Mediterranean has been on the whole unchanged, except by the silting out of the sea by the sediment of rivers such as the Po, and the elevation and depression of small areas by volcanic energy, as at Santorind. The physical character of the shores testifies to the truth of this view.

"On entering the Straits of Gibraltar," Mr. Maw writes, "from the Atlantic, a notable change takes place in the aspect of the coast. Cape St. Vincent, on the Atlantic coast, presents a bold line of cliffs to the sea, and bluff cliffs extend many miles towards the Straits; but as soon as these are passed, a change of coast-form takes place, which must be noticeable to every observer. Cliffs on the sea-board become the exception, and the general line of the coast is merely a shelving under the sea of the general hill-and-valley system of the land, the sea running up all the depressions, and the land elevations spreading out into the sea with scarcely any abrupt cliff-line of demarcation. The uneven sea-bottom of the Straits seems to be a continuation of the contour of the adjacent land, consisting of rolling alternations of hill and valley, which must have received its conformation by sub-aerial agencies.

"Corsica, and the adjacent islands of Elba, Capraja, and Monte-Christo, are also remarkable for the absence of cliffs, and are wanting in those abrupt escarpments separating land and water which are so abundant on our own coasts. Their aspect is that of mountain-tops rising out of the sea, suggesting to the eye the seaward prolongation of their sub-aerial contour of sloping hill-sides and river-cut valleys, as though the sea had not stood sufficiently long at its present level to excavate an escarpment. The deep intersecting bays that occur along the coast from Marseilles to the Riviera suggest the same conclusion, the undulating land surface spreading down to the water's edge, and the deep bays running up the intervening valleys which must have had an origin common with that of their landward prolongations."

It is impossible to shut our eyes to the full force of this admirable reasoning. The present aspect of the Mediterranean is, geologically speaking, a thing of yesterday.

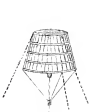


Fig 1.

Fig 2.

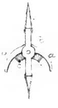


Fig 3.

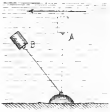


Fig. 4.

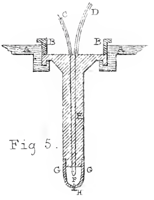


Fig 5.

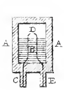


Fig. 6.

Fig 7.

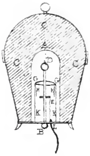


Fig 8.

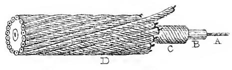


Fig 9.

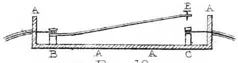
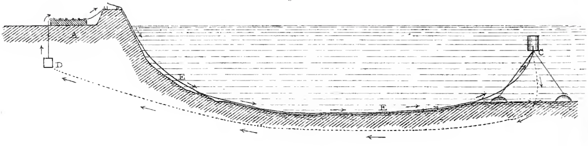


Fig 10.

Fig. 11.



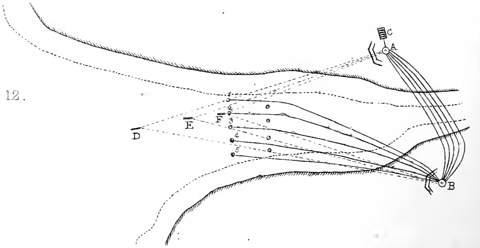


Fig. 12.

A. H. A. W. West & C. Lith.

Torpedoes and their application

TORPEDOES.

By A. HILLIARD ATTERIDGE.

[PLATE XCVIII.]

THERE are few things more remarkable than the great revolution which science has effected in modern warfare. Within the last twenty years there have been hundreds of inventions and improvements in our means of attack and defence, and the result has been such a development of destructive power that in all but its great unalterable principles war has been completely changed. On the battle-field, before the deadly fire of the breechloader, the long line and the massive column have given way to clouds of skirmishers; huge guns, such as men only dreamed of a few years ago, are mounted in our ships and fortresses; and instead of the old three-deckers which carried our flag in the days of Howe and Nelson, our fleets are composed of ironclad monsters, any one of which could annihilate all the armadas of former times. A new feature, too, has been introduced into naval warfare—a new means of defence has been gradually devised—and now an armament, when it approaches a hostile shore, has to risk destruction from mines hidden deep below the surface of the sea. Torpedoes, once rude contrivances scarcely less dangerous to those who used them than to the enemy against whom they were employed, are now, thanks to the researches of our electricians, marvels of ingenuity, perfectly safe to handle, but fearfully dangerous to the aggressor. By their means coasts and harbours can be easily and cheaply placed in a thorough state of defence; and ports, while secure from the approach of a foe, can be still left open to friendly men-of-war and merchant ships. It is only of late years that torpedoes have been brought to this high state of perfection; they have hitherto been employed comparatively rarely in actual warfare, but there is little doubt that they will play a great part in future conflicts. In this paper we propose to give a short account of the various ways in which they are constructed; but as in a few pages it would be difficult even to enumerate all the methods which have been adopted, we can only describe the more important plans of action which have been used or suggested.

A torpedo may be briefly described as a waterproof case of gunpowder, or some similar explosive, so arranged as to be fired close to a hostile vessel, with the object of sinking her. They may be at once divided into two great classes—stationary torpedoes, which are fixed at one spot and fired on the enemy's touching or approaching them, and locomotive torpedoes, which are either propelled against a ship by some mechanical contrivance or allowed to drift with the current. It would be difficult to say when or by whom torpedoes were first used; certain it is that the original idea must be an old one, for drifting fireships were employed at a very early date, and gunpowder could not be long invented before some one would think of making a fireship into a floating mine. The first attempts in this method of attack were of the rudest kind. Nearly a hundred years ago, in 1778, the Americans used drifting torpedoes against the English fleet in the Delaware. The plan adopted was to fill small kegs with gunpowder, and place in them a gunlock, so arranged that the collision with a ship's side would bring down the hammer and explode the charge. "Bushnell," says Fenimore Cooper, "made several unsuccessful attempts to blow up the ships of the enemy by means of torpedoes, a species of warfare which it can hardly be regretted has so uniformly failed." * This was written in 1839, and up to that time it might be said with truth that torpedo warfare was an utter failure. But men worked on, improvements were suggested, new plans were invented, but still it seemed almost impossible to construct anything like a safe and at the same time efficient torpedo. In the Crimean war the Russians used drifting torpedoes against the allied fleets in the Baltic. Many of these were exploded mechanically by coming in contact with French and English men-of-war, but the charges were so small that no serious damage was done by them, and more than one which failed to explode was picked up and found to be quite incapable of doing harm, because the men employed to place it in the water had neglected to put the firing apparatus in working order by withdrawing the safety key, lest they should themselves be destroyed by an accidental explosion. Indeed the great defect of any torpedo fired in this way is the peril to which it subjects all who have to handle it, as any rough usage would ignite the charge, and moreover when once it is set adrift it is dangerous alike to friend and foe.

It was in the civil war in America that torpedoes were first used to any great extent, and for the first time were really successful. The Confederates, in particular, were very active in this

* "History of the Navy of the United States of America,' vol. i. p. 157.

way; they succeeded in sinking many of the Federal ships; and at Charleston, though the guns of the blockading fleets again and again silenced the land batteries, the ships were kept out of the harbour by the lines of torpedoes moored at its mouth. It was during this conflict, too, that the first great step was taken towards making torpedoes at once safe and effective, by using electricity as a means of ignition, thus keeping those terrible weapons completely under the control of the defenders, so that by merely disconnecting the electric battery from the wires they can be rendered perfectly harmless, and by renewing the connection they can be in a moment again made ready for action. In this way friendly vessels can be allowed to get into a harbour in safety, while an attacking squadron is held at bay; but with the old plan of firing the torpedoes mechanically, when once they were laid down neither friend nor foe could enter the port; and, moreover, to remove them when the war was over would be an undertaking of such frightful peril that it would be hard to get anyone to attempt it, as an incautious touch would be enough to explode the mine and blow the working party into the air. By adopting electricity as the igniting agent all those disadvantages are obviated.

Again, in the "Seven Weeks' War" of 1866 we see torpedoes once more employed, and now still further improved. In that year the Austrian engineers arranged and executed a complete system of torpedo defence for Venice and the Adriatic coasts of the empire. It was not, however, put to the test of having to resist an attack of the Italian fleet, for Tegethoff, by his splendid victory at Lissa, crushed for the time the naval power of Italy. This is, nevertheless, an important epoch in the history of this kind of warfare, as it was the first time that a regular system was adopted; for in America all that had been done was to use such materials and such forms of apparatus as came readily to hand; and almost every sort of contrivance was used at different times and places. At the great Paris Exhibition of 1867 the methods used in the defence of the Venetian coast were exhibited by the Austrian government, and the period between the wars of 1866 and 1870 was one of great activity in researches and experiments in this department. When war was declared by France, the Prussian government at once proceeded to put all their ports in a state of defence with the help of torpedoes. The most improved forms of apparatus were used, and there could not be a better example of the way in which an inferior naval power can now render itself secure from the attack of a much superior one. The Germans tacitly acknowledged their inferiority on the sea, for their men-of-war never left the protection of the forts of Kiel and Wilhelmshaven; yet the French fleet, from which so much had been expected, effected absolutely nothing. The German harbours, with this new defence, were almost impregnable, and they were not attacked. So well satisfied is the German government with the experience of 1870, that it is said that they have decided to build no more men-of-war for the present, but to devote the funds which would otherwise be used for this purpose to the construction of floating batteries and the acquisition of torpedo *matériel* for the defence of their coasts and harbours.

With this brief sketch of the history of torpedo warfare we must pass on to an account of how it is conducted. We shall speak first of fixed torpedoes, and the way in which they are secured in position and fired so as to do their work; then we shall go into the general principles of harbour and coast defence; and finally we shall briefly refer to the most successful efforts which have been made to construct effective locomotive torpedoes—a branch of the subject which is not yet so far advanced.

The first thing necessary in the construction of a torpedo is a case in which to place the charge. This case must be perfectly water-tight, otherwise the explosive will be rendered useless by the water leaking into it; and to secure this it must be strong enough to bear a good deal of rough handling, and also the pressure of the water at the depth to which it is to be submerged. When (as is usually the case) it is to be floated up from an anchor, it must have, when loaded, sufficient buoyancy to keep it steady at its moorings. It must be of such a shape that the charge may be readily and completely ignited with as few fuzes as possible; and as with gunpowder, or gun-cotton with an ordinary fuze, the explosion is not instantaneous in a charge of any size, but as it were runs through it, the case must be strong enough to hold together for a moment till the whole explosive force is developed; otherwise the first portion of the charge ignited will burst it, and admit the water to the rest. Various forms of case and various materials have been used or suggested. For their smaller torpedoes the Americans employed wooden barrels, and for the larger kind cases made of boiler-plate, and not unfrequently they used steam-boilers for this purpose. The barrels would of course be strengthened at the heads, and every kind of extemporised case would have to be made thoroughly water-tight by being coated either inside or outside with tar or some other waterproof material. The torpedoes for the defence of the Venetian coast in 1866 had either iron or wooden cases. (See figs. 1 & 2, Pl. XCVIII.) The former consisted of two cylinders, one within the other; the inner one contained the charge, and the space between them was left empty, to give buoyancy to the whole. The outer case was about 4 ft. high and 4 ft. in diameter, and the charge was 3 cwt. of gun-cotton. The wooden cases were also double, the space between them being filled with tar to make the torpedo water-tight. The inner case (about 4 ft. × 4 ft.) was further protected by being covered with plates of zinc, and contained a charge of 4 cwt. of gun-cotton, with air-spaces in the centre to make it buoyant. The form here adopted—a cylinder of equal height and diameter—seems to be the best. In theory the best form would be a globe, the charge to be ignited at the centre; but there would be a hundred difficulties in the manufacture and use of such a case in practice; and the cylindrical case of these dimensions, which is the nearest form to it we can conveniently use, gives us almost all the advantages which theoretically belong to the globular form, the greatest of which is that the thorough and uniform ignition of the charge is secured by its compact form, which brings all the outer portions within an equal distance of the point at which the ignition commences. A case of English invention consists of a cylinder of iron to contain the charge, protected by a thick outer covering of fir-wood soaked in tar and painted to make it water-tight. Besides wood and iron, a third material has been suggested; this is vulcanised india-rubber made into bags to hold the charges. It is found, however, that the bag gives way before the whole explosive force is developed, and thus a large portion of the charge is lost. To obviate this it has been proposed to place in the centre of the torpedo a long perforated brass tube containing the fuze and a small priming charge, so as to fire the explosive at several points, and thus ignite the whole of it before the india-rubber gives way. It is doubtful, however, if, even with this improvement, the india-rubber case is suitable for torpedoes, at least with charges of gunpowder. Its great advantage is the perfect security from water which it affords to the charge, but the difficulty of producing a complete and effective explosion quite outweighs this. It seems that the vulcanised india-rubber bag might be used with advantage in constructing wood and iron-cased torpedoes, as any defect in the tightness of the case would be neutralised by the charge being enclosed in such an inner covering.

The form and material of the case having been decided upon, the next thing is to select the explosive best suited for the conditions under which it is to act. A few years ago there would have been little to be said on this point, for the only available explosive then known was gunpowder; but now there are a host of such compounds as gun-cotton, xyloidine, nitro-glycerine, dynamite, picrate of potassium, glyoxyline, and more of less importance, and chemistry is continually adding to the number. The essential qualities required in an explosive for this purpose are great power, so that the space within which its explosion will be effective may be as wide as possible; and uniformity of action, in order that we may be able to reckon with certainty on its doing its work. Moreover, it must be capable of being stored for a long time without injury or deterioration; and it must be safe to work with, so as to avoid as far as possible the chance of an accidental explosion. This last condition at once excludes picrate of potassium, picric powder, and all similar compounds, which, though they are very powerful, are also terribly dangerous. Gunpowder fulfils all the required conditions, and it was used almost invariably by the Confederates. Their experiments seem to point to fine-grained powder as better than any other variety; but a much longer series of trials would be necessary before finally deciding on this matter. But if we could obtain an explosive equally safe and more powerful, weight for weight, it is clear that it would be far better suited for our purpose, being more portable, requiring smaller cases, and giving greater buoyancy to the submerged torpedoes. This we find in gun-cotton—a preparation of waste cotton which is impregnated with nitric and sulphuric acids. Its explosive force may be taken as at least four times that of gunpowder; it can be stored without deteriorating, and with almost perfect safety. Even if it is accidentally set on fire in air, it burns with a bright flame without exploding, and besides the advantages we have enumerated, it possesses another which at once marks it as the best for forming the charges of torpedoes. Gun-cotton, when fired with a detonating fuze,* developes its full force instantaneously, and there is therefore no need of using the strong case necessary to ensure the complete explosion of gunpowder. When gun-cotton is used in torpedoes, all that is necessary in the case is, that it should be water-tight, and there is no need of its possessing the great strength which would be otherwise required. A detail of a few experiments will show how efficiently it can be used under water, even in the lightest of cases. In 1870 it was very successfully employed at the Isle of Sombrero, in blasting rocks at a depth of 20 or 25 feet under water. The charges were from 8 to 10 lbs. of compressed gun-cotton, and the cases were made of tarred paper. These charges, which may be looked upon as miniature torpedoes, were placed in the fissures of the rock; and after the explosion the débris they brought down was dredged up. In June 1868 both gunpowder and gun-cotton were used in destroying a sunken iron steamer in the Thames, and this demolition affords very striking evidence in favour of gun-cotton. "Amidships, where the engines and boiler and machinery were situated, a charge of 300 lbs. of gunpowder was fired in contact with the side of the wreck, but it made no breach whatever, owing to

* That is, with a fuze primed with detonating fulminate of mercury.

the great resistance encountered in the interior of the vessel. The machinery, however, showed symptoms of having been shaken, and some beams were cracked. A charge of 230 lbs. of compressed gun-cotton was placed in the same position and fired, and it appeared entirely to complete the demolition. The engines, weighing 300 tons, were shifted bodily out of place; the boilers also were moved, and the wreck was so shattered as to permit of its being pulled up. . . . The work done by the cotton was estimated to be equal to that which would have been done with 1,000 lbs. of gunpowder."* Experiments made at Chatham prove that, under water, a charge of gun-cotton will (as in the instance we have just given) produce the same effect as four times its weight of gunpowder. This supposes that in both cases the object aimed at is vertically, or almost vertically, above the charge. But it is found that the proportion is different with regard to the lateral or horizontal range of the two explosives. The conclusion drawn from another series of experiments, directed to determine the point, was that charges of gun-cotton and gunpowder, in the proportion of 2 and 5, would give equal radii of destructive effect; but within the radius, the gun-cotton would do the greater damage of the two. All these facts point to one conclusion—that gun-cotton is by far the best explosive for torpedo service. Its advantages are—(1) it can be safely stored; (2) it requires only a light watertight case; (3) its explosive power is to that of gunpowder as 4 to 1; (4) it has, weight for weight, a greater radius of destructive effect. Gun-cotton has therefore been generally adopted for torpedo work, and, as we have mentioned before, it was the substance used by the Austrians in 1866.

As for the other explosives, there are none of them which show any superiority to gun-cotton, and none of them are equally safe. One, indeed, nitro-glycerine, possesses the great advantage of not being injured by water; so that, if it were used for torpedoes, the cases need not be so perfectly watertight. But this is compensated by a correspondingly great defect—it is very dangerous to use; and the reader will readily call to mind more than one fatal explosion, the result of some slight accident in its employment or transport.

As to the proper amount of the charge, different writers give various estimates. It will depend on several considerations—the nature of the explosive, the size and build of the ships against which it will probably be used, the depth at which the torpedo is placed, and, finally, the nature of the bottom. It is found that on a soft muddy bottom the downward force of

* "Journal of the Royal United Service Institution," vol. xiv. p. 444.

the explosion forms a crater in the mud; but where it is hard and rocky, it is reflected upwards, and adds considerably (at least 30 per cent.) to the effect of the charge. One scale used by the Confederates began at 300 lbs. of gunpowder for two fathom water, and to this 300 lbs. were to be added for every additional fathom. A scale proposed for gun-cotton begins at 125 lbs. at depths not exceeeding 20 feet, and goes on to 500 lbs. for depths greater than 40 feet. This is, however, one of the many points connected with torpedo warfare on which we have still much to learn.

We have now supposed the case for the torpedo and the explosive it is to contain selected; the next thing to decide upon is, how it is to be secured in its place, and how it is to be fired. Where the depth of the water is inconsiderable, the torpedoes are usually weighted to deprive them of all buoyancy, and then sunk to the bottom; but in the defence of the mouths of great rivers and large harbours it is generally necessary, on account of the depth of water, to moor them in position. It would seem, at first sight, a very simple matter to anchor a torpedo at a previously selected point; but the fact is that the mooring of the torpedoes is the most difficult operation in the arrangement of a system of defence. The sea, or even the surface of a large harbour, is seldom perfectly smooth, and a slight breeze, the rise and fall of the tide, a current, or the flow of a river, all put obstacles in the way. Several points have to be attended to in fixing a torpedo in position. It must be steady in one place, and that place must be accurately known; there must be on the surface no indication of the presence of danger; and, lastly, there must be as little twisting of the mooring lines by the current as possible, otherwise the insulated electrical cable of the torpedo might be injured. According to circumstances, from one to three moorings, connected with anchors or heavy weights, are attached to each torpedo. The Austrians in 1866 used a triangular wooden platform, heavily weighted, and having a mooring-line fastened at each angle. But this method of fixing the torpedoes was used in the Adriatic, an almost tideless sea, where there was no danger of the moorings twisting and entangling. The form of anchor used in English experiments was generally what is called a crab-anchor—a dome-shaped mass of metal, with points round the circumference of its base to take hold of the ground. The torpedo is attached to this by a mooring-line of wire-rope, of such a length that the charge is kept at the required depth below the surface. There are two methods of effecting this. The anchor and the torpedo may be fastened to the mooring-line at the proper distance apart, and then both together may be lowered into the sea. But it is found to be almost impossible to fix a charge accurately in position in this way, unless with small torpedoes, in shallow water, and during fine weather. A second method has therefore been devised for use under ordinary circumstances; and though it may seem at first sight more complicated than the other, it is found to be much simpler in practice. This is the method of hauling down the torpedo to an anchor already placed in position, and it is accomplished in this way. The wire rope is passed through the ring of the anchor, and it is then lowered to its place, the working party retaining both ends of the rope. The torpedo is then fastened to one end, and the distance at which it is to float up from its moorings being decided upon, a catch (the structure of which will be presently explained) is placed on the rope at that number of feet or yards below it. The catch (fig. 3) consists of two iron arms, A A, working on a common pivot, and provided with shoulders, which close against each other at B, and prevent the arms opening any further than the extent shown in the figure, and they are kept apart by a spring of vulcanised india-rubber, C C. Now, on hauling on the free end of the mooring-line, the torpedo will be pulled down; and as soon as the catch reaches the ring of the anchor it will be dragged through it, the spring giving way, and the arms being forced together. As soon as it has passed through the ring, the arms will be again opened out by the action of the spring, and the working party will cease pulling and let go the spare end of the rope. The torpedo will then be securely fixed in position, as the catch cannot be pulled back through the ring of the anchor, and its buoyancy will keep it steady and nearly vertically over its moorings. A single mooring-line will be sufficient, if there is no tide or current flowing faster than four or at most five knots an hour; but if there is a strong current the torpedo will be forced away laterally from the vertical line in which it should float up from its moorings. If this took place to any great extent it would make it impossible to count with certainty on the effect. (See fig. 4.) Therefore, where there is a strong current or any rise of the tide, two anchors are used for each torpedo; they are placed up and down stream, and so far apart as to prevent all risk of the cables twisting together. By adopting the hauling down plan the most difficult part of the work of placing a harbour in a state of defence, the fixing of the moorings, can be done leisurely and accurately in time of peace; the anchors being lowered into position, with the ropes rove through their rings, and their ends buoyed at the surface. When it is necessary to moor the torpedoes, all that is required is to fasten them and their catches to the ropes and haul them down — a very simple operation when once the anchors are ready.

As torpedoes are generally arranged in lines, it has been proposed to moor them at intervals along a heavy chain sunk to the bottom, two parallel chains being used where there is a current. Another suggestion is a modification of this, and proposes to use a sunken hawser, with branches and anchors at their ends. The advantages of this latter plan are the ease with which the anchors would be fixed in line, and the facility it affords for raising any anchor by lifting the slack of the main hawser, working along it till the branch hawser belonging to the required anchor is reached, and then raising the branch in the same way. It is, however, not very likely that any plan of this kind will be adopted, as both possess great disadvantages, amongst them the danger of the chain or hawser which forms the main line of the system being grappled by an enterprising enemy.

Before we leave this part of the subject we must say a word about moorings in a tideway. When the rise of the tide is inconsiderable, there is no need of taking it into account in arranging a torpedo defence; but where it rises 15 or 20 feet, if the torpedoes are moored with reference to the low-water line, they will be almost harmless at high water; and if with reference to the high-water line, they will be visible on the surface at low water. A medium must therefore be adopted, and the charges being increased so as to act through a greater depth of water, they must be moored a little below the surface at low water, and then they will still be within range at high water. Sometimes it will be impossible to prevent the torpedoes being seen on the surface when the tide ebbs; in those cases the Confederates used dummies, such as empty cases and barrels, to deceive the enemy.

There are two ways of firing the charges of torpedoes—electrically and mechanically. As we have said before, the mechanical torpedo is the older form of the apparatus; but as the electrical method of ignition is used almost without exception now-a-days, we shall describe it first. Four things are necessary in a system of electrical firing—the battery which originates the current; the insulated cable by which it is transmitted to the torpedo; the fuze, which is fired by the current and ignites the charge; and, finally, the firing-key, which completes the circuit by connecting the battery and the cable. Of the first little need be said; all that is necessary is a voltaic battery of moderate power.* In the Chatham experiments the

* Other forms of apparatus are occasionally used. Frictional electricity cannot be employed with safety, as the passage of the electric fluid through one cable induces similar action in all the others in its neighbourhood, and thus several charges may be fired instead of one. The Austrians used a

usual agent was a Grove's battery; a trough battery may also be used, but the best for the purpose are constant batteries, such as Bunsen's or Daniel's. One end of the battery, whatever it may be, is connected with the ground by an earth-plate; the other is connected with the insulated cable by means of the firing-key, which for the present we shall leave out of consideration. There are several different patterns of cable. One of the strongest and best insulated is that which is made by the Hooper's Cable Company. It consists of a copper conducting wire, A (fig. 9), surrounded by an india-rubber insulator, B, formed of three coats. The inner one is of raw india-rubber, and then comes one of india-rubber mixed with oxide of zinc. These two are very thin, and their object is to prevent the sulphur of the thick outer coat, which consists of vulcanised india-rubber, acting chemically on the copper of the conductor. When the cable is not likely to be subjected to any rough usage, it is completed by placing a covering of india-rubber felt over the insulator; but as in most cases something stronger would be required, the insulator is usually covered with tarred hemp, C, and where the bottom is rocky an additional protection of wires and tarred hemp, D, is added. This cable is laid from the firing point along the bottom, and enters the torpedo by a water-tight and insulated joint, and there the conducting wire is attached to the fuze.

Of fuzes there are dozens of patterns, of which we shall describe two or three, to illustrate the principle on which they are constructed. Some require a powerful current of large quantity; others, on the contrary, can be fired with a current of very high tension. Of the former the best example is the platinum-wire fuze, which acts by a strong current melting a small piece of platinum wire placed in the circuit and surrounded by a priming charge which the heated wire ignites, and in this way the torpedo is fired. Fig. 5 shows the usual form of this fuze; E is a small solid cylinder of ebonite with a shoulder at the top, which fits into a corresponding shoulder in the torpedo case, AA, in the loading-hole of which the fuze is inserted. Where the shoulders meet, a ring of vulcanised india-rubber is placed to act as a packing between them, and make the joint water-tight, and they are held firmly together by the ring or hollow screw, BB, which fits a female screw cut in the inside of the loading-hole. Two wires, CF, DF, are passed through holes in the ebonite cylinder, a watertight composition being forced in round them; they project a little below it, being about $\frac{3}{10}$ of an inch apart, and are connected by a piece

dynamo-electric apparatus specially designed for the purpose, and electro-magnetic coils have also been similarly employed.

of thin platinum wire, F, which is carefully soldered on to them. Finally, a metal cap, GG, is screwed on to the lower end of the cylinder to protect the wires and hold the priming. In the cap there is a small loading-hole closed by a screw, H. The priming may be either gunpowder, gun-cotton, or—if, as will be generally the case, the torpedo is loaded with gun-cotton—detonating fulminate of mercury. If the latter is used, the cap which holds it must be strengthened, in order to ensure detonation at the moment of ignition. Of the wires, one will belong to, or be connected by an insulated joint with, the conducting cable, and the other will be left uninsulated, in order to act as an earth-plate, and pass the current into the water and thence to the ground. This was the fuze used by the Confederates, and it was always found to act well. On account of the strength of the current, it can be fired even when there is a fault in the insulation of the cable; and this alone is a great advantage, for of all the parts of the apparatus the cable is the one most liable to injury.

High-tension fuzes require a more perfectly insulated cable, but smaller battery power. A great number of them have been designed, nearly all on the same principle. Baron von Ebner's fuze, used by the Austrians in 1866, is one of the simplest. It consists of a small hollow cylinder of gutta-percha, AA (fig. 6), about three-fifths of which is filled with an insulating material, B, formed of a mixture of sulphur and glass ground to powder. A wire is introduced at C, passes through the insulator, is bent back at D, passes again through the insulating material, and comes out at E. The little arch at D is then cut through with a file, so as to leave a very small separation between what are now the extremities of the two wires CD, ED. The fuze is then primed by filling the vacant space around D with a highly inflammable composition, consisting of chlorate of potassium and sulphate of antimony, with a little powdered plumbago to give it a slight conducting power. This priming is at once ignited by the passage of a current through it at the little gap between the wires at D. The other ends of the wires are of course arranged in the same way as those of the platinum-wire fuze. Beardslee's fuze, invented by Mr. Beardslee, of New York, is still simpler, and possesses the great advantage that it is always easy to procure the materials of which it is composed, and it can therefore be readily extemporised. It is made as follows:—Take a small cylinder of light soft wood A (fig. 7), and drive two copper nails through it, so that their heads will be very near each other but not touching, and their points may project below it at some distance apart. Then draw a line, with a pencil, across the two heads and connecting them. Attach the upper ends of the wires D E to the points of the nails, and press some wax about them, so as to form an insulator, B. Then roll paper round it, tying it at the bottom round the wax and wires, and leaving a cup at the top above the cylinder. Fill this with fine-grained powder (C), twist the paper and tie it up firmly, and then paint and varnish the whole. The passage of a current between the heads of the nails will fire the powder. There are many other fuzes constructed on the same principle; but there is no need of referring to them, as the two we have described will give the reader a good idea of the way in which they act.

The firing-key is a very simple apparatus for closing the circuit and exploding the charge of the torpedo, by connecting the battery with the insulated cable. It is arranged in a shallow box or tray, A A A A (fig. 10), and consists of two binding-screws, B and C, the former of which holds the end of the wire from the cable, while the latter is similarly connected with the voltaic battery. A strong steel spring, D, is fastened to the binding-screw, B, in such a way that its free end, E, stands suspended a little above the other one; and through this end of the spring a small metal screw, E, with a broad head of some non-conducting material, is driven.* Now, on placing the finger on the head of the screw, E, and pressing down the spring, it will touch the binding-screw connected with the battery, and thus the electrical circuit will be completed. The current from the battery will pass up the wire and by the binding-screw, B, into the spring, then on to the second binding-screw and into the cable, thence to the first wire of the fuze and on to the second (firing the priming on its way), and thence to the water, which will conduct it to the ground and back by the earth-plate to the battery. The sketch (fig. 11) shows the course of the current, the direction of which is indicated by the darts. A is the battery, B the firing-key, C the anchored torpedo connected with it by the cable, E. D is the earth-plate of the battery, which receives the return current marked by the dotted line. We may here observe that experiment has proved that there is no need of an earth-plate being attached to the torpedo; for, on account of the high conducting power of sea-water, even a few inches of bare wire is quite sufficient for the purpose. With iron-cased torpedoes, the bottom of the case may be made to act as an earth-plate, by merely connecting the return wire of the fuze with it.

We have all this time spoken only of the structure of a

* In the English form of this apparatus the usual plan is to place a cover on the box, having a hole, across which a piece of india-rubber is stretched, just above the screw, E; then, by pressing down the india-rubber, the spring is depressed.

single torpedo; let us now see how numbers of them are used in combination. We will suppose that the mouth of a river is to be defended. The principle on which the torpedoes are to be arranged is that they shall be so placed that it will be impossible for a ship to run up the river without passing over, or at least coming within close range of, one of them. It would seem at first sight that this ought not to be a very difficult matter, and that all that would be necessary would be to moor the torpedoes in a row across the river, so near each other that nothing could pass through the line without coming within reach of one of them. But the effect of this arrangement would be that the explosion of any one torpedo would probably destroy all the rest within range of it, and leave an immense gap in the line. It is therefore essential to have more or less of an interval between the torpedoes, according to the weight of the charges. Between charges of 200 lbs. of gun-cotton, for instance, there should be an interval of at least 100 feet. Supposing, then, there is a channel 500 yards wide to be defended, fifteen of these torpedoes will be placed in line across it, and, as it might easily happen that a ship would run through one of the intervals between them, a second line is placed about 100 yards further back, the torpedoes in which are opposite to the intervals of the first; and then a third and a fourth and even more lines may be added, each additional row making it more difficult to enter the river in safety.

There are two ways in which arrangements can be made for firing the torpedoes with effect. They may be fired by watching the course of the hostile vessel and igniting them with the firing-key, or the vessel herself may be made to close the circuit. In the first case, before the torpedoes are moored, two stations are selected behind the line of defence, and so far apart that it will be easy to find the position of each torpedo after it is sunk in its place, by taking cross-bearings from those two points. To recur to our former example of the river-mouth, the firing points, or stations A and B (fig. 12), are selected on opposite banks, and probably in two forts, or, if these do not exist, in two buildings which command a good view of the river, and by position or distance up the banks are secure from being destroyed by the fire of ships which have not passed the rows of sunken mines. For the sake of clearness, only the cables of the first line (the torpedoes of which are numbered from 1 to 5) are shown in the diagram. The voltaic battery is at C, and is connected, one end with the earth, the other with the first series of firing-keys at A. From these, five insulated cables cross the river to the second group of firing-keys at B, and another series of five cables connects these keys with the torpedoes 1, 2, 3, 4, 5. There are thus two breaks in every circuit, one at the firing point A, the other at B. Now let us suppose that a hostile man-of-war attempts to enter the river on the course DEF.

When the ship is at D she will be, as seen from A, on the bearing line AD corresponding to torpedo No. 1. At A, therefore, the firing-key No. 1 will be pressed down by the man in charge there, and one break in the circuit will be closed; but, as seen from B, she will not be on the bearing-line of any of the torpedoes; therefore the second break will still be left open, and no current will pass along the wires. As soon as the ship has advanced from D towards E, the key will be allowed to rise again, and both breaks will be once more open.

The ship now reaches E. Seen from A she will be on the line of none of the torpedoes; therefore none of the keys will be touched. But as seen from B she will be on the bearing-line of torpedo No. 3. There, therefore, the firing key No. 3 will be depressed, and the second break of the circuit will be closed; but as the first (at A) is open, just as before no current will pass.

The ship still advancing reaches F. As seen from A she is now on the bearing-line of torpedo No. 2, and the same is the case when she is seen from B. She is in fact directly above the torpedo. At each station the key No. 2 is depressed, both breaks in the circuit are closed, the voltaic current passes from C through A, across the river by the cable to B, and then on by another cable to the fuze of torpedo No. 2, which it ignites. The charge is fired, and the hostile vessel is either sunk or terribly injured. If the ship had succeeded in passing through an interval in the first line she would have to run a similar risk at the second, and every additional one would increase the peril and make the attempt more desperate.

In some cases it may be possible to occupy, without any danger of being cut off, a point about a mile inland on the flank of the system of torpedoes. In this way the arrangements for the defence can be greatly simplified; for if the lines of torpedoes are made to converge towards this advanced point, an observer placed there can watch the course of an approaching vessel, and when she is passing over the first line, signal the fact to a single firing station to the rear of the sunken mines. The man in charge there will then observe the bearing of the vessel, and if it indicates that she is over a torpedo, he will explode it by pressing down the corresponding firing-key. If she passes through an interval, the same method will be adopted with regard to the second line. In this way the necessity of having two firing-stations and a double system of firing-keys and electric cables can be avoided.

To ensure great accuracy in the system of firing torpedoes by cross-bearings, telescopic firing-keys have been designed. In these a telescope is mounted, so as to command a full view of the space occupied by the mines, which it can sweep from right to left or from left to right, by moving it horizontally on a vertical pivot. A projecting arm moves with it, and carries on its extremity a firing-key, which can be depressed and brought in contact with any one of a number of firing points placed on the arc of a circle, over which the key moves. The key is connected with the voltaic battery, and each of the points with one of the cables leading to the sunken mines. These are, moreover, so arranged, that when the telescope is directed to the position of any of the torpedoes, the key moving with it is over the firing point corresponding to that mine. Thus all that is necessary is to watch the approaching vessel with the telescope, and whenever its movement brings the firing-key over one of the points, press it down and so close the break in the circuit. In this way torpedoes can be fired with perfect accuracy and certainty.

The second method of firing torpedoes is that in which the vessel herself closes the circuit. To accomplish this an apparatus, called a circuit-closer, is moored above the torpedo, so as to float a little below the surface of the water. The electric cable passes into the torpedo, and its conducting wire is connected with one of the wires of the fuze, while the other (in the ordinary arrangement the return wire) is joined to the conductor of a second insulated cable, which is connected with the circuit-closer, and through this, when the circuit is closed, the voltaic current is carried to earth. As is the case with almost every part of the apparatus belonging to the torpedo, there are several plans for constructing circuit-closers, and we shall content ourselves with describing one which has had its efficiency tested by many severe trials, and which will probably be adopted whenever torpedoes are used for the defence of British harbours. Mathieson's circuit-closer (fig. 8) consists of a metal cylinder, A B, with an outer covering, C, of light wood soaked in tar, which protects and gives buoyancy to the whole. This woodwork is held together by iron bands, which are firmly attached to the iron foot-plate or base, B. At the top is a ring for carrying the apparatus, and there is a similar ring at the bottom to which to fasten the mooring line. All this is only the case of the apparatus. In the centre of it there is an upright flexible metal bar, BD, having at its top a leaden ball, D, and about half way up a horizontal brass disk, E, insulated from the rod by a piece of ebonite in its centre. To this disk the end of the conducting wire of the cable (which is introduced through the foot-plate at L by a water-tight and insulated joint) is attached. Four metal uprights, KKKK (two only appear in the section), support a brass ring, GG, which surrounds the pendulum, BD, and sustains four springs, HHHH, the lower extremities of which are close to, but do not touch, the brass disk, E, connected with the insulated wire. There is therefore a break in the circuit between the disk, E, which is in communication with the battery and torpedo, and the springs, H H H H, which by means of the ring, G G, the uprights, K K K K, and the iron foot-plate, B, are in communication with the earth. Now when a passing vessel hits the circuit-closer, the upright pendulum, B D, is set in motion by the concussion, and the disk strikes the springs several times.* At each of these contacts a current passes along the cable, through the fuze of the torpedo, on by the second length of the cable to the disk, E, thence to the springs, and by the ring and uprights to the foot-plate, which sends the current back to the earth-plate of the battery. In this way the vessel herself closes the circuit and fires the torpedo. When friendly ships are passing up or down the defended channel the battery can be disconnected, and they will be perfectly safe; but when an enemy is approaching, the battery can be connected with the wires again, and all the torpedoes will be ready for action. At night, by using a current not sufficiently strong to fire the fuzes, and employing a galvanometer, a deflection of the needle will indicate the fact whenever a circuit-closer is touched, in other words, whenever a ship is passing up the channel. Thus a line of these circuit-closers acts at night as a line of outposts to a fortified harbour or river mouth. Of course, unless under exceptional circumstances, it would be very dangerous to fire torpedoes in the darkness.

We have given only a brief sketch of the methods adopted in using electrical torpedoes. Nothing has been said of scores of ingenious plans for laying down the torpedoes and their cables,—for carrying the latter into the operating rooms,—for testing the cables, fuzes, and circuit-closers before and after they are placed in position,—for retaining the power of firing the torpedo by disconnecting the circuit-closer, if it is grappled by the enemy,—and, finally, for protecting the whole system from injury when once it is arranged. On all these points, and on many more, much could be said; but, as our object is only to give the reader a general idea of the subject, we must pass them by, referring those whom our remarks may have interested in the matter, to the various English and foreign works on torpedo warfare, for fuller and more detailed information.

We shall conclude with a few words on mechanical and locomotive torpedoes. The Russian drifters in the Baltic are a

* It is found by experiment that the regular rolling of the sea will not influence the pendulum, but that it requires the sharp shock of a collision to close the circuit.

good example of the mechanical method of ignition. They contained a chemical fuze, which has also been used in fixed torpedoes. It consisted of a thin glass globule filled with sulphuric acid, and so arranged that, when the torpedo struck a ship's side, a bolt would break the glass and let free the acid. This would fall on a mixture of chlorate of potassium and powdered loaf-sugar, and by chemical action set it on fire, thus igniting the charge. As we have said before, all contrivances of this kind are terribly dangerous, as any carelessness on the part of those placing them in position will fire the fuze. By some improvements made by Captain Harding Stewart in the methods of constructing and mooring them, they have been rendered somewhat safer; but where electrical torpedoes are available they are infinitely to be preferred.

Of locomotive torpedoes, the one which has perhaps excited most public attention is Lupin and Whitehead's "Fish Torpedo," which was adopted by our government in 1870. No detailed description of its mechanism has yet been published; indeed, its structure is kept as secret as possible. Its case is roughly fish-shaped (whence its name), being a cylinder narrowing to both ends, and having a point at one extremity and a small screw-propeller at the other. It is discharged from a tube fittted in the bow of a man-of-war below the water-line, and is driven by the propeller, the motive power being (it is conjectured) compressed air. It explodes mechanically on hitting its mark. In a trial at Chatham in 1870 it was very successfully employed in sinking an old man-of-war, but it is believed that with a strong current, or at a considerable range, it could not be aimed with any great accuracy; and how easily a ship could be defended from it was shown in another experiment, in which it was caught in a net hung at some distance from a vessel's side, and exploded without doing any damage. Another torpedo, which was invented about the same time, and which has met with general approval, is Harvey's Towing Torpedo. It is a metal case, containing a heavy charge to be ignited by a sulphuric acid fuze, which is fired by a bolt being pressed against it by a projecting metal arm. This is towed out at an angle from the side of the attacking ship, which runs past her antagonist so as to bring the torpedo in contact with her bottom, when the projecting arm is forced down by the collision, and the charge is fired. A ship, manœuvring to avoid these torpedoes, has been struck three times out of four attacks. Of course, on the one hand the torpedoes were not charged, and on the other the ship attacked did not use her guns, but offered only a passive resistance. It yet remains to be seen how these contrivances will work in actual warfare.

In the American war many ships were destroyed by being attacked by boats or small steamers having torpedoes rigged out on a spar or pole projecting from their bows. These attacks were, however, often complete failures; and it appears at times to have been very difficult to get men to volunteer for them. There is a very simple drifting torpedo, which seems well adapted for military use, as it would be comparatively easy to destroy a bridge of boats, pontoons, or barrel-piers on a river, by letting a few of these drifters go down the stream. A wooden buoy floats on the surface, and to this the torpedo is suspended by a metal rod. The charge is in an iron case with a conical top, at the apex of which is a firing apparatus, connected with a small paddle-wheel, so arranged that by a few turns it looses the firing-bolt and ignites the charge. Suppose a bridge is attacked, the torpedo is dropped into the water and floats on until it strikes against the bridge. As long as the whole apparatus is in motion, the current has no effect on the little paddle-wheel; but as soon as the torpedo is stopped by the obstacle, the current acting on its broad blades makes it revolve, and the charge is fired.

Such is a brief account of what has been done up to the present time in torpedo warfare. The subject is one of the best illustrations of the way in which science every day puts new weapons into our hands; and we cannot help wondering, when we see the peaceful researches of scientific men, directed to far different ends, adding these powerful engines of destruction to our means of attack and defence. To a greater extent than any other country, Great Britain has a deep interest in all that is done in this branch of engineering science; for in time of war it would afford us an easy means of guarding the coasts and harbours of our wide extended colonies, as well as our own; and thus our ships, instead of being forced to act on the defensive, and await attack, would be free to go boldly out to protect our commerce and destroy the naval armaments of our foes.

Note.—It has been lately discovered that, by means of the detonating fuze, gun-cotton can be exploded even when it is wet. Government experiments are now in progress, with a view to fully developing this discovery. It adds another to the many advantages possessed by gun-cotton for torpedo-warfare, as it will now be possible to fire it even in cases the tightness of which is very defective.

EXPLANATION OF PLATE XCVIII.

Fig. 1. Austrian Torpedo, 1866. Wooden Case.
„ 2. Austrian Torpedo, 1866. Iron Case.
„ 3. Mooring Catch.
„ 4. Sketch illustrating Action of a Current on Torpedoes with Single Moorings. A, Theoretical Position of Torpedo; B, Actual Position.
„ 5. Platinum Wire-fuze. Section.
„ 6. Von Ebner's High-tension Fuze. Section.
„ 7. Beardslee's High-tension Fuze. Section.
„ 8. Mathieson's Circuit-closer. Section.
„ 9. Hooper's Insulated Electrical Cable; ½ of full size; strongest pattern.
„ 10. Firing-key.
„ 11. Sketch showing Course of Voltaic Current, and Method of Firing Torpedoes.
„ 12. Defence of a River Mouth. Firing Torpedoes by Cross-bearings.

REVIEWS.

ELEMENTARY ANATOMY.*

THERE are some to whom doubtless the title of a work which expresses, as the title of Mr. Mivart's book does, that it deals with elementary anatomy, will imagine that it treats only of that driest of all branches of science, human dissection. Such, however, will be but those whose examination of the book before us does not extend beyond the cover. To him who looks into its pages there will be opened up a glimpse such as he has seldom seen before; a grand view in outline, less or more, of the anatomy of the whole vertebrate sub-kingdom. We have said an outline, because to imagine anything more would have been to have had a poor conception of the limits of comparative anatomy. But assuredly the student—and he must be an advanced one—will find in this volume what he has never seen in a work addressed to students before: an admirable sketch of the anatomy of man contrasted in its several sections with the anatomy of the several typical forms—mammalian, avine, reptilian, batrachian, and piscine—from the higher to the lower of vertebrate living forms. And this too in no mere popular manner, but with a degree of minuteness and accuracy, and with a terseness and lucidity of style, which are not too often met with in works of this description. The book is intended as a companion to Huxley's admirable little manual of Physiology, which is published in the same series; and indeed we think that it is well worthy of, not superior to, the rank in which it is placed. Whether from the nature of its matter, its style, or the exceeding perfection of its illustrations, we know indeed of very few compeers; while from its being in point of fact an essentially new book, we were quite ready to accept those many imperfections which are so characteristic of any novel form. But indeed the faults of the book do not present themselves to our vision, unless it endeavours to accomplish too much, and its matter is too deep for the majority of students. On this score we fancy the critic can have little to say; for those who know aught of students, and of medical students in particular, are aware that they are of two distinct groups, almost without a connecting link: those who work, and those who don't. And from a long experience of these, we feel certain that the working student will hail Mr. Mivart's manual with the most

* "Lessons in Elementary Anatomy. By St. George Mivart, F.R.S., Lecturer on Comparative Anatomy at St. Mary's Hospital." London: Macmillan & Co., 1873.

pleasurable emotion; for it is a book which will give him in condensation, without the too frequent faults of dryness and imperfections of composition, an accurate and clear account of vertebrate comparative anatomy, such as he could only otherwise acquire by years of research, which he would not possibly have had the time to expend.

Besides, if our argument appears weak to some, we may urge the more weighty reason that knowledge of the subject on which Mr. Mivart writes has become, from having been the study of the specialist, one of the most important lines of everyday research. We say this seriously; and if the reader will look to the United States of America, to Germany, France, and even to Norway and Sweden, he will see how much attention is given in these various States to the study of comparative anatomy. If the English student differs from his compeers on the Continent, to his shame be it said; and this leads us to remark, *en passant*, that it is not so much the pupil as the examiner that is to blame; for in none of the medical boards, save those of a few universities, is the candidate for a medical diploma required to know anything whatever of zoology, while in many cases a crude and most unscientific knowledge of botany is particularly demanded.

Of the plan of Mr. Mivart's volume a few words may be said. The greater amount of matter is given to the consideration of the osseous structures, and we think with the author that this is right and proper, for the following reasons, which he thus expressly states: (1) The general resemblance borne by the skeleton to the external form. (2) The close connexion between the arrangement of the skeleton and that of the nervous system, muscles and vessels. (3) The relation borne by the skeleton of each animal to the actions which it performs. (4) The obvious utility of the skeleton in classification and the interpretation of affinity. (5) Parts of the skeleton or casts of such are all we possess of a vast number of animals formerly existing in the world, but now entirely extinct. After Mr. Mivart has dealt in a masterly manner with the skeleton of man and the several groups we have already mentioned, to an extent which covers nearly 300 of the 500 pages which compose the volume, he then proceeds to treat of the muscular organs, the nervous apparatus, and the circulatory, alimentary, and excretory systems. In these several chapters he deals as fully with the organs of one animal as another, and by an ample series of illustrations—over 400 woodcuts—gives examples of types and of those organs which are specially set forth in the volume. Indeed these illustrations are remarkably good, some of them being quite new, and many of them being rare even to the student of comparative anatomy.

We object but to the last passage of the volume. It is certainly questionable, and we do not see why it was introduced. Nothing short of a very long essay could attempt its proof, even to those who are from the first likely enough to accept the dictum. To other readers it seems out of place, as it is equally beyond satisfactory evidencing. We refer to the expression of opinion as to the totality of man's nature. But for this—indeed we may say notwithstanding this—we believe Mr. Mivart's volume to be the best book that could have been produced upon the subject on which it treats.

THE NATURAL HISTORY OF OZONE.*

AS the writer of the present work has observed, a succinct account of all the results that have been arrived at in regard to ozone is required. But then the question comes, by whom is such a labour earnestly demanded?—and in answer to this we certainly should think that the chemists, and not the general public, are the special audience to which such a volume as the present one ought to be addressed. Perhaps we may be wrong in supposing so, but we imagine that the subject has not been sufficiently worked out to establish its ends beyond all question; and that therefore it is wrong to introduce to the general public a series of problems, which, for all we know, may eventually be regarded somewhat in the same light as we are accustomed to view the earlier efforts of the chemical world as regards the function of oxygen. However, we confess that this conjecture may have nothing in the world to support it; and admitting the justification for publishing such a book as that which Dr. Fox has offered us, we are bound to confess at the outset that it is admirably got up. If we overlook certain peculiarities of the author—such, for instance, as his method of grouping the title of his work and the signature to the preface, which is accomplished by the musical letters  and come to consider the labour which he has bestowed on the book, the excellent account he has given of most scientific researches conducted on the Continent and at home, the admirably convenient and enormously expensive side-notes which he has given, and finally the number of excellent charts and illustrations which he has appended to the volume, we are bound to say that the essay leaves very little to be desired. If we leave aside consideration of Dr. Fox's remarks concerning the observations of Homer on this subject, which we confess do not strike us as of much importance, and come to the subject of ozone itself, we think we shall do well. In this chapter the author enters upon an historical account of the earliest observations on the subject, and we think he very justly regards Schönbein as the first discoverer of this substance. He then passes on to the observations of Williamson on ozone; next he travels through the successive examinations made by a great host of English and Continental chemists, and he lays stress upon the investigations of the Irish philosopher Andrews, as being one of the most important of all the great series of researches that the subject of ozone has called forth. All these inquiries, he says, show that ozone is "simply a condensed or allotropic form of oxygen," which is simply correct, save that the word *allotropic* by no means involves the condensation of the substance to which it is adjectively conjoined. We do not think that *antozone* is as clearly established as Dr. Fox would have us believe; still we accept his statement, made on very good authority, that "it is regarded as a modification of oxygen, to which belongs the power of oxidising water and converting it into the peroxide of hydrogen, with the simultaneous development

* "Ozone and Antozone; their History and Nature. When, where, why, how, is Ozone observed in the Atmosphere?" Illustrated with engravings, &c. By Cornelius B. Fox, M.D. London: J. and A. Churchill, 1873.

of clouds—a feat which ozone is not able to accomplish, although it may be allowed to remain in contact with this fluid for weeks. Whilst ozone is insoluble in water, antozone is said to have a powerful affinity for it." In the chapter entitled "Does the atmosphere contain ozone?" Dr. Fox enters upon a very full and fair discussion of the subject. In this he gives us his numerous authorities, showing where ozone is most exhibited and where it is least developed, with different reasons for its presence or absence given by those who have made the subject a special study. In this we are led very strongly to reject the testimony as to its absence from certain towns—Lyons for instance—because of the extreme improbability of such an important constituent of the atmosphere (if it is so) being not present in the atmospheric air of that city. We are inclined to think that far more numerous analyses than those on which Dr. Fox bases his views should be made before such a conclusion is openly expressed in public. And we have not the smallest doubt that minute observations will yet be made which will throw the author's statement—made upon authority of others—completely into the dark. Still, admitting the justification of the work, we cannot help confessing that the author has done well in most parts of the book. We must, however, call him to task for some of the conclusions which he would appear to hold, or at least to give a place to. And foremost of such is his quotation of that monstrous doctrine of Mr. Haviland, that geological structure has anything—save in the case of swamps and such like—to do with special forms of disease. For example, he appears to accept that most absurd doctrine that heart disease and dropsy occur "wherever the prevailing sea-winds have uninterrupted access, as over a flat or elevated country, or up broad valleys." How Mr. Haviland's doctrine could ever have gained the least attention is only to be explained by the utter ignorance that medical men yet have of geology and everything relating to it. Anything more absurd than to attempt a classification of diseases according to the geology of a country it is difficult to conceive. It is hard to imagine any two countries more dissimilar geologically than Ireland and England, or more alike epidemically—with the one exception of typhus, or famine fever, which is easily explained by the former poverty of the inhabitants of Ireland. Dr. Fox gives several very good reasons why ozone should be observed, and we think his book is likely to increase the number of ozonometricians at present existing. In all that concerns methods of recording ozone his book is a veritable mine of wealth; more than half of it is devoted to this subject, and so far as we have seen, with clearness and comprehensiveness. Indeed, altogether we are much pleased with the volume; and leaving aside the question whether it should have been published, we feel bound to award the author our best praise for the manner in which he has discharged the task which he undertook.

GEOLOGICAL STORIES.*

GOOD as was undeniably the former work by Mr. Taylor which we had to review in these pages, we are bound in all honesty to confess that the volume now before us is still better. Indeed we know of few who are so admirably adapted to the task of writing for the public alone as the author of the "Geological Stories." We, of course, do not consider this little book as in any way addressed to students of geology; but to those who have never opened a geological volume, who, even if they had the time, would never dream of taking up a geological text-book, the "Geological Stories" must undoubtedly appeal. They are popular in the extreme, and withal they have not the faults of popular treatises. Their author is too good a geologist for that. But they furnish a series of stories much in the vein that Professor Huxley adopted some years ago in many of his popular lectures. A series of stories constitute the chapters of the volume, and in this way the several formations are disposed of. Thus, there is the story of a piece of granite, a piece of slate, a piece of limestone, a piece of sandstone, a piece of coal, a piece of rock-salt, a piece of jet, a piece of Purbeck marble, a piece of chalk, a lump of clay, a piece of lignite, and finally the story of the crags, a boulder and a gravel pit. The volume which contains these several stories is amply and excellently illustrated, the cuts numbering nearly 200, whilst a number of plates, of most of which we heartily approve, are scattered through the volume. Each substance is made to tell its tale in the first person, and the humour of the author displays itself occasionally in a pleasant and telling manner. The illustrations are capitally printed, better far than is generally the case; some of them, too, are novel to most readers—those of the foraminifera being especially so. Altogether we are well satisfied with the work, and we cordially trust our young friends will get it and read it: if they derive as much pleasure from its perusal as the writer has, we will vouch for their satisfaction.

HARVESTING ANTS AND TRAP-DOOR SPIDERS.†

IT is not often we find a series of observations published now-a-days upon the habits of a particular animal. Nor indeed is it at all common to find, when such a series of studies are given to the public, that they at all justify the praise of the Natural History reviewer. But such can certainly not be said in the case of Mr. Moggridge's labours, for they are unquestionably most valuable, and have been most ably made and most creditably published. The illustrations to this book are, by themselves, of extreme value,

---

* "Geological Stories. A Series of Autobiographies in Chronological Order." By J. E. Taylor, F.G.S. London: Hardwicke, 1873.

† "Harvesting Ants and Trap-door Spiders. Notes and Observations on their Habits and Dwellings." By J. Traherne Moggridge, F.L.S. London: L. Reeve and Co., 1873.

for they show us, by a series of drawings conducted as alone an artist and naturalist combined could achieve, the whole history of the remarkable group of insects and arachnids which the author has been engaged in the study of. Indeed some of the coloured plates representing the residence, &c., of the trap-door spider are veritable works of art of a very high character, Plate XII. being especially remarkable in this respect. This book is peculiarly valuable, because it tends to set at rest a considerable difference of opinion in regard to the so-called harvesting power of ants. Our readers may not be aware that for a very long time it has been believed in this country that the well-known aphorisms about the ant were simple absurdities; that it provided for the future no better than any other animal; and that the so-called observations in proof of its habits were valueless, because the observers had mistaken for food the larvæ of the ants which they carried in their mouths. Indeed this idea has been set forth even by Kirby and Spence, who are the best and most popular authors. They say, "When we find the writers of all nations and ages unite in affirming that, having deprived it of the power of vegetating, ants store up grain in their nests, we feel disposed to give larger credit to their assertion. Writers in general have taken this for granted. But when observers of nature began to examine the manners and economy of these creatures more narrowly, it was found, at least with respect to the European species of ants, that *no such hoards of grain were made by them; and in fact that they had no magazines in their nests in which provisions of any kind were stored up.*" Now, on the contrary, Mr. Moggridge has proved, beyond the possibility of a doubt, that European ants are unquestionably of the character attributed to them for so many centuries, and that they do regularly lay up a store of seeds of different kinds. And he even thinks that this is carried out to such an extent that it may be followed by certain injurious results. The tale which the author tells of his various days' researches is full of interest, and shows how much may be learned in any department provided there be not wanted patience and industry. One of the plates in illustration of this part of the volume gives a good sketch of a nest which was made by the ants in the substance of a soft fine-grained sandstone to a depth of twenty-three inches. In this case he found the inner surface of the excavation of a different colour and appearance from the outer, and he supposes this is due to some cementing process adopted by the ants themselves. His observations on the habits of the ants are full of interest and importance.

In dealing with the trap-door spiders the author is as comprehensive in detail as in his account of the ants. He commences with the first account of those singular animals, which he thinks was an English one, being that by Patrick Browne in the "Civil and Natural History of Jamaica," a book published in 1756. Mr. Moggridge then proceeds to give a very full account, illustrated by the marvellous drawings of which we have spoken, of the different varieties of trap-door spiders which he has observed, and details many singularly curious facts in the Natural History of these animals, and of the wonderful nests and trap-door openings. It seems to us that he has really hit upon the exact object of the second tube, which is connected with the first. We think with him that its object is to protect the inhabitant in the event of any intrusion into its abode, and the way in which this is done

—which is fully described in the volume—is marvellously clever. Anent the cork doors of these cells, and the silk lining to them, we also think the author is perfectly right in supposing that the enlargement made from time to time is indicated by the width of the door and in the number of layers of silk which it contains. Indeed, we do not see what other conclusion can be drawn from the table given in Appendix H. On the whole we do not remember for a long time having read a book which pleased us so much, and we return our hearty thanks to its author for its publication.

BRITISH AND AMERICAN GEOLOGY.*

WE took up Dr. Dawson's book in a happy spirit of expectation, for the book looked a good one, and the author was familiar to us as the Discoverer of *Eozoon*, and as the writer of some other interesting works of a geological character. We laid it down with a very different feeling, for we found in its scientific parts nothing that has not found its way into every popular manual that the press has produced during the past fifteen years, and in its other portions about the very feeblest and most drivelling argument that we have yet seen against the school which Darwin, Huxley, Spencer, and Mill represent in their countries. The book, we are told, is written for the purpose of showing the scientific world that those masters of human thought are utterly wrong in their beliefs, and that Dr. Dawson and his very few scientific followers are alone correct. Now, if there was any attempt at argument, we could have pardoned the attempt which the author has made; for when a man's object is a good one, as Dr. Dawson's is undoubtedly, we are bound to listen to him even when his views are most strongly directed against us. But assuredly when he adopts the logic of the Sunday School, and attempts the mode of reasoning which the good-natured curate finds thoroughly convincing at a country tea-board, we are compelled to eschew his doctrines. Yet assuredly it is not in the least doing an injustice to Dr. Dawson's book to say it is conceived thoroughly in the Sunday School strain. We may, therefore, be excused for declining to answer any of his statements on the subject of theology, on the score that they were originally addressed to the readers of the "Leisure Hour," from which periodical, we believe, the greater part of this volume is taken.

The plan of the book, so far as its science is concerned, is simply to devote a separate chapter to each formation, commencing with the *Laurentian* and terminating with the *Post-pliocene* deposits. Besides these there is a chapter on the subject of the genesis of the earth, and two on the question of man's origin. The illustrations to the volume are with two or three exceptions simply barbarous, and we are somewhat astonished at a scientific man's admitting into his pages a series of plates which more than anything

---

* "The Story of the Earth and Man," by J. W. Dawson, LL.D., F.R.S. London: Hodder and Stoughton, 1873. "The School Manual of Geology," by the late J. Beete Jukes, M.A., F.R.S. Edited by A. J. Jukes-Browne, of St. John's Coll., Cambridge. Edinburgh: Adam and Charles Black, 1873.

resemble those well known pictures which M. Figuier is so fond of admitting into his works. Indeed the illustrations are altogether miserably few, and most of them are cuts of this kind. Perhaps the best engraving in the book is that of *Eozoon canadense,* for it illustrates the structure in the imperfect manner that is characteristic of a good and faithful drawing. On this subject the author is of course at home, and we naturally find that Messrs. King and Rowney do not receive very favourable consideration at his hands, and doubtless correctly so, for there cannot be a question that Eozoon is simply a low type of foraminiferous structure. In treating of the Carboniferous age we are sorry to find the following paragraph, as it gives us but a poor insight into an author's character. Dr. Dawson observes that "*He* has named and described the oldest known animal. *He* has described the oldest true Exogen, and the oldest known Pine tree. *He* was concerned in the discovery of the oldest known land snails, and found the oldest millipedes. *He* has just described the oldest bituminous bed composed of spore cases; and *he* claims that his genus Hylonomus includes the oldest animals which have a fair claim to be considered reptiles." We feel here disposed to add that he has certainly produced some of the oldest ideas on the religious aspects of the question also. When the author comes to deal with the Mesozoic age we certainly conceive that he is right in rejecting the notion that we are still living in the *Cretaceous* period. He states that:—

"In this broad sense we may be said to be still living in the Laurentian epoch. In other words the whole plan of the earth's development is one and the same, and each class of general condition once introduced is permanent somewhere. But in another important sense we are not living in the Cretaceous epoch; otherwise the present site of London would be a thousand fathoms deep in the ocean; the Ichthyosaurs and Ammonites would be disporting themselves in the water, and the huge Dinosaurs and strange Pterodactyls living on the land."

In these observations we thoroughly concur, and we wish we could have been able to say so of the entire volume. But we suppose the author does not expect his book to command a scientific public, and he knows doubtless that the bitterest words will have all the more relish for the popular uneducated party, when they are the outpourings of a scientific man himself against the leading *savans* of the day. We have only to say in conclusion that the book, as a tolerably general sketch of geological phenomena, is a good one, more especially in those parts which are not dependent on the author's reasoning powers.

Mr. Jukes-Browne's little book is a capital introduction to geology. It was, even when it was first brought out by the late Professor Jukes himself, an excellent work; and now the editor has taken so much trouble, and has exercised such judicious skill in the direction of his amendments, that the volume is for the present date as good a book as it unquestionably was when it first appeared about ten years since. Parts of some chapters have been quite re-written, and others have been modified in accordance with the changes that the science has undergone since. But it seems to us that the editor very wisely left the chemical part as it was. So many systems are now in vogue, and it is so impossible to say which will eventually hold its own against its compeers, that a wise discretion was shown in the maintaining of this section as in the old book. The general plan has not been altered, but many woodcuts have been introduced, and the entire work has been brought down to 1873 with skill and discretion. On the whole we are very much pleased with this second edition, and we wish it what it deserves, a very good sale.

USEFUL PLANTS OF INDIA.*

THIS is the second edition of a good book, which deserves perusal, especially by Assistant-Surgeons and others who are likely to spend some of their time in India. There is only one thing to be regretted, and that is the utter absence of plates. This is a decided defect. Col. Drury must know as well as anyone how useful are representations of certain plants even to the well-trained botanist. And if this be the case, how much more necessary are they to the person who, unskilled in botanical work, endeavours from a mere book-knowledge to ascertain a plant from the mere description! This difficulty exists even where the plant is minutely described or the system of classification adopted is a good one. How much more then must it present itself in the present case, where the account given is vague! We hope therefore that when this good work sees a third edition, it will have a series of rough engravings of either the plants themselves, or of the "floral" and "essential" parts at least. Another failing to which we would call the attention of the author is the absence of any natural order or system. There appears to be nothing more given than the brief specific characters, with the name of the natural order prefixed. We think this is objectionable. As well might the author have left out of the book the descriptive portions entirely, for we cannot see by what means he intends the student to find or to identify any particular plant. We think that this is a point worthy of some consideration, though we are aware of the many objections that can be raised against it. Of the various valuable plants and their industrial uses described by the author, we may mention a few, such as *Cinchona*, from which we get much of our quinine; *Gossypium*, which is cotton; *Nicotiana*, which is tobacco; *Papaver*, from which opium is extracted; *Piper*, or the pepper plant; *Tectona*, the well-known teak timber; *Theobroma*, or cocoa; *Zea*, or Indian corn; *Zingiber*, or ginger; and lastly, the well known tea plant. On all of these the author's remarks are full and to the point, and in his appendices he has gathered together a mass of matter from different reports which is as valuable as it is interesting. Besides the foregoing, he gives a long list, first of Bengalee and Hindostanee, and then of Teloogoo synonyms for the plants. Altogether the book, with the index, covers more than 500 pages, and is a splendid record of the vegetable productions of our most valuable and extensive colony—Hindostan.

---

* "The Useful Plants of India, with Notices of their chief Value in Commerce, Medicine, and the Arts." By Colonel Heber Drury. Second Edition. London: W. Allen, 1873.

HANDY BOOK OF ROCK NAMES.*

THIS will prove, we do not doubt, a very useful little book to all practical geologists, and also to the reading student of rocks. When a difficulty is incurred as to a species of deposit, it will soon vanish. Mr. Kinahan's little book will soon make it all clear. The work is divided into three parts. The first is a classified table of rocks, the second part treats of the *Ingenite* rocks, and the third part deals with those rocks which are styled *Derivate.* Dana's termination of *yte* has been most generally used by the author, but he has also given the *ite* terminations for those that like them. Mr. Kinahan gives the following direction:—A student wishing to have the description of a rock must first look for the name in the index, and if the name does not occur there, it will be found in the classified list in its proper group, class, and order; he must then refer for the description to either Part II. or III. The book will be purchased, for it must be had, by every geologist; and as its size is small, it will form a convenient pocket companion for the man who works over field and quarry. We fancy that the late John H. Kinahan had the idea of this book in his head some time before he died: at least, the writer has heard him say he wished much for such a work.

RELIQUIÆ AQUITANICÆ.†

AFTER a long lapse of time another "Part" of this well-known and well got up volume has at length appeared; and with it has come a promise from the editor—Prof. Rupert Jones, F.R.S.—that it will now go on to completion, though not so far as had doubtless been intended by the distinguished co-author, Mr. Henry Christy. Still it is, we think, well that it should be completed notwithstanding the death of M. Édouard Lartet, which produced the last cessation. It is now somewhere about two years since M. Lartet died, and during that time no part has been issued. Now that it has begun to reappear, the editor promises that he will lose no time over it, and hence we may probably assume that it will not be long till it is completed. Meantime the part that has appeared is in no measure inferior to any that have preceded it, but in point of matter, and especially in plates, is fully equal to its predecessors. The remarks on the reindeer are full of interest, and the classical knowledge of the author is brought to good account in explaining the great change of climate which Rome has undergone even in historic times. This part also includes a letter [Dec. 10, 1870] from A. C. Anderson, Esq., of Vancouver's Island, on the assumed co-existence of the reindeer and the hippopotamus, in which he expresses very fairly and clearly an adverse opinion to that held by M. Lartet. Altogether this "Part" is very good, and gives excellent promise for its successors.

---

* "A Handy Book of Rock Names, with Descriptions of the Rocks." By G. Henry Kinahan, M.R.I.A. In the Geological Survey of the United Kingdom. London: Hardwicke, 1873.

† "Reliquiæ Aquitanicæ: being Contributions to the Archæology and Palæontology of Périgord, &c." By Édouard Lartet and Henry Christy. Edited by T. R. Jones, F.R.S. London: Williams and Norgate, 1873.

SHORT NOTICES.

Catechism of Zoology. By the Rev. J. F. Blake, M.A., F.G.S. London: Longmans, 1873.—If we admit the advisability of making zoology into a catechism, doubtless this attempt is not a bad one, especially for the very young. But we confess we have a decided dislike to this form of book. It is associated in our mind with that abominable habit of "cram." It is likely that a fellow who studies hard at this book may get enough of zoology into his unhappy brain to pass, let us suppose, a medical examination for the Navy in India—to pass and to forget it all completely in a few months. But we ask who else could read such a book as the present one? Assuredly not a boy, unless, indeed, the cane were frequently employed. How could he feel the smallest particle of interest in such a cut and dry method? Most assuredly the author is not unacquainted with the "grinding" system, but we very much doubt his powers as a successful teacher. For "cramming" we doubt not his skill. He seems, too, in some passages to be not very well acquainted with Anatomy, for he tells us that the "atlas" is a "hollow" bone: what does he mean? And again, is there not some obscurity in the answer for the *Lyencephala*, that "none of the *lobes* of the brain are overlapped by the cerebrum."

The Story of Creation as told by Theology and by Science. By T. S. Ackland, M.A. London: Society for Promoting Christian Knowledge, 1873.—The author of this little *brochure* evidently means well. He has attempted a reconciliation of Scripture and Science. He admits Darwinism, and even the evolution of man from the Quadrumana. But he will have it that the Bible must be right. On the various matters of science he urges the scientific value of evidence to its furthest steps. On the theological he thinks his conclusions are to be accepted with as much force, although there is no evidence whatever in the same aspect. This we need not say is manifestly unfair. We must in any argument use the same test for the witnesses on both sides. One must not be bound by a serious oath, and the other allowed to give his evidence without any guarantee as to its accuracy. Yet this is what characterises the present interesting little work.

A Year-book of Facts in Science and Art. By John Timbs. London: Lockwood and Co., 1873.—We have almost universally had to condemn this book as a useless summary of a few ill-assorted paragraphs from various scientific and popular journals. We are sorry to be compelled to say the same thing of the present volume. Its engraving of Dr. Carpenter is good as a picture, very good indeed, but as a likeness it is imperfect. The upper part of the face is like the original, but the lower part is not at all like. The best thing in the volume is the sketch of Dr. Carpenter's life, which, though brief, is an admirable outline of this physiologist's labours.

The Astronomical Almanack for 1873. By W. Hollis, Ph.D., F.R.A.S. London: Simpkin and Co., 1873—is of course much smaller than the Nautical Almanack. Still it will be a useful book for amateur astronomers, as it contains the various events which are to occur in every day stated with distinctness.

SCIENTIFIC SUMMARY.

ASTRONOMY.

The Approaching Transits of Venus.—The subject of the approaching transits of Venus is again attracting marked attention among astronomers. It will be remembered (see our "Summaries of Astronomy" for the year 1869) that four years ago Mr. Proctor in England, and M. Puiseux in France, independently and almost simultaneously pointed out that the Astronomer Royal had made a serious mistake when he concluded that Halley's method "fails totally" for the transit of 1874. In the discussions which followed in the Royal Astronomical Society and elsewhere, this important point was tacitly conceded, and an effort only made to maintain that Delisle's method is as good, or nearly so. Of course this is a detail altogether insignificant. If it be once admitted that Halley's method is advantageously applicable, then whether Delisle's is as good, or slightly better, or slightly inferior, the former method ought certainly to be applied. For, as every one knows who has studied the history of astronomical researches to determine the sun's distance, the great point has always been, and must still be, to attack the problem in every possible way. Moreover, the Astronomer Royal, by advocating the employment of Halley's method in 1882, although it will then certainly be inferior to Delisle's, has indicated unquestionably the line which should be taken in 1874, now that Halley's method has been shown to be advantageously applicable during the earlier transit. It chances that the station most suitable for applying Halley's method in 1874 is that very station—Possession Island, near South Victoria Land—where the Astronomer Royal and the most eminent geographers and naval officers had decided that we ought to have a wintering party in 1882. Nevertheless, incredible as it may appear, nothing whatever has been done during the last four years to repair the blunders made in 1857, and left uncorrected for twelve years. It is still Great Britain's purpose, as originally suggested by the Astronomer Royal, to occupy five stations for applying Delisle's method, although four out of the five can be as well occupied by other countries, whereas no other country but Great Britain is bound in honour to occupy Possession Island. What renders the matter more serious by far, is that Russia is doing *her* duty in occupying a most unpleasant station in Siberia, solely for applying Halley's method. This station is Nertchinsk, the very spot pointed out as best by Mr. Proctor four years ago. Of course, without a suitable southern station, observations at the northern station will be thrown away. Yet, at present, Kerguelen Land, far inferior to Possession Island in all respects, is the only southern station where Halley's method will be applied under moderately favourable conditions.

The other mistake made by the Astronomer Royal—that of overlooking the value of stations in North India for observing the "retarded egress" of Venus—has been partially corrected, and a photographic party will be established at some North Indian Station.

It cannot be too often repeated that the investigation applied by the Astronomer Royal to the conditions of this most important problem was utterly inadequate.

Report of Council of the Royal Astronomical Society.—It is rumoured that the plain (though surely not uncourteous) way in which the defects in the Astronomer Royal's papers have been pointed out has given offence, and that in consequence an effort has been made to eject from office one of the honorary secretaries of the Royal Astronomical Society and several members of the Council. We are persuaded these rumours are wholly unfounded; and that the Astronomer Royal, though he may object to be corrected, is unable to become a party to any underhand proceedings. The real circumstance, in fact, which has led to recent secessions from the Council of the Astronomical Society, is of quite a different complexion, and it is perfectly well known that neither the Astronomer Royal nor a single eminent member of the Council had any sympathy with the scheme of the seceders. The following passage from the Report of Council (p. 189) sufficiently indicates the real state of the case :—

"After long and careful consideration of this subject, extending over four meetings, two of which were specially convened for the purpose, and including the discussion of points importantly affecting as well the interests of science as the dignity of this Society, your Council by a large majority passed the following resolutions on the 5th of July, 1872 :—

"'1. That the President be authorised, on behalf of the Council and Fellows of the Royal Astronomical Society, to bring before the Royal Commissioners on Scientific Instruction and on the Advancement of Science, now sitting, the importance of further aid being afforded to the cultivation of the Physics of Astronomy.

"'2. They think such aid would be most effectually given by increased assistance, where needed, to existing public observatories, in the direction recommended by the heads of those observatories, especially that at the Cape of Good Hope, and by the establishment of a new observatory on the Highlands of India, or in some other part of the British dominions where the climate is favourable for the use of large instruments.

"'3. The Council do not recommend the establishment of an independent Government Observatory for the cultivation of Astronomical Physics in England, especially as they have been informed that the Board of Visitors of the Royal Observatory at Greenwich, at their recent meeting, recommended the taking of photographic and spectroscopic records of the Sun at that observatory.'"

It is known that resolutions 2 and 3 were substituted for a resolution proposed by Col. Strange, and seconded by Mr. De La Rue, to the effect that an independent Government Observatory should be established. Manifestly if such a scheme had been advocated by the Council, and eventually it had appeared that one or two members of the Council reaped personal advantage from the scheme, the dignity of the Society would have suffered. It was probably the fear of such a result (which does not seem to have occurred to Mr. De La Rue) which led the Council to oppose the scheme.

The following Council list, while it is marked by one regretable feature —the absence of Mr. De La Rue's name (at his own request)—has, nevertheless, the great advantage of showing that the Society supports the efforts of the former Council to prevent any action by which the dignity of the Society and the self-respect of its individual members could in any way suffer:—

President, Arthur Cayley, Esq., M.A., F.R.S. *Vice-Presidents,* Sir G. B. Airy, K.C.B., F.R.S., Astronomer Royal; William Lassell, Esq., F.R.S.; Rev. Robert Main, M.A., F.R.S.; Rev. Charles Pritchard, M.A., F.R.S. *Treasurer,* Samuel C. Whitbread, Esq. *Secretaries,* Edwin Dunkin, Esq.; Richard A. Proctor, Esq., B.A. *Foreign Secretary,* William Huggins, Esq., D.C.L., LL.D., F.R.S. *Council,* J. C. Adams, Esq., M.A., F.R.S.; J. Browning, Esq.; R. B. Clifton, Esq.; H. M. Christie, Esq.; E. B. Denison, Esq.; T. A. Hirst, Esq.; George Knott, Esq.; Lord Lindsay; Capt. W. Noble; Rev. S. J. Perry; A. C. Ranyard, Esq., M.A.; Capt. G. L. Tupman, R.M.A.

Observations of the Solar Prominences with Small Telescopes.—Those who are interested in the subject of the solar prominences will find the following remarks by Capt. Tupman of great value, though it must be premised that such success as he has attained depends fully as much on the observer as on the telescopic and spectroscopic means made use of:—"In order to view the prominences on the limb of the Sun," he says, "it has generally been thought necessary to employ a somewhat large telescope, fitted with a spectroscope of great dispersion. To show that this is a mistaken idea, I have brought for your inspection the small instrument with which the observations detailed below were made. The telescope is a common one of 3 inches aperture, with an indifferent object-glass of 40 inches focal length. The spectroscope, by Mr. Browning, is a direct vision of five prisms, producing a dispersion very little greater than that of an ordinary flint prism of 60°. There is a small tube carrying the slit and achromatic collimating lens, and a small telescope for examining and magnifying the spectrum, the whole being attached to the telescope by means of a screw adapter. The entire cost of the combination, including the pillar and claw-stand, was 18*l.*; and I have no doubt that an equally effective instrument could be made for much less.

"The adjustments are very simple. The small telescope is first focussed for celestial objects and marked. The slit is then adjusted, by means of the sliding-tube, so that its edges are perpendiculur to the plane of dispersion, and exactly in focus of the small telescope. The latter is best done by focussing on the lines of the solar spectrum with a very fine opening. The slit is then opened to ·002 or ·003 of an inch, moved laterally, until the C line is approximately in the middle of the field, and the spectroscope attached to telescope so that the slit is in the principal focus of the object-glass.

"If the instrument be mounted in this simple manner,* the observer must rest both elbows securely upon the table in order to keep the limb of the Sun precisely on the centre of the slit. A little practice is all that is necessary. The red line due to hydrogen produces a monochromatic image of the chromosphere which partly fills up the dark C line, and, if all the focussing is good, the little tongues that cover the outer surface—especially near the equatorial regions—can be distinctly seen with this instrument. To examine different parts of the limb the spectroscope is rotated, and the slit used tangentially. The angle of rotation is measured on a divided circle attached to the telescope by a small pointer fixed on the spectroscope.

"To save the eye fromthe glare when the full sunlight passes occasionally through the prisms, a diaphragm is placed in the focus of the eye-lens, so that all the spectrum is cut off except a little on either side of the C line. This answers perfectly. A little scale might, with advantage, be added, so as to measure approximately the length of the portion of the limb occupied by a prominence.

"The zero of the position circle may be obtained by turning the slit until the rotation of the earth causes a prominence to travel evenly along it. Owing, however, to the want of stability in the mounting, I prefer to measure the position of the prominences from the vertex of the disk, the zero being determined by placing the slit several times horizontal and vertical by estimation.

"The height of a prominence above the upper surface of the chromosphere may be measured by opening or closing the slit until it just contains the prominence. The value of a revolution of the micrometer-screw for opening the slit may be found accurately by actual measurement, and turned into seconds of arc, for the radius equal to the focal length of the object-glass, by simple proportion. A focal length of 100 inches requires the slit to be open to 0·0485 inches to subtend 100 seconds of arc.

"A quicker way, and quite as accurate, is to turn the spectroscope round until the top of the prominence and some other part of the surface of the chromosphere enter the field together. The angle through which the spectroscope is turned will give the perpendicular height of the prominence as in the following table, which is sufficiently accurate all the year round.

Angle.	Height.	Angle.	Height.	Angle.	Height.
10°	15″	22°	77″	34°	199″
11	19	23	84	35	212
12	22	24	92	36	228
13	26	25	99	37	244
14	30	26	109	38	261
15	34	27	119	39	277
16	39	28	129	40	293
17	45	29	139	41	312
18	51	30	149	42	333
19	56	31	161	43	355
20	62	32	174	44	379
21	69	33	187	65	404

* Viz. on a pillar-and-claw stand.

"Professor Respighi has seen bright prominences upwards of 6 minutes high. As yet I have only seen one 5 minutes high, and that was faint and wholly detached like a little cloud.

"The depth of the stratum of hydrogen, called the chromosphere, is 4″ or 5″ at the poles, and increases to 7″ or 8″ in the equatorial regions, where its surface is generally much disturbed and dotted all over with little tongues which are really minute prominences.

"The prominences seen at any instant may, of course, be very far from the true limb of the Sun. According to their height they are scattered over a zone of from 20° to 50° in breadth, as seen from the Sun's centre."

Biela's Comet and the Display of Meteors on November 27, 1872.—These subjects will be found fully discussed in another part of the present number.

BOTANY.

On Leaf-arrangement.—A somewhat complex paper has been presented to the Royal Society, by Dr. H. Airy, on this subject. Those who are interested must consult the original paper, which is of some length [it was read on Feb. 27 last], but for ourselves we do not see much to support the author's views. He says, assuming, as generally known, the main facts of leaf-arrangement—the division into the whorled and spiral types, and in the latter more especially the establishment of the convergent series of fractions, $\frac{1}{2}, \frac{1}{3}, \frac{2}{5}, \frac{3}{8}, \frac{5}{13}, \frac{8}{21}, \frac{1}{34}, \frac{21}{55}, \frac{34}{89}, \frac{55}{144}$, &c., as representatives of a corresponding series of spiral leaf-orders among plants—we have to ask what is the meaning that lies hidden in this law? Mr. Darwin has taught us to regard the different species of plants as descended from some common ancestor; and therefore we must suppose that the different leaf-orders now existing have been derived by different degrees of modification from some common ancestral leaf-order. One spiral order may be made to pass into another by a twist at the axis that carries the leaves. This fact indicates the way in which all the spiral orders may have been derived from one original order, namely, by means of different degrees of twist in the axis. Then, after a great series of examples, he concludes by stating we are led to suppose that the original of all existing leaf-orders was a two-ranked arrangement, somewhat irregular, admitting of two regular modifications, the alternate and the collateral; and that the alternate has given rise to all the spiral orders, and the collateral to all the whorled orders, by means of advantageous condensation in the course of ages.

Preparing Charæ for the Herbarium.—The calcareous-encrusted Charæ make wretched herbarium-specimens, as is well known, being not only unsightly, but usually very fragile. M. Corum (*vide* "Bull. Soc. Bot. Fr.," xvii. p. 153) remedies this by plunging the fresh specimens for a short time in water containing one per cent. of hydrochloric acid, and afterwards washing in pure water. Their aspect, when thus prepared and dried, is nearly that of the living plant.

A Monograph on the Genus Pyrus.—M. Decaisne has recently published a valuable monograph on the genus Pyrus, with a full generic character, and descriptions and figures of the *races,* as he would term them, considering as he does all known forms of the restricted genus as a single and very polymorphous species. The six races are: 1. The Celtic, *Proles Armoricana,* of three quasi-species, *P. cordata, Boissieriana,* and *longipes.* 2. The Germanic, *Proles Germanica,* or *Pyrus communis,* including our common pears, both pear-shaped and apple-shaped, "both forms being often met with upon the same tree." Under this head (says a reviewer in "Silliman's Journal") Professor Decaisne gives some interesting pages upon the history of the cultivation of pears in France, which cannot be ancient, and of cider (perry) as a drink. It appears that it took the place of beer in the north of France in the fifteenth century or later, and is now giving way to wine and perhaps beer again; and that pears would have disappeared before this from a part of Normandy, were it not that *they are carried in immense quantities to Epernay, where they are used in the manufacture of champagne.* 3. The Hellenic race, which comprises *P. parviflora* and three other subspecies. 4. The Pontic race, *P. salicifolia* and its allies. 5. The Indian race, *P. Pashia* and its relatives. 6. The Mongolian race, *P. Sinensis* and its varieties. As one turns over the excellent plates one can hardly be persuaded that such extremely diverse forms can practically be regarded as of one species. A list of the species remanded from Pyrus to other genera shows that the result of our author's prolonged and sagacious study is to increase the genera about as much as he diminishes the species of the Linnæan Pyrus.

What Parts of Chlorophyll-bearing Plants exhale Oxygen.—Professor Draper, of New York, in a recent paper on "Evolution in Seedlings," says that of the chlorophyll-bearing plants it is found that in the Phanerogamia it is only the green parts that at any time exhale oxygen, and then only under the influence of sunshine. The other parts of the plant above the ground, that are not green, viz., the stem, twigs, flowers, &c., are at all times, day and night, exhaling carbonic acid. The whole history of the plant, from the time the seed is planted to its death, is a continuous story of oxidation, *except when sunlight is falling on the leaves.* The seed is put into the ground, and during germination oxygen is absorbed and carbonic acid exhaled. If the seedling is kept in the dark, oxygen is never exhaled, only carbonic acid, and the plant not only grows, but all visible structures except flowers are formed in a rudimentary condition. In the light the growth during the night time is attended by the evolution of carbonic acid, while during the day time the bark of the stem and branches is throwing off carbonic acid. When flowers and seeds form, the evolution of carbonic acid attending this highest act of which the plant is capable is often greater than that produced at any time in many animals. Hence the author concludes by saying that "Everything in the history of plants, therefore, tends to show that the evolution of their structures is inseparably attended by the formation of carbonic acid, and it seems impossible, when we consider the evolution alone, to arrive at any other opinion than that already expressed—that, *all living things, whether plant or animal, absorb oxygen and* *evolve carbonic acid, or some other oxidized substance, as an essential condition of the evolution of their structures.*"

The "Yucca" and the "Pronuba."—According to the researches of Professor Riley, which will be published in the "Transactions of the St. Louis Academy of Sciences," these two—plant and animal—are wonderfully interdependent. He lately described the generic and specific characters of a little moth, which is one of the most anomalous known to entomologists. He first described how many of our flowers, such as the Ascelpias and Orchids, were curiously constructed so as to be incapable of fertilising themselves, and at the same time to attract insects to do it for them. Dr. Englemann had this year discovered that Yucca was one of those plants which depended on insects for fructification, and Professor Riley had discovered that the little moth in question, which he calls *Pronuba guccassella*, is the only insect which can have anything to do with this fructification. But what is more interesting in this case is, that the plant not only depends on the assistance of the moth, but that the moth, in turn, is likewise dependent upon the plant, since its larvæ live on the seeds. We have, consequently, a mutual interdependence which is very striking, and in the structure of a female moth there is a curious adaptation of means to an end by a complete modification of parts, and especially of the maxillary palpi, which are formed into prehensile tentacles, by which she collects the pollen to insert it into the stigmatic tube.

Origin of Weeping Willows.—In a late number of "Silliman's American Journal," a writer, whom we imagine to be Professor Gray, says that from the investigations of Karl Koch it appears that the "*Garab*," upon which according to the Psalmist, the captive Jews at Babylon hung their harps, is not the weeping willow named *Salix Babylonica* by Linnæus in view of the current tradition, and is not a willow at all, but a poplar. Indeed Ranwolf had long ago concluded that it was not a willow. And the *Salix Babylonica*, the hardiness of which attests a cooler climate than that of Mesopotomia, is now regarded as of Chinese or Japanese origin; so that its Linnæan specific name gives place to that of *Salix pendula* Mœnch.

Dicranum undulatum in Britain.—Dr. Robert Braithwaite, writing to the first number of "Grevillea" for the present year, says:—"This may now with certainty be entered as a member of our Moss-Flora, Prof. Lindberg having detected it in Mr. Spruce's herbarium. Having recently paid a visit to that gentleman, he kindly gave me some of his original specimens, and informed me that he found it in August, 1842, growing in dryish sand-pits in a fir plantation on Stockton Forest, near York, and although specimens were sent to the late Mr. Wilson, it has no place in his 'Bryologia Britannica.' My friend Mr. Anderson of Whitby, has found it again in the same locality a few weeks ago, and it is probable that it occurs in many other places; but, being barren, has not been distinguished from *D. scoparium* or *D. Bonjeanii*; at least this is much more probable than that such a widely diffused Continental and American species should be totally absent from Britain. Mr. Spruce informs me that it is not uncommon in the lower Pyrenees, growing in grassy glades of sandy woods."

The Selective Power of Plants.—Prof. S. W. Johnson, of Yale College, Connecticut, has called our attention to the circumstance that in the passage quoted from his work "How Crops Grow," in Mr. A. W. Bennett's article on "Spontaneous Movements in Plants," in the number for Oct. 1872, p. 372, the writer of that article has omitted to complete the quotation, which should have run thus:—"It is in this way that we have a rational and adequate explanation of the selective power of the plant, *as manifested in its deportment towards the medium that invests its roots*." To the words italicized, omitted in Mr. Bennett's quotation, Prof. Johnson attaches considerable importance, remarking that "the selective power of the plant as manifested towards the medium that invests its roots is one thing, and the selective powers of the tissues towards the substances dissolved in the cell-juices is, in many cases, or may be, another;" and wishes it to be understood that it is of the former and not the latter phenomenon that he has proposed what he considers an "adequate and rational explanation." The misrepresentation is, we are assured, quite unintentional, the immediately succeeding sentence in the book, "*the same principles* govern the transfer of matters from cell to cell, or from organ to organ within the plant," appearing to Mr. Bennett to remove the effect of the limitation conveyed in the words quoted above. There appears also to be some difference between the two writers in the use of the word "tissue," the English writer using it in the ordinary sense of agglomeration of cells, the American apparently in some slightly different sense. Prof. Johnson also points out that in "How Crops Grow" he has adduced evidence which appears to show conclusively that silica is unessential to the growth and perfect development not only of leguminous plants, but of all its various cereals.

Sachs's Lehrbuch der Botanik.—We are glad to hear that an English translation of this most important work is about to be published by the Clarendon Press, Oxford. The translation will be made from the third edition, just published at Leipzig, and greatly enlarged, as compared with previous editions, by Mr. A. W. Bennett, assisted by Prof. Thiselton Dyer; and the translators will also annotate the work on those points where the German author does not appear to have taken fully into account the most recent researches of French or English workers. All the beautiful woodcuts illustrating the original work will be reproduced in the English translation. The "Lehrbuch" was among the works recently recommended by the Board of Studies of the Natural Science School at Oxford.

CHEMISTRY.

The Chemistry of Safranine.—Dr. Hofmann and Herr A. Geyger have recently presented a paper to the Royal Society ("P. R. S." No. 140), in which they have given us nearly the entire chemical history of this important body. With regard to the substance itself, apart from its salts, they say that it occurs in commerce either as a solid body or *en pâte*. In the solid state it forms a yellowish-red powder, in which, together with considerable quantities of chalk and common salt, the chlorhydrate of a tinctorial base may be recognised. The pure dye is easily separated from crude safranine. It is only necessary to exhaust the commercial product with boiling water; on cooling, the filtrate deposits a slightly crystalline substance which, after several recrystallisations from boiling water, leaves no residue on ignition. During these operations, however, the salt undergoes perceptible alteration; with every recrystallisation it becomes more soluble and less crystalline. These alterations depend upon the separation of chlorhydric acid from the salt. In fact the percentage of chlorine is found to diminish in the product of successive crystallisations; thus the product of the third contained 8·48 per cent., that of the fourth crystallisation only 7·46 per cent. Addition of chlorhydric acid to the mother liquors at once reproduces a crystalline precipitate. This instability of the chlorhydrate, and in fact, as may even now be stated, of the salts of safranine in general, has very considerably impeded the study of this body, and often materially affected the accuracy of the analytical results. In order to obtain the normal salt, the boiling liquid during the last crystallisation had always to be acidified with chlorhydric acid. The authors also describe rather fully the chlorhydrate, nitrate, sulphate, oxalate, and picrate of the base, but we have not space for a further abstract.

The Sensitiveness of Collodion Films.—Dr. J. W. Draper has an interesting note on this subject in "Silliman's American Journal" for January. He says that the silver compounds of collodion absorb the radiations falling on them, which are capable of producing a photographic effect. Yet sensitive as it is, collodion is very far from having its maximum sensitiveness, as is shown by the following experiment, which is of no small interest to photographers. I took five dry collodion plates, prepared by what is known as the tannin process, and having made a pile of them, caused the rays of a gas flame to pass through them all at the same time. On developing it was found that the first plate was strongly impressed, and the second, which had been behind it, apparently quite as much. Even the fifth was considerably stained. From this it follows that the collodion film, as ordinarily used, absorbs only a fractional part of the rays that can affect it. Could it be made to absorb the whole, its sensitiveness would be correspondingly increased.

Pyrology, or Fire Analysis.—This is the subject of a series of interesting papers by Captain W. Ross, R.A., in the "Chemical News" [Feb. 1873]. They are too long for abstract, so we must refer our readers to the original.

How to ascertain change of colour of Litmus in Alkalimetrical Assays.—A paper contributed to the "Comptes Rendus" of the French Academy [Jan. 27] by M. L. D'Henry gives a description of a Bunsen gas-burner so arranged that the flame is kept constantly saturated with sodium, so that while the blue colour of litmus appears deep black, the red colour produced by the addition of an acid appears as colourless as water; thus affording a better means of ascertaining the precise moment when the alkali is saturated.

How the London Vestries look after Adulteration.—The scandalous system adopted by these bodies has been exposed in an able fashion in the "Chemical News," Feb. 7. The writer of the article says that the vestries, for the sake of economy, offer a paltry 100*l.* or 150*l.* a year to the salary of their medical officers to undertake the analyses. Now what is, generally speaking, the scientific experience of these gentlemen? At a remote period of their student days they were required to be present at not more than sixty chemical lectures, and sixty hours of the most elementary laboratory practice; in such work boys in the Grammar Schools of Birmingham and Manchester could excel them. Even the little knowledge then gained has by this time faded away, and they could not, off-hand, establish the difference between sulphate of zinc and Epsom salts, much less the presence of alum in bread, or bromide in iodide of potassium. Adulterators may continue their evil practices, relying in cases where detection may ensue that the criticism of an able chemist will so damage the evidence as to render conviction impossible. A humbling picture of a Local Government Board engaged in electing an analyst was lately afforded by a report of the proceedings in a recent copy of the "Times." The request of the medical man that he should be authorised to spend not more than 100*l.* in fitting up a laboratory with the necessary apparatus for his chemical work was "received with much laughter." A vestryman stated that he possessed a laboratory in which he could do almost anything, which cost only 20*s.*

The Action of Sodium on Aniline.—At the meeting of the "Chemical Society" on Feb. 6, Dr. H. E. Armstrong said that he was induced to lay before the society the results of his experiments on this subject some years ago, as Messrs. Merz and Weith had recently stated that sodium had no action on aniline. This was correct for temperature below the boiling-point of aniline; but when the two substances are heated in a sealed tube to 200° the sodium disappears, hydrogen is evolved, and a colophonium-like substance produced, which appears to be a mixture of—

$$N \begin{cases} C_6H_5 \\ Na \\ H \end{cases} \quad \text{and} \quad N \begin{cases} C_6H_5 \\ Na \\ Na. \end{cases}$$

It darkens when exposed to the air, and is decomposed by the action of water with formation of sodium hydrate, and reproduction of aniline. With methyl-aniline the action is only partial even at 250°, and with ethyl-aniline there is no action even at 300°. The simultaneous action of potassium and carbonic anhydride on aniline gives rise to potassium carbonate and diphenyl carbamide—

$$N_2(C_6H_5)_2H_2CO.$$

The latter substance, however, is not always produced, and even under favourable circumstances the amount is but small.

A strongly decolourising animal charcoal.—Herr Dr. Granger describes this in the "Bayerisches Industrie und Gewerbe-Blatt" for December last. The common powdered bone-black is first mixed with from four to six times its bulk of a solution of from four to five per cent. of crystallised carbonate of soda, and boiled therewith for some time; next it is washed by decantation, and after that, treated with a large excess of dilute hydrochloric acid, sufficient not only to dissolve the carbonate, but also the phosphate of lime it contains. (In order to see whether enough acid had been added, a small sample of the previously-filtered fluid is tested by means of ammonia, which, when added in slight excess, should not produce a turbidity.) When the mineral matter is removed, the charcoal is thoroughly washed, first by decantation, and next placed on a filter and washed until the water exhibits no acid reaction; the material is then carefully dried at from 100° to 120°. 100 parts of crude animal charcoal yield 20 of the purified, which has highly decolourising properties. The method requires time and patience.

European Paraffin Oil bids fair ere long to do away with the American trade in this coal product. It appears that [" Chemical News " Jan. 31] in Galicia large quantities of the petroleum (in every respect like the American) occur, and according to the investigation, made by competent engineers, the country alluded to will soon be able to compete with the foreign trade in this article. Well-boring is actively pursued in several localities, but none have as yet reached the main oil-bearing strata, which are known to be at depths varying from 1,000 to 1,500 feet below the surface.

GEOLOGY AND PALÆONTOLOGY.

Professor Marsh's discovery: a new group of fossil birds.—A new subclass of fossil birds with biconcave vertebræ has been quite recently discovered by Prof. O. C. Marsh in the United States of America. The fossils were described some time before [Jan. 21, 1873]; but the discoverer says [" Silliman's Journal," Feb. 1873] that they prove on further investigation to possess some additional characters, which separate them still more widely from all known recent and fossil forms. The type species of this group (*Ichthyornis dispar*, Marsh) has well-developed *teeth in both jaws.* These teeth were quite numerous, and implanted in distinct sockets. They are small, compressed and pointed, and all of those preserved are similar. Those in the lower jaws number about twenty in each ramus, and are all more or less inclined backward. The series extends over the entire upper margin of the dentary bone, the front tooth being very near the extremity. The maxillary teeth appear to have been equally numerous, and essentially the same as those in the mandible. The skull is of moderate size, and the eyes were placed well forward. The lower jaws are long and slender, and the rami were not closely united at the symphysis. They are abruptly truncated just behind the articulation for the quadrate. This extremity, and especially its articulation, is very similar to that in some recent aquatic birds. The jaws were apparently not encased in a horny sheath. The scapular arch, and the bones of the wings and legs, all conform closely to the true ornithic type. The sternum has a prominent keel, and elongated grooves for the expanded coracoids. The wings were large in proportion to the legs, and the humerus had an extended radial crest. The metacarpals are united, as in ordinary birds. The bones of the posterior extremities resemble those in swimming birds. The vertebræ are all biconcave, the concavities at each end of the centra being distinct, and nearly alike. Whether the tail was elongated cannot at present be determined, but the last vertebra of the sacrum was unusually large. This bird was fully adult, and about as large as a pigeon. With the exception of the skull, the bones do not appear to have been pneumatic, although most of them are hollow. The species was carnivorous, and probably aquatic. The bird belongs to the new sub-class *Odontornithes,* and to the new order *Ichthyornithes.*

Actual Glaciers in California.—These have been recently discovered by Mr. John Muir, and are fully described in the "Overland Monthly" for December last. The author having stated his cursory observations, goes on to tell of his more scientific experiments. He says that on the 21st of August last he planted five stakes in the glacier of Mt. McClure, which is situated east of Yosemite Valley, near the summit of the range. Four of these stakes were extended across the glacier, in a straight line, from the east side to a point near the middle of the glacier. The first stake was planted about twenty-five yards from the east bank of the glacier; the second, ninety-four yards; the third, 152; and the fourth, 225 yards. The positions of these stakes were determined by sighting across from bank to bank, past a plumb-line, made of a stone and a black horse-hair. On observing these stakes on October 6, or in forty-six days after being planted, he found that stake No. 1 had been carried down stream eleven inches; No. 2 eighteen inches; No. 3 thirty-four, and No. 4 forty-seven inches. As stake No. 4 was near the middle of the glacier, perhaps it was not far from the point of maximum velocity—forty-seven inches in forty-six days, or one inch per day. Stake No. 5 was planted about midway between the head of the glacier and Stake No. 4. Its motion he found to be, in forty-six days, forty inches. Thus these ice-masses are seen to possess the true glacial motion. Their surfaces are striped with bent dirt-bands, and are bulged and undulated by inequalities in the bottom of their basins, causing an upward and downward swedging, corresponding to the horizontal swedging as indicated by the curved dirt-bands. The Mt. McClure glacier is about one-half of a mile in length, and the same in width at the broadest place. It is crevassed on the south-east corner. The crevasse runs about south-west and north-east, and is several hundred yards in length. It is nowhere more than one foot in width. The Mt. Lyell glacier, separated from that of McClure by a narrow crest, is about a mile in length. He has planted stakes in the glaciers of "Red Mountain" also, but has not yet observed them.

Activity of the Volcano of Kilauea.—The "Hawaiian Gazette," quoted by an American Journal, states that it learns that the crater is very active. The old South Lake is full, and running over in two broad streams, one to the south and the other to the west. A number of beautiful cones were in action, and sending up continuous jets of lava. Mr. Jones, the proprietor of the Volcano house, describes the scene as finer than any he has seen for years. During two weeks a number of slight earthquake shocks have been felt at Kapapala, and later on a very heavy one was felt at Hilo—the heaviest that has been felt since the great shock of April, 1868.

The Jaw of a Powerful Labyrinthodont.—This fossil, which was partly described by Professor Huxley in 1862, has been recently very fully treated in a paper by Messrs. A. Hancock and T. Atthey in the "Natural History Transactions of Northumberland and Durham" (vol. iv. part 2). Mr. Atthey dealt with it in a paper in the "Annals of Natural History," in 1869; but the two authors have treated it at some length in the present communication. The piece now described and very excellently figured is a portion of the posterior extremity; but the articular process is wanting.

The fragment is seven inches long, and measures nearly four inches from the alveolar border to the inferior margin. There is just two inches of this margin perfect; and this is at the point where undoubtedly the ramus is deepest. The inner surface is exposed to view, and is concave longitudinally, the outer surface being a little convex, as is evident in the transverse section of the specimen in front. The bone, which is in a very perfect state of preservation, is composed of two parallel layers—an inner, the splenial plate, and an outer, the dentary piece, and is stout, particularly at the alveolar border, where it is an inch thick; thence it becomes gradually thinner to the longitudinal middle line; here it is scarcely more than one-fourth of an inch thick, and so continues to the inferior margin. After these general remarks the authors deal at length with the whole subject.

Death of Professor Sedgwick.—It is with profound regret that we have to acknowledge the death of this veteran geologist, who was born as early as 1786. He died at Trinity College, Cambridge, of which he was a Fellow, on the 27th of January, in his 88th year. He had held the chair of Woodwardian Professor of Geology in the University since 1818, and his works are thoroughly familiar to everyone who has studied geology.

Professor Sedgwick's Successor.—The "Geological Magazine" (March) informs us that the election of a successor to the late Professor Sedgwick was held on the 20th February, when Mr. Thomas M'Kenny Hughes, M.A., of Trinity College, was chosen by a majority of seven. By a statute of the University, the election must take place within one month from the vacancy being declared. No fewer than nine candidates had issued applications to the electors who were the members of the Electoral Roll, consisting of the Heads of Houses, Professors, University Examiners, and resident members of the Senate. The candidates were as follows: Rev. O. Fisher, F.G.S., Rev. T. G. Bonney, F.G.S., and Messrs. T. M'K. Hughes, F.G.S., and A. H. Green, F.G.S. (Cambridge), Rev. P. B. Brodie, F.G.S., Mr. W. Boyd Dawkins, F.R.S., and Mr. T. H. G. Wyndham, F.G.S. (Oxford), Professor Morris, F.G.S., and Professor Martin Duncan, F.R.S. (London).

The Medals given by the Geological Society, and the Anniversary Address.—The medals were given away at the Anniversary Meeting that was held on Friday the 21st February. His Grace the Duke of Argyll, K.T., President, in the Chair. The Wollaston Gold Medal was awarded to Sir Philip de Malpas Grey Egerton, Bart., M.P., for his eminent services to Palæontological Science, and particularly in recognition of his researches in fossil fishes. The balance of the Wollaston Fund was awarded to J. W. Judd, Esq., F.G.S., in aid of his investigation into the Geology of Sutherlandshire, &c. The First Murchison Bronze Medal (together with a part of the Fund) was awarded to Mr. William Davies, of the British Museum, in recognition of his long and valuable services, rendered during a period of thirty years, to the cause of Palæontological Science. The balance of the Murchison Fund was awarded to Professor Oswald Heer, of Zurich, in aid of his researches into the Miocene Flora of Arctic Europe, Greenland, and America. The Anniversary Address was then delivered by His Grace the Duke of Argyll, as President, in which he ably controverted the theory of a Polar Ice-cap extending to the South of Europe, and contended that even the powers of glaciers to cut out valleys and excavate lake-basins had been vastly over estimated, and argued that the valleys down which the glaciers flowed existed before the glaciers occupied them.

Gigantic Fossils of the order Dinocerata.—Professor O. Marsh gives an account of these in "Silliman's Journal" (February), and points out some of the features which distinguish these fossils from the *Proboscidea.* These are:—1st. The absence of upper incisors. 2nd. The presence of canines. 3rd. The presence of horns. 4th. The absence of large air cavities in the skull. 5th. The malar bone forms the anterior portion of the zygomatic arch. 6th. The presence of large postglenoid processes. 7th. The large perforated lachrymal, forming the anterior portion of the orbit. 8th. The small and horizontal narial orifice. 9th. The greatly elongated nasal bones. 10th. The premaxillaries do not meet the frontals. 11th. The lateral and posterior cranial crests. 12th. The very small molar teeth, and their vertical replacement. 13th. The small lower jaw. 14th. The articulation of the astragalus with both the navicular and cuboid bones. 15th. The absence of a true proboscis. The last character may be fairly inferred from the short anterior limbs, the moderately lengthened neck, and the very elongated head, which rendered a proboscis unnecessary, as the muzzle could readily reach the ground. The small nasal opening—smaller even than that of the Rhinoceros or Tapir—also testifies against it, while the nasal horns and the sharp decurved canines would seriously have interfered with such an organ, had it been present. The horns of the *Dinocerata* were a remarkable feature. Those on the nasal bones were probably short, dermal weapons, something like those of the Rhinoceros, but much smaller. Those on the maxillaries were conical, much elongated, and undoubtedly formed most powerful means of defence. The posterior horns were the largest, and their flattened cores indicate that they were expanded, and perhaps branched. All the horn cores are solid, nearly smooth externally, and none of them show any indication of a burr. Whether both sexes had horns cannot at present be decided, but this was probably the case. The remains on which this description is based are all from the Eocene deposits of Wyoming. A more complete description, with full illustrations, is in course of preparation.

MECHANICS.

An Atmospheric Coal-winding Machine.—In the "Revue de Chimie" (January 2nd, 1873), M. Z. Blanchet gives a detailed account of a mechanism contrived to supersede the ordinary methods used for bringing to bank the coal wrought in pits. We learn from the statistics here given, that this atmospheric system saves a great deal of labour, and is far more effectual than the plans now in use.

Professor Tyndall's Gift to the Americans.—The "Scientific American" has a highly appreciative article on this subject. It says (March 8th):—"Professor Tyndall has set us a noble example of unselfish liberality. He had every right to carry with him to his home all the money that had been cheerfully given by those who were instructed and enchanted by his lectures; but instead of doing so, he prefers to hand it back for the benefit of those who gave it, and in aid of the common cause of scientific learning in which the whole world takes an interest. This is an example worthy of imitation. The trustees who have charge of the Tyndall Fund will no doubt be glad to have the amount increased as largely as our wealthy citizens may desire. They cannot have too much money for the promotion of original research, and it is equally certain that no investigation founded upon correct scientific reasoning can be made in vain."

Improvement in Safety Valves.—This consists of an arrangement of spring loaded safety-valves for marine boilers, designed by Messrs. Pollit and Wigzell, of Sowerby Bridge, and lately applied by them on board a steamship which they are fitting with engines. "Engineering" says that the valves are of the ordinary form, and are fitted with the usual lifting gear; but on the top of the valve box are fixed two cylindrical casings, each containing a helical spring which bears upon a disk carried by the spindle of the corresponding valve. The lower ends of these spring casings are kept air and water tight by india-rubber disks, while at the upper end each casing is fitted with a cap secured by a bolt and padlock, this cap preventing the spring from being tampered with. The valves are quite free, and can be turned round by the two flat places formed on the spindles just above the valve box cover. The arrangement is a very simple one, and the plan of protecting the spring by means of an india-rubber disk, which closes the mouth of the spring case, and at the same time does not interfere with the play of the valve, is, we believe, novel.

MEDICAL SCIENCE.

Heat Produced in Body, and Effects of Exposure to Cold.—This subject has been thoroughly investigated by Dr. Draper of New York, who communicates a paper on the matter to "Silliman's American Journal" for December, 1872. After giving the figures resulting from experiments in columns, he says that if we compare the column representing the condition before entering the bath with that representing the condition immediately after leaving it, we find that in both experiments the exposure for one hour to water at a temperature of about 74° F. lowered the temperature of the mouth two degrees, of the armpit four degrees, and of the temple two degrees. The rate of respiration is also diminished in one case two and in the other four movements, and that of the pulse twenty beats in one, and twenty-three in the other. It is therefore evident that the effect of the long continued application of a degree of cold such as that employed is to reduce the temperature of the body and the rate of respiration slightly, while it affects the rate of pulsation in a very profound manner. One of the consequences of this effect of cold on the action of the heart was a great reduction in the quantity of oxygen introduced into the system. The rate of pulsation being reduced nearly one-third, the quantity of oxygen conveyed into the interior of the body was diminished in a somewhat similar ratio. In a short time this began to exert its influence on the nervous centres, and there was an overwhelming disposition to fall asleep, which was unconsciously indulged in in both experiments shortly after leaving the bath, notwithstanding the strong desire to keep awake for the purpose of recording the rates of pulse and respiration at given periods.

On Typhoid Fever.—In Sir W. Gull's lecture on this subject, which we should have reported earlier, it is remarked that two hundred and fifty years ago one of the kings of England died of ague, but now by improved agriculture and drainage the disease had become rare, and certainly very few die of it. Typhoid fever, he asserts, is as preventible as ague, and two hundred and fifty years hence deaths from it will be as rare. The disease is caused by a virus of nature, which may get into the healthy body, increase in it, and destroy it. It is an accidental condition, and not one of the ordinary processes of nature. The origin of the disease is somehow or other connected with drainage; it has therefore been called the filth fever, and to get rid of the filth is to get rid of the fever. This was illustrated in the case of the Millbank Prison, where typhoid and dysentery were once thoroughly established, but where both almost wholly disappeared when the water-supply was changed and efficient drainage provided. In his closing remarks on the treatment of the disease, the lecturer said that no one can approach a case of typhoid fever without paying some attention to hygiene. This he claimed was of the greatest importance, and with it he would prefer to carry anyone through the disease by wines and soups and fresh air, rather than by the use of drugs.

A Collection of Peruvian Skulls at the Anthropological Society.—This society's museum has lately been enriched by the presentation of a splendid collection of Peruvian skulls of vast age and 130 in number. They were dug out of the old aboriginal burying-grounds of Pasamayo and of Ancon, 20 and 30 miles north, and from Cerso del Oro about 100 miles south, of Callao. Twenty-four of these were taken by the Consul himself from the Huacas of Ancon, and are probably those of Chinchas or perhaps Aymaras.

The Nutrition of the Lung-tissue in Consumption.—Dr. W. Marcet, F.R.S., has contributed a valuable paper on this subject to the "Philosophical Magazine." Among a great number of conclusions the following especially bear on the point above stated: (a) That in phthisis a given weight of muscular tissue contains less nutritive material than it does in health, less mature or insoluble tissue, rather more water, and a much higher proportion of chlorine and soda. (b) That, in phthisis, the phosphoric acid and potash effete in muscular tissue are present exactly in the right proportion for the formation of a pyrophosphate, as occurred in healthy flesh. This shows that the process of waste of muscles in phthisis takes place precisely as it did while in the state of health, and confirms the result relative to the composition of the effete material of muscular tissue, eight analyses of flesh yielding phosphoric acid and potash effete in the proportion of a pyrophosphate. (c) That the emaciation in phthisis appears due mainly to the blood not being in the proper condition to supply nutritive material to muscular tissue. The damp or wet state peculiar to muscles after death from phthisis appears to show that the colloid state of flesh in that disease is somewhat deficient. (d) That the tubercular or adenoid formation in pulmonary tissue actually undergoes nutrition, and is consequently *a growth*, the phosphoric acid and potash being apparently eliminated, as in the case of flesh, under the form of a crystalloid phosphate. The nutrition of the abnormal growth accounts for the absence of any smell of decomposition, which is nearly invariably observed at the post-mortem examination when performed shortly after death from consumption. (e) The process of softening of the tubercular substance appears due to a loss of colloid power; it can hardly be owing to an increase in the proportion of water, as there is but very little more water in softening tubercular lungs than in healthy lungs.

How to Distinguish Cancer (?) from Innocent Growths.—Dr. I. N. Dunforth, in writing on the subject of the great difficulty of recognising cancerous growths under the microscope, says that in conclusion he would lay down the following simple rules for drawing the distinction between innocent and morbid growths: whenever a description of *one* of the cells of a microscopic specimen is a description of *all* of its cells, the chances are as ten to one that it is *not* cancer; whenever, on the other hand, the cells of such a specimen are so varied in form and size that philology, and ingenuity, and imagination, and the most unflinching resolution combined, utterly fail to accomplish the task of describing them, the chances are as ten to one that the specimen is from a malignant growth, whatever may be its name or location.

METALLURGY, MINERALOGY, AND MINING.

The Manufacture of Iron.—A lecture, especially interesting to iron and steel manufacturers, was delivered on Thursday evening, March 20, to a crowded audience of the Fellows of the Chemical Society, at Burlington House, by Dr. C. William Siemens, F.R.S., on the manufacture of wrought iron and cast steel direct from iron ore by a new method, which is intended to supersede most of the present operations. By this process the blast furnaces, as well as the laborious puddling operations, are suppressed; the ore being simply deoxidised, and the iron precipitated in a new furnace, specially arranged for the purpose, from which it is withdrawn in the state of blooms, and at once shingled or melted into steel. The special feature, however, and the one of the greatest interest at the present time, is the extraordinary economy of fuel effected by this invention. In place of some four tons of the best coal, as by existing processes is required to obtain a ton of wrought iron, but 28 cwt. of coal of an inferior coal is necessary to produce the same weight.

Changes in Coal owing to Exposure.—A valuable paper on this subject, but one too long for abstract, is that by Mr. H. Engelmann in the "Chemical News" [Jan. 10, 1873]. The author gives actual experiments showing the extreme loss which coal undergoes by storage. He says that an interesting experiment was made some years ago in Germany to test the deterioration by exposure of Silesian gas coal. A quantity of coal slack was divided in three parts. One part was directly used in the gas factory, another after having been housed one month, and the third after one month's exposure in the yard. The relative proportions of gas obtained were 135, 111, 95. The losses by exposure were therefore 17·2 per cent. and 29·5 per cent. The gas coke from the first lot was serviceable, from the second and third unserviceable. The rest of this paper is full of interest.

A new method of Assaying Lead Ores has been devised, according to the "Chemical News" [Feb. 7, 1873], by Herr A. Mascazzini. Previous to reducing the galena or other lead ore to the metallic state, the author converts the lead present in the ore into sulphate by igniting it in a porcelain crucible with sulphate of ammonia, after which the ore is treated in the usual manner. The flux preferred by the author is that recommended by Plattner, consisting of 13 parts of carbonate of potassa, 10 of dry carbonate of soda, 5 of previously fused borax, and 5 of well dried starch.

MICROSCOPY.

The microscopic characters of Cotton.—This subject has been frequently attempted before. However, we think that the little pamphlet which the Rev. H. Higgins, M.A., has sent us, is likely to be better than most others. It is illustrated by a number of photographs of the cotton of different kinds as seen beneath the microscope. Some of them are excellent. But we confess that others appear as though they were photographed from drawings.

Value of Chloride of Gold in Microscopy.—Dr. Woodward, of America, thus expressed himself recently on this subject:—Attention was first drawn to this reagent by the now renowned Dr. J. Cohnheim, in a paper on the ending of the sensitive nerves of the cornea, published in "Virchow's Archiv." vol. xxxviii. p. 343, March 1867. It is true, Dr. Lionel S. Beale, the following year, informed his readers, in the fourth edition of "How to Work with the Microscope," that "Cohnheim's drawings alone" excited doubts in his mind "as to the accuracy of his observations;" and that his statements should be received "with the utmost caution." Nevertheless, Cohnheim's observations on the cornea have been substantially confirmed by numerous reliable observers, and the value of chloride of gold as a histological reagent has become too well established for any authority, however great, to sneer it away.

A new form of Mount for Microscopic objectives is described by Dr. R. L. Maddox, in the "Monthly Microscopical Journal" for January. He says that to others who, like himself, occasionally do a little glass grinding, the following form of mount may prove useful. It was made about two years ago. It consists of the usual outer tube, but near the shoulder, on the outside, are turned a few threads of a coarse or fine screw, as desired, on which works the fine adjustment collar; a slot, below or in front of the threads, permits a steel pin, which screws into the inner core or tube, to slide up and down, according as the collar is rotated, the inner tube being carried up by a couple of turns of steel wire forming a spring, which works in a small space near the neck of the mount, bearing against a shoulder in front and above, against a stop attached to the top of the inner or core tube, which carries, as usual, the back and middle cells. It works quickly, easily; has a considerable range, and no sensible slip; moreover, its construction is not difficult.

The calcareous parts of the sucking feet of Echinus.—This subject has been well illustrated in a paper accompanied by a plate in the "Monthly Microscopical Journal" [Feb.], by Mr. Chas. Stewart. He says that the description these parts generally given is not quite correct: the marginal spines do not stand out horizontally, but project forwards from the flat anterior surface; this arrangement seems to enable them to grasp the body to which the sucker is applied when its centre is pulled towards the animal. The part of the rosette nearest the animal is very complex, each plate showing a depression of great depth, so that the inner as well as the outer margin of the rosette is thin, the greatest thickness being found a little to the inner side of the centre of each plate. Just inside the outer margin of the depressed area may be seen a small extremely transparent tubercle; it is upon this tubercle that the angles of the polygonal ring rest, and to the constant motion of the ring upon the rosette must be attributed the solidity and consequent transparency of the tubercle. The posterior contiguous edges of the plates of the rosette are bevelled off, so that their anterior diameter is greater than their posterior; the result of this is, that when the posterior margins of all the plates are brought together the anterior surface of the entire sucker is rendered convex, and so becomes detached from the body to which it was fixed, whereas, when the posterior margins are separated, the front surface of the sucker becomes concave, and the marginal spines grasp like claws any inequalities of the body to which they are applied.

Gundlach's Objectives will henceforth come from America instead of from Germany. We hear that Herr Gundlach has gone from Berlin to the United States.

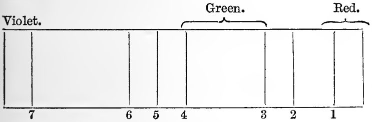
A Hæmatozoon in Human Blood has been discovered and described by Dr. R. T. Lewis, in a book which he has published on the subject. It is published at the office of the Superintendent of Government printing at Calcutta.

PHYSICS.

Browning's Panergetic Binocular Opera or Field-Glass.—This is a glass which we can honestly recommend as an excellent opera or field-glass, being admirable as the former, bringing out the figures with marvellous distinctness, and having a very large field of view. Used as the latter, its advantages are still striking; for in the dusk of evening, or when a considerable deal of mist or fog is about, it brings out the objects with a very great deal of distinctness. There is but one slight objection, and that refers simply to its weight; however this is an objection that will occur to very few, and to those who can afford the Aluminium form it disappears at once. Its eye and field glasses being each compounded of three lenses, there are in all twelve glasses, so that chromatic and spherical aberration are largely counterbalanced. Altogether it has so very many advantages over the other Binoculars that we have seen, that we confidently award it very high praise indeed.

Nature and Duration of Discharge of a Leyden Jar.—Prof. O. N. Rood, who has investigated this question ("Silliman's American Journal," Nov. 1872), sums up his opinions as follows. He says that if a Leyden jar, of a selected size, with a fixed striking distance, be connected with an induction coil, the act of exciting the coil will charge and discharge it at *once;* as the size of the jar is diminished, it will be charged and discharged oftener, and the aureol will begin to mingle itself with the spark discharges, and as the size still further diminishes, will finally replace all of them except the first; for it is evident that we may regard two brass balls, with an intervening layer of air a millimeter thick, as a minute Leyden jar, representing the last of the series.

The Spectrum of Lightning has been recently obtained by Lieutenant E. S. Holden. (S. A. J. Dec.) He says that from the sheet lightning he repeatedly obtained series of bright bands in the green, but the width and intensity of these bright bands continually changed. Of the bright and sharp lines he saw but three:—1, line in green; 2, line in blue; 3, line in violet (or extreme blue?). These were seen frequently, and sometimes those of one flash would be immediately succeeded by those of the following flash, thus giving him a means of assuring himself that the *same* lines appeared as well in *position* as in colour. The second set he regards as trustworthy. The observations were taken at West Point, N. Y., August 22nd, 1872, at 6·00 P.M., looking toward the east through a violent rain. The spectroscope was first directed toward the sky, and the spectrum with dark lines, which was constantly seen, was mapped as below, and the following notes taken:



Notes—The red ends slightly beyond 1.
2 = D line.
3 bounds yellow line.
5 near boundary of green.
6 seems to be sometimes green and sometimes blue.
7 violet = H.

The spectroscope was then turned to the lightning, and with the above dark lines as reference lines the following bright lines were mapped: (*a*) bright line *less* refrangible than red end (border) of spectrum, i. e., *extra red*; (*b*) bright line slightly *more* refrangible than 4; (*c*) bright line near 5 or 6 "green *or* blue;" (*d*) bright line in blue between 6 and 7, once seen, bright purple.

The Wear of Stone.—At a meeting of the "Literary and Philosophical Society of Manchester" (too late for the last number of this Journal) Dr. A. Smith said that he, like others, had observed that the particles of stone most liable to be in long contact with rain from town atmospheres, in England at least, were most subject to decay. Believing the acid to be the cause, he supposed that the endurance of a siliceous stone might be somewhat measured by measuring its resistance to acids. He proposed therefore to use stronger solutions, and thus to approach to the action of long periods of time. He tried a few specimens in this way, and with most promising results. Pieces of about an inch cube were broken by the fall of a hammer, and the number of blows counted. Similar pieces were steeped in weak acid; both sulphuric and muriatic acids were tried, and the latter preferred. The number of blows now necessary was counted. Some sandstones gave way at once and crumbled into sand; some resisted long. Some very dense siliceous stone was little affected; it had stood on a bridge unaltered for centuries—in a country place, however. These trials were mere beginnings; he arranged for a very extensive set of experiments to be made, so as to fix on a standard of comparison, but has not found time.

Water Supply to the Vienna Exhibition.—This is given in the "Journal für Gasbeleuchtung" No. 20, 1872, from which it appears that the total quantity of water to be supplied for all purposes, inclusive of fountains, driving of machinery, &c., amounts to 1,240 cubic mètres per hour—a quantity sufficient for a population of 200,000.

Death of Lieutenant Maury.—This distinguished American physicist died at Lexington, Virginia, on the 1st February. He was the author of several works, among which may be mentioned the "Physical Geography of the Sea," and one on Navigation. He was astronomer to the South Sea Exploring Expedition under Commodore Jones, and was at one time in charge of the depôt of charts and instruments, which served as a nucleus for the National Observatory and Hydrograph Office of the United States, of both of which he became superintendent. His labours in organizing the observations as well as his investigations in connection with the winds and currents of the sea are familiar to all. The King of Prussia presented him with a gold medal, and the Emperor of Austria gave him the large gold medal of the Arts and Sciences as a recognition of his services. He has been living in retirement for some time.

The Royal Society's Rumford Medal.—It seems that the Rumford Medal has been awarded to Anders Jonas Ångström, For. Memb. R.S., for his researches on Spectral Analysis. The limitation in time attached to the adjudication of the Rumford Medal compels the Council to connect this award with the latest of M. Ångström's published memoirs; but they are not insensible to the circumstance that this is but the termination of a long and valuable series. M. Ångström's researches generally are described with great clearness in the late President's Address at the Anniversary Meeting of 1870. To the subjects there mentioned need only be added a mathematical theory of the Conduction of Heat.

Professor Tyndall's Reception by the Royal Institution on his return from America.—At one of its March meetings the Royal Institution very properly passed a resolution congratulating Professor Tyndall on his safe return to England, and expressing satisfaction at the very admirable manner in which he had been received in America. The Institution had also to return Professor Tyndall its thanks for his generous gift of the splendid and elaborate apparatus which he had used during his lectures in America. The Americans have to thank the Professor, too, or rather they have thanked him, for his noble gift of the profits of his lectures as a fund to assist young Americans who proposed a scientific tour through Europe.

Electric and Gas Lights are, we are informed by the "Times," to be shortly exhibited from the clock-tower of Westminster. It is further proposed that the trial of the two shall be at the expense of the experimenters. The current in the electric will be generated by a comparatively novel and remarkable magneto-electric machine moved by steam power, which a high authority in this country pronounces to be a decided step in advance of every other machine of the kind. The latter is in operation at various lighthouses on the Irish coast, and may in favourable weather be seen at the distance of twenty-five miles.

The New Gas and its Prospects.—Mr. Crookes, F.R.S., gives in the "Chemical News" Feb. 21st, an account of a visit he paid to the new works, and of the results, as far as he can judge of them. He does not seem at all to report favourably—indeed we do not see that he could do otherwise. The following is a quotation from the Report: "The new process claims to effec a great saving in regard to expense. One ton of coal by the old process yields, in round numbers, 10,000 cubic of feet of gas; whereas by the new one ton of coke should yield from 130,000 to 150,000 cubic feet, or possibly even more. The result is stated in the Prospectus to be that the labour of twenty-nine out of every thirty men will be saved. In another part of the same Prospectus, we are, however, told that the saving of labour will be 'to the extent of 50 per cent.,' so that there appears some ambiguity in the matter. Messrs. Quick and Son, the engineers, report, as the result of their experiments and calculations, that 'gas of 16½ candle-power may be manufactured at a cost of 1*s.* 7¾*d.* per thousand cubic feet.' Such a consummation is devoutly to be wished, but its realisation must obviously depend upon a somewhat complex set of conditions. The managers of the undertaking do not hope, we understand, to get their processes adopted in large English towns, for the present at any rate. Probably they are wise, for if they did they would at once be met with the difficulty—Where is the necessary coke to come from if the old mode of gas-making be abandoned? Charcoal, or even wood, would hardly be proposed as a substitute in this country. In many foreign countries the case is very different, and it certainly appears possible, or even perhaps probable, that in places where wood is cheap and coal very dear, this process, or some slight modification of it, may be adopted with advantage."

ZOOLOGY AND COMPARATIVE ANATOMY.

American Dredging expeditions.—Some of the results, on a smaller scale than we may expect from the "Challenger" expedition, but still important enough, have been published by those who accompanied one of the late American excursions. They have been put together in form of a set of contributions to "Silliman's American Journal" [Jan. 1873 and following numbers]. They are, however, much too long for abstract, but nevertheless the objects to be attained by the expedition are very distinctly defined in a series of statements extending to about a dozen of which the following struck us as zoologically of most importance:—1st, the exploration of the shores and shallow water for the purpose of making collections of all the algæ and marine animals living between tides, on every different kind of shore, including the numerous burrowing worms and crustacea, and to ascertain as much as possible concerning their habits, relative abundance stations, &c. 2nd, the extension of similar observations by means of the dredge, trawl, tangles, and other instruments, into all depths down to the deepest waters of the Bay of Fundy, and to make a systematic survey, as complete as possible, of all the smaller bays and harbours within our reach, both to obtain complete collections of the animals and plants, and to ascertain the precise character of the bottom, special attention being paid to localities known to be the feeding grounds of valuable fishes, and to those animals upon which they are known to feed. It is believed that when the collections and notes made by the writer and his associates during previous years shall have been combined with those made during the past season, we shall have a tolerably thorough knowledge of the physical character and life of the bottom and shores in this region.

The Life History of the Macropode has lately been given to the French Academy by M. N. Joly. The "Lens" [Jan.], commenting on the fact, states that eight years ago M. Agassiz said that he had found among the fish tribe metamorphoses as considerable as those which had been remarked in reptiles; and this is a case in point. The egg of the macropode, not bigger than a poppy seed, when hatched is perfectly transparent and lighter than water. It is hatched in about sixty-five hours, just as is the case with the egg of the tench. But on account of this rapid birth, the creature is necessarily in an imperfect state. It makes its appearance in the shape of a tadpole, the head and trunk of which are attached to a large belly, the tail being free and surrounded with a natatory membrane which is exceedingly transparent. Although the animal seems to have no striped muscular fibres, it is very nimble under the microscope, and is not more than a millimeter and a half in length. Its head has two large eyes still deprived of their pigment; there is no mouth, and no digestive apparatus either. But the heart is already active, and some circulation is perceptible in the upper part of the tail. There are no gills, so that respiration must be effected through the skin. There are no secretory organs and no fins. The same as in all fish, the nervous system is formed at an early period, and is composed of two parallel cords, which branch out into the head. Of the skeleton nothing appears as yet but the dorsal cord. Numerous pigmentary spots appear all over the body. A short time after, the mouth, intestines, liver, and air-bladder are formed, together with the gills. New vessels gradually make their appearance, while the earlier ones are obliterated. The caudal natatory membrane is gradually formed into two pectoral fins, and brilliant scales cover the body, and from that moment the creature assumes the shape of a regular fish. Here, therefore, we have changes similar to those which are observed in Planer's lamprey, in insects and in crustacea. This is an important fact, since naturalists had hitherto denied the existence of such changes in fish.

The Snakes of India.—We are glad to see that Dr. Fayrers' fine work on this subject, which was much referred to in Professor Greene's article in our last number of the *Popular Science Review*, has been very well received by the French Academy. The Academy appointed M. Dumas to review the book and state the results. This M. Dumas has done in a short but most favourable notice which is published in the "Comptes Rendus" (February 24, 1873).

Philadelphia Academy of Sciences.—When the new building is complete, the fine collection will be displayed to the general public. We understand that it has now in its possession, though of course not under public view, more than 6,000 minerals, 700 rocks, 65,000 fossils, 70,000 species of plants, 1,000 species of zoophytes, 2,000 species of crustaceans, 500 species of myriapods and arachnidians, 25,000 species of insects, 20,000 species of shell-bearing molluscs, 2,000 species of fishes, 800 species of reptiles, 21,000 birds, with the nests of 200 and the eggs of 1,500 species, 1,000 mammals, and nearly 900 skeletons and pieces of osteology. Most of the species are presented by four or five specimens, so that, including the archæological and ethnological cabinets, space is required now for the arrangement of not less than 400,000 objects, as well as for the accommodation of a library of more than 22,500 volumes. A new building to cost half a million dollars is now in process of erection.

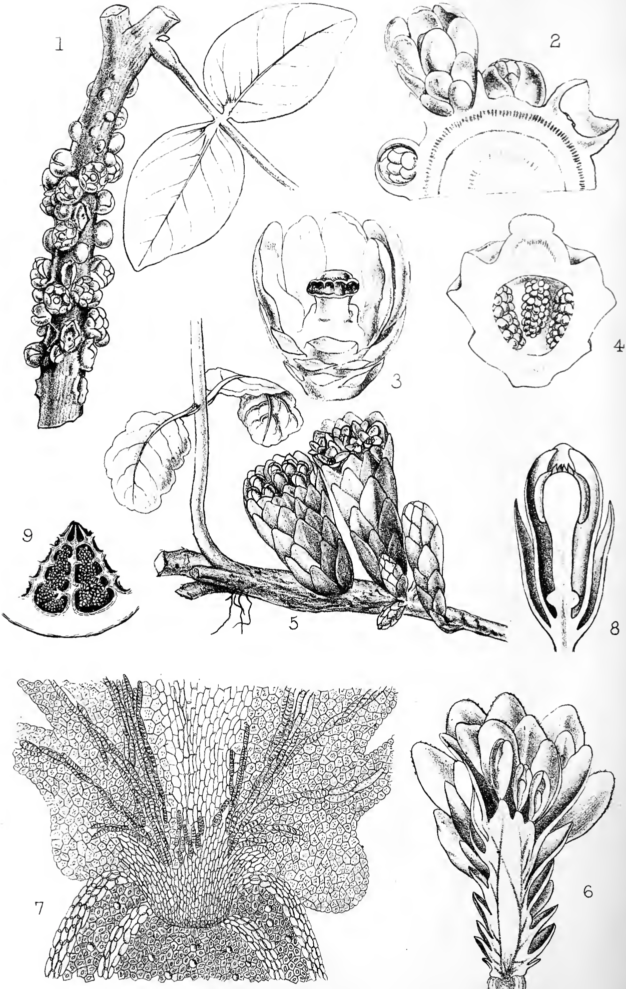
The Anatomy of the Negro.—Professor Agassiz is well known as a believer in the view that the different races of man are specifically distinct. But in a recent lecture, as reported by one of the American journals, he seems to have gone too far. He says: "I have pointed out over a hundred specific differences between the bonal and nervous systems of the white man and the negro. Indeed, their frames are alike in no particular. There is no bone in the negro's body which is relatively the same shape, size, articulation, or chemically of the same composition as that of the white man. The negro's bones contain a far greater proportion of calcareous salts than those of the white man. Even the negro's blood is chemically a very different fluid from that which courses in the veins of the white man. The whole physical organisation of the negro differs quite as much from the white man's as it does from that of the chimpanzee—that is in his bones, muscles, nerves and fibres, the chimpanzee has not much farther to progress to become a white man. This fact science inexorably demonstrates. Climate has no more to do with the difference between the white man and the negro than it has with that between the negro and the chimpanzee, or between the horse and the ass, or the eagle and the owl. Each is a distinct and separate creation. The negro and the white man were created as specifically different as the owl and the eagle. They were designed to fill different places in the system of nature. The negro is no more a negro by accident or misfortune than the owl is the kind of bird he is by accident or misfortune. The negro is no more the white man's brother than the owl is the sister of the eagle, or the ass the brother of the horse. How stupendous and yet how simple is the doctrine that the Almighty Maker of the universe has created different species of men, just as He has different species of the lower animals, to fill different places and offices in the grand machinery of nature."

Non-parasitic marine Copepoda of the north-east of England.—A very full list of these, accompanied by a capital pair of plates, has been published in the "Nat. Hist. Trans. of Northumberland, &c.," by Mr. George S. Brady, C.M.Z.S. [vol. iv. part ii.]. He states that this list, though embracing all the species at present known to him as inhabiting this district, must be taken only as an instalment of what an exhaustive survey would no doubt reveal. The examination of these little creatures is exceedingly tedious and laborious, the points of difference being often indistinguishable except with tolerably high microscopic powers. Thus a very small gathering, if it contain any great variety of species, will often occupy many hours in its examination. By far the greater number of species noted by the author or described by foreign authors are free-swimming animals; some have a special predilection for the fronds of fuci, and others for muddy localities or the bed of the sea; but little is yet known of the ground-inhabiting forms, and among them there remains doubtless a rich harvest for future collectors. Then follow the list, which we must refer our readers to.

Is Bipalium allied to the Leeches?—Mr. H. N. Moseley, M.A., who has described the anatomy of this creature in the "Proceedings of the Royal Society" [Feb. 20], states that in considering the general anatomy of *Bipalium*, it is impossible to help being struck by the many points of resemblance between this animal and a leech. Mr. Herbert Spencer has, in his "Principles of Biology," placed a gulf between Planarians and leeches, by denoting the former as secondary, the latter as tertiary aggregates, so called because consisting of a series of secondary aggregates formed one behind the other by a process of budding. It is obvious, however, that a single leech is directly comparable to a single *Bipalium*. The successive pairs of testes, the position of the intromittent generative organs, the septa of the digestive tract, and most of all, the pair of posterior cæca, are evidently homologous in the two animals. Further, were leeches really tertiary aggregates, the fact would surely come out in their development, or at least some indication of the mode of their genesis would survive in the development of some annelid. Such, however, is not the case. The young worm or leech is at first unsegmented, like a Planarian, and the traces of segmentation appear subsequently in it, just as do the protovertebræ in vertebrates, which Mr. Spencer calls secondary aggregates. If Mr. Spencer's hypothesis was correct, we should expect to find at least some Annelid developing its segments in the egg as a series of buds. It is not, of course, here meant to be concluded that Annelids are not sometimes in a condition of tertiary aggregation, as *Nais* certainly is when in a budding condition, but that ordinarily they are secondary and not tertiary aggregates, and if so, then so also are Arthropoda.

A Medal to Mr. Carter.—A Royal Medal has been awarded to Mr. Henry John Carter, F.R.S., for his researches in Palæontology and Zoology, on the Infusoria and Rhizopoda, and the root-cell of the *Chara*; but more particularly for his inquiries into the Natural History of the Spongiadæ.

Zoological Society's Papers on Comparative Anatomy.—Besides the many very valuable papers which have been published during the past quarter on purely zoological subjects, some admirable communications have been made on questions of Comparative Anatomy. Foremost among these was Mr. Kitchen Parker's (F.R.S.) able communication on the osteology of certain orders of birds, and also two papers by Mr. A. H. Garrod, the able anatomist of the Society. One of these (Jan. 7th) was on a peculiarity in the termination of the anterior margin of the nasal bones of certain birds, according to which the Schizognathæ of Prof. Huxley might be divided into two groups, to be called Schizorhinæ and Holorhinæ; and the other (Jan. 21st) was upon the visceral anatomy of the Sumatran Rhinoceros (*Ceratorhinus Sumatrensis*) based on a specimen of this species lately living in the Society's Gardens.



D. Blair del et lith.

W. West & Co imp.

Parasitic Flowering Plants

PARASITISM IN FLOWERING PLANTS.

By HENRY TRIMEN, M.B., F.L.S.

Lecturer on Botany, St. Mary's Hospital.

[PLATES XCIX. and C.]

The tendency of words to degenerate in meaning has frequently been commented on by philologists, and to the more commonly known examples may be added the term 'parasite.' Originally, in early Greek times, applied to the members of a college of priests (*παράσιτοι*) it possessed simply its grammatical meaning of taking meals in common, but later it came to signify living at another's expense, and was then applied to the contemptible toady and flatterer—one of the stock characters in Greek and Roman comedy—who would put up with any indignity from his patron for the sake of food and lodging. This character, which the social habits of classical times seem to have brought to great perfection, is by no means extinct in our days, though the objects sought by such voluntary degradation may be generally higher than mere creature enjoyments. The word is now however rather rarely applied to human beings, nor are we here concerned with such a use of it. In science also, the term parasite is given to beings which live upon others in the sense of getting from them their food, and is applied to animals which batten upon others, and to plants which are attached to, and live upon the juices, either of animals or of other vegetables.

Such habits, inimical to other creatures, are possessed by a very large number of plants. Probably all the Fungi are parasites, and a good many attack the lower animals, among insects frequently causing their death; whilst even the body of man himself is the suitable soil for about a score of minute species. Of these lowly organised plants, it is not however intended to speak, and indeed their mode of parasitism is very different from that of the flowering plants which follow that mode of life. Among the Phanerogams, we find that there are only five or six natural orders all the members of which are parasitic; but there are isolated genera, or species scattered through about a dozen other families. A list, which might probably be somewhat enlarged, is given below, upon which it may be remarked that Monocotyledons are few, and that none of the Dicotyledons are polypetalous (unless it be preferred to consider *Balanophoraceæ*, as belonging to that division)—

Dicotyledones.
[Polypetalæ—*none.*]
Monopetalæ:
Convolvulaceæ—*Cuscuta.*
Ericaceæ—*Monotropa, Pyrola aphylla,* &c.
Lennoaceæ, Solms.—*all.* (*Ammobroma, Lennoa, Corallophyllum, Pholisma.*)
Scrophulariaceæ—*Harveya,* &c., *Striga,* &c., *Rhinanthus,* &c.
Orobanchaceæ—*all.*
Gentianaceæ—*Voyria,* &c.
Gesneraceæ—*Christisonia.*

Apetalæ:
Lauraceæ—*Cassytha.*
Loranthaceæ—*very nearly all.*
Santalaceæ—*Thesium,* &c.
Cytinaceæ—*all.*
Rafflesiaceæ—*all.*
Balanophoraceæ—*all.*

Monocotyledones:
Melanthaceæ—*Petrosavia.*
Orchideæ—*Neottia,* &c.
Triurideæ—*all?*

What is called "habit," is a very fallacious guide to affinity, and has frequently proved so to even experienced systematists. It mainly results from modifications of the organs which for purposes of classification are of minor importance. Some of the parallelisms in outward appearance between plants with little real affinity have been noticed by A. W. Bennett, in an article in this Review for January 1872, and the matter is of that curious and suggestive character which leads to many speculations. The parasitic facies is a very marked one, and has naturally had an undue prominence assigned to it by some systematic botanists. Lindley and Endlicher, for example, created a class under the name of Rhizogens or Rhizantheæ to include the orders *Rafflesiaceæ*, *Cytinaceæ* and *Balanophoraceæ*, which was considered to be intermediate between thallogenous Cryptogams (like the Fungi) and Endogens. Though these eminent authors endeavoured to support their views by various arguments drawn from supposed constant peculiarities of the embryo and the tissues, the group was no doubt founded chiefly on the habit of the plants composing it. This, however, results from adaptive or "homoplastic" modifications fitting the plants for the peculiar conditions of their life. The last-mentioned order has but very slight affinity with the two first, and indeed the group hung but loosely together, and is now generally abandoned; all three orders are doubtless dicotyledonous with well-marked affinities to other orders of that class.

Before we examine the peculiarities in question, it will be as well to recall to the mind of the reader the usual constitution of an ordinary phanerogam. Functionally, all its organs are either nutritive or reproductive; that is, they are employed in processes which either contribute directly to the maintenance of the life of the individual to which they belong, or are directed towards the formation of new individuals in an embryo state which shall reproduce the species. The former system of plant-organs includes the green leaves spread out in the sunshine, the absorbent root-hairs buried in the soil or immersed in water—both food-obtaining organs, and both periodically renewed—and the whole system of axes, stem, branches and root, which carry these temporary structures, and are themselves of more solid and durable make, fitted to be not only supports, but also channels through which pass in various directions, according to the necessities of the plant, the sap and other juices. The structure of the widely separated leaves and root-hairs is very different, and adapted in either case to the surrounding conditions. The delicate walls of the latter readily allow the passage of fluid, and through them is constantly streaming into the plant a current of water charged with carbon-dioxide, and containing, copiously diluted, the varied mineral and nitrogenous constituents of the soil needed by the plant. This fluid is then transmitted upwards from cell to cell, through the structure of the axial system, and is especially drawn to its extremities and to the leaves where growth is going on rapidly, and evaporation is great. The skin which covers these parts is, on the leaves especially, provided with minute orifices (stomata), so that the atmospheric air freely passes into the loosely-built cell-structure below. The walls of these cells are thin; the substance chiefly needed for the formation of plant-structures is carbon, and this is one constituent of carbon-dioxide, a gas which always exists in the atmosphere in small quantity as the result of combustion and animal respiration. This gas the leaf-cells extract from the air, it passes through the walls, and is reduced to its elements, almost the whole of the oxygen being returned to the air whilst the carbon is retained and assimilated. At the same time are produced, by combination of the constituents of the sap, the organic compounds, often very complex, which are proper to the plant. These very remarkable processes occur chiefly in those parts which possess the characteristic green colour of healthy vegetation, which is due to the presence in the cells of a substance called chlorophyll. There can be little or no doubt that this is the main agent in the assimilation of carbon. It is well known that plants deprived of sunlight develope none of this green colouring matter, and that their tissues are weak and flabby;

> Pale, fleshy, as if the decaying dead
> With a spirit of life had been animated.

Such plants cannot take up carbon-dioxide; on the contrary, and this is also true of the parts of all plants which are not green —as the bark and the flower—they expire that gas, and so vitiate the atmosphere like animals.

By these processes the plant increases in size and complexity, and at the same time is able to store up in its tissues starch and other carbonaceous substances to be employed as fuel during the flowering and fruiting seasons. These reproductive functions do not commence till a period pretty definite in the life of the species, when, instead of unfolding green leaves, the buds produce those variously modified organs which form the flower and the end of all of which is directed to the production of ripe seed. The process of their evolution, and the changes they pass through, are all wasteful to the plant and involve the consumption of its hoarded stores: so great an effort is flowering that it frequently causes the death of the plant.

The modifications in external anatomy which are met with in parasites are chiefly in the organs of nutrition. Disregarding altogether for the present the green parasites, such as the Mistletoe and *Loranthus*, the first thing that strikes the observer is the absence of leaves. True there are not wanting a few fleshy or dry scales, but of green foliage, and indeed of green colour at all, the plants are absolutely devoid. Nor can we find root-hairs; indeed, in many no root at all can be said to exist, but where there is a branched root, it possesses instead of root-hairs suckers applied to the tissues of the supporting plant. Even the supporting axis may be greatly reduced, and so the whole nutritive system be wanting, as in the *Rafflesiaceæ*, where the base of the flower is in close apposition to the tissues of the alien stem upon which it grows. From this extreme case we may pass to parasites with a short axis closely covered with large scales (*Cytinus*), with a prostrate, half-buried rhizome, angular and branched (*Hydnora*) or very large and swollen (*Balanophoraceæ*), and so reach plants with an erect, well-developed scale-bearing axis, as the Broomrapes (*Orobanche*). In another type, as Dodder (*Cuscuta*) and *Cassytha*, the axis is present in the form of long slender twining threads, upon which are placed the absorbent suckers, but scarcely a vestige of any leaf-organs. On the other hand there is usually a great development of the inflorescence. Parasites seem, and sometimes are, all flower, and their flowers are generally handsome. The largest flower known is *Rafflesia Arnoldi*, a parasite on vines in Sumatra, and a profusion of blossom is produced by our more familiar Dodders and Broomrapes.

The meaning of these modifications in the structure of parasites is in part obvious. Organs for the acquirement of raw food are clearly not needed; all that is required is a union of the tissues of the parasite and nurse-plant so close that the fluid nutriment of the latter may readily pass from one individual to the other. Nor, as this pabulum is already in a somewhat thickened condition, is an extensive surface for evaporation needed. The usual absence of chlorophyll is less readily explained. It is commonly stated that the food of the parasite is already in a prepared state, and that therefore no elaboration on its part is necessary; but a very little examination is sufficient to show that this is not the case. A very large number of parasites possess an abundance of green colouring matter, and there is no reason to suppose it useless to them. But a more direct argument is found in the fact, that the juices of stock and parasite have usually an entirely different chemical composition. It must, indeed, be evident that a parasite, such as the Dodder, which often holds in its strangling embraces half-a-dozen or more different plants of various composition, must have the power of selecting what it needs from each; and when we find compounds in the parasite which do not occur in any of its victims, we are forced to allow that processes of assimilation go on in its tissues. The chemistry of these plants has been but little studied; they, however, contain stores of starch, and are generally far richer in hydrocarbonaceous principles than the species upon which they grow. Thus Orobanches and *Cytinus* contain abundance of oleo-resinous matter, and a species of *Balanophora* is said to be employed in Java to make candles. This excess of hydrocarbons is especially worth remark, as it exists along with a loss of large quantities of carbon by the constant expiration of carbon-dioxide, for in relation to the atmosphere parasites act like the coloured parts of other plants. Nearly all of them possess stomata, but in smaller numbers than foliage-bearing vegetables. Many contain strongly astringent principles, and most become black when dried.

We must then admit that the power of elaboration of new substances is possessed by parasites, and it seems likely that along with the constant expiration of carbon-dioxide, there is concurrently an absorption of the same gas in smaller quantity continually going on in the ordinary way; the amount of carbon-dioxide apparently given out would then in reality only represent the difference between a small absorption and a great expiration. The expiration of carbon-dioxide is, of course, very exhausting to the host-plant, weakening it quite in the same way as a disproportionate and excessive production of its own flowers would do.

It is also to be noted that parasitism is a condition which may vary in degree. The plants most absolutely dependent upon others are those which, like the *Rafflesiaceæ*, are quite without provision for a separate existence; the seeds, doubtless, though this has not been observed, germinate on the branches upon which the fully developed plants are found, as is the case with those of the various green parasites. The numerous leafless root parasites present several gradations from such absolutely parasitic forms as *Cynomorium* and the *Balanophoræ*, through *Orobanche*, *Harveya*, *Lathræa*, *Striga*, &c., to those *Scrophulariaceæ* and *Santalaceæ* which are but slightly dependent for supplies of food on the plants to whose roots they are attached. Some of these forms are completely parasitic only in early life: this is probably the case with our *Neottia* (Bird's-nest) and *Monotropa*. In that singular stem-parasite the Dodder, the embryo, entirely without cotyledons, is able to live for a short time after germination, and rises into the air until it attaches itself to some plant, when its connection with the ground is speedily broken.

In attempting to classify the parasites all these conditions must be taken into account; but unfortunately the mode of attachment has not been carefully noted in numerous cases, whilst in several presumed parasites the actual union with another plant has never been observed. We may, however, at once divide them into the essentially distinct groups of chlorophyllous and non-chlorophyllous plants, and in classifying the latter we cannot do better than follow A. P. De Candolle, and group them into those with a single sucker (monobasic), those where the attachments are numerous (polystomal), and those where along with but one large sucker there are numerous thick fleshy roots (polyrrhizal). Further division is shown in the following table, though it must be admitted that the distinctions between the first and third groups are not very well defined:—

*Without green leaves or chlorophyll:

Monobasic.
- On stems:
  - *Rafflesiaceæ.*
- On roots:
  - *Cytinaceæ.*
  - *Balanophora*, &c.

Polystomal.
- On stems:
  - *Cuscuta.*
  - *Cassytha.*
- On roots:
  - *Lathræa*, &c.
  - *Cynomorium*, &c.

POLYRRHIZAL.
On roots:
Harveya, *Striga*, &c.
Orobanche, &c.
Monotropa? &c.
Voyria, &c.
Neottia, &c.
Petrosavia.
Lennoaceæ?

**With green leaves or chlorophyll.
On stems:
Loranthus, &c.
Viscum, &c.
On roots (partially parasitic):
Rhinanthus, &c.
Thesium, &c.

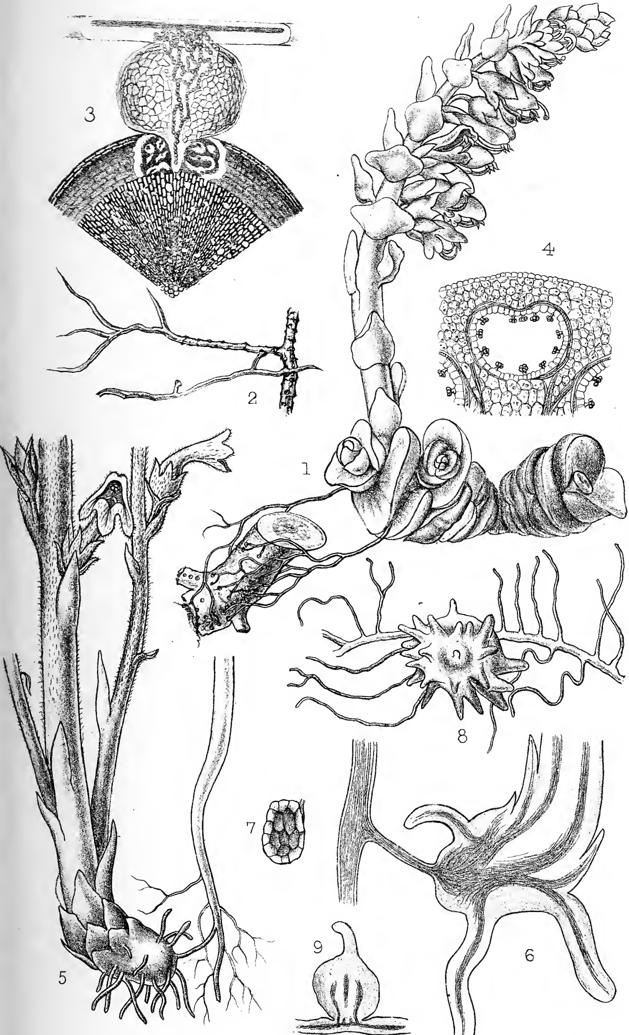
In the plates accompanying this article are figures, drawn partly from nature and partly from various published memoirs on the subject, of non-chlorophyllous parasites, selected as examples of the various modes of attachment above mentioned. To illustrate the monobasic condition a species of *Pilostyles* (*P. æthiopica*, Welw.) has been chosen. This genus is placed in the *Rafflesiaceæ*, an order consisting of some twenty-five species, mostly tropical, and contains a few forms, chiefly from South America, but some occurring in Asia Minor and in Africa. Each plant (see Plate XCIX., figs. 1–4) consists simply of a little unisexual flower, surrounded with several rows of bracts, and containing in its centre either a column, round the head of which is a circle of one-celled anthers (fig. 3), or a hemispherical knob, the stigma, below which is situated the unilocular ovary, containing numerous minute ovules attached to its sides (fig. 4), and succeeded by a globose fleshy berry. These little flower-plants occur in groups sessile and half immersed on the younger twigs of trees and shrubs, and, so far as known, all the species grow on Leguminosæ only. They appear to originate beneath the bark, little round knobs upon which are the first indication of their presence. These increase in size, split open, and allow the contained *Pilostyles* to emerge. The bark thus forced up forms a prominent ridge round the parasite, and after the latter has fallen off a little cup-shaped cavity long remains (see fig. 2). The union of stock and parasite is not difficult to rupture, and the latter is readily detached, its base not penetrating into the woody structure of the branch. In the great species of *Rafflesia*, *Sapria*, and *Brugmansia* of the East Indies, there is, at least in the first, actual vascular connexion, the vessels of the stock passing absolutely into the base of the parasite.

Cytinus Hypocistis (also figured on Plate XCIX., figs. 5–9), is another monobasic parasite. This pretty plant is not uncommon in the South of Europe and North Africa, growing, as its name implies, on the roots of species of *Cistus* in the spring. The whole plant is brilliant orange-yellow, and consists of an axis clothed with overlapping scales, and bearing at the top a tuft of flowers. These are unisexual, the antheriferous ones occupying the centre, and the pistilliferous the circumference. In both the perianth has four lobes; the anthers are usually eight, arranged in a circle round a central column (fig. 8); the pistil is single, with a radiately-lobed stigma and an ovary adherent to the perianth, and imperfectly divided into compartments containing a great number of ovules (fig. 9). The sucker, or cone of attachment, is slowly developed and perforates the bark of the *Cistus*; it possesses numerous spiral vessels, but no distinct vascular connexion with the stock occurs (figs. 6-7). This plant is the *ὑπόκιστις* of Dioscorides, in whose time the black juice, which contains gallic acid, was used, as it still is, as a styptic and astringent.

As an example of the polystomal parasites *Lathræa Squamaria*, a familiar British species, is figured (Plate C., figs. 1–4). This is to be found in early spring, on a diligent search, half hidden (whence its name) at the foot of hazels, elms, and other trees, in damp shady places. When fresh, the whole plant is white with a pink or purple tinge, and semi-transparent, but becomes perfectly black when dried.* It possesses a subterranean definite branched rhizome, from which the flower-branches arise, and which is clothed with thick tooth-like scales, from the axils of some of which slender rootlets are given off. The observations of Mr. Bowman in 1829 first showed that upon these rootlets were borne the absorbent tubercles (fig. 2). Careful washing away the soil will show these attached to the rootlets of the supporting plant, and a section through both (fig. 3), displays a perforating cone, penetrating the bark at least, and, as I am informed by Mr. Stratton, actually pushing its way into the very wood. The singular fleshy scales of this plant, from which it has received its name of Toothwort, are, like the whole plant, very brittle; they are of course homologous with leaves, and are remarkable for possessing in their interior numerous irregular cavities, on the walls of which are arranged stalked gland-like bodies (fig. 4). The allied genus, *Clandestina*, possesses similar organs, the objects of which are not known.

Of the genus *Orobanche*, which we may take to illustrate the polyrrhizal parasites, there have been described seventy or eighty species all having a strong family resemblance; about ten of these are inhabitants of England, but their distinctions are ill-defined. The common *O. minor* is a pest of clover-fields in some parts, being doubtless often sown with the crop, and doing con-

* Immersion in spirit has the same effect, and the spirit becomes of a fine purple colour. *Monotropa Hypopitys* behaves in the same way, and Dr. Lindberg suggests that the colouring matter may be indigo. See his paper in "Journal of Botany," 1873, p. 179.



D. Blair del. et lith. W. West & Co. imp.

Parasitic Flowering Plants.

siderable damage. Still more harmful in some parts of France is the *O. ramosa*, parasitic on hemp chiefly, and the subject of the illustration Plate XCIX., figs. 5–9. Their habits were known to antiquity, as the name *Orobanche* (ἄγχειν, to strangle), which dates from Dioscorides, denotes. Turner, the first English botanical author, describes in 1562 his discovery of the clover species thus:—He noticed an Orobanche by the side of a "common claver or medow trifoly which was all weathered, and when I had dragged up the root of the trifoly to see what shulde be the cause that all other clavers or trifolies about were green and freshe that that trifoly should be dede, I found the rootes of orobanche fast clasped about the rootes of the claver, which as I did plainly perceive did draw out all the natural moisture from the herbe that it should have lived withall and so killed it" (Herball, pt. ii. f. 71). The aspect of the various species is very similar; a spike of rather showy flowers on a brown erect stem, with scattered scales more numerous at the base, which is swollen and possesses a single large sucker, attached usually laterally to the extremity of a rootlet of the victim. Around this, from the bulbous base of the axis arise numerous thickened fibres, which penetrate the soil and probably serve chiefly as holdfasts. The germination of the minute seeds of *O. ramosa* (fig. 7) has been investigated by Vaucher and Caspary. This occurs in the soil, but an adherence to the extremity of a young rootlet of the hemp is almost immediately effected. At first the little parasite puts out a number of rootlets (fig. 8), but before long it forms a true union with the stock. The vessels of the hemp are stated to pass actually into the young *Orobanche*, as represented in fig. 9, and in the adult state in fig. 6. Besides *Lathræa* and *Orobanche*, there are about twenty other genera in the order *Orobanchaceæ*, containing over 130 species, the whole of which are parasitic.

The leafy or chlorophyllous parasites may perhaps form the subject of another communication.

HOW TO SKETCH THE MOON.

By the Rev. T. W. WEBB, M.A., F.R.A.S.

THE unprecedented development, during late years, of the science of astronomy as regards its extent, must necessarily in the end lead to a subdivision of labour. In the days of the old refractor, the earlier achromatic, and the metallic speculum, the ordinary subjects of observation could easily be examined within a moderate time; before we had penetrated so far into the temple, the eye could readily embrace its more accessible and obvious glories. But the case is now greatly altered by the increased facilities of study. The achromatic has been at once enlarging in size and diminishing in price; and its beautiful and less expensive substitute, the silvered reflector, has been gradually winning its way, as it well deserves: and not only are observers thus greatly multiplied by the removal of a very serious pecuniary restriction, but the objects of observation are almost indefinitely increased, and work is found to abound even in a greater proportion than corresponds with the improved means of accomplishing it. It is therefore advisable that those who are disposed to cultivate this fascinating study should mark out for themselves some definite line of enquiry, and such a line as may conduce in its prosecution not merely to individual amusement, but to the advancement of the science. If, indeed, our intention goes no further than merely to see for ourselves, or to show to our friends, in a general view, how the heavens declare the glory of God, we may be well satisfied with simply gazing at such objects as the season of the year may present. But if we really intend to 'leave our footprint on the sands of time,' we had better arrange our operations on some definite system. Nights may be wasted; energy misapplied; fine weather turned to little account, in merely looking about us, when we might have been doing work of some value.

Numerous lines of enquiry might be specified, that promise a reward to the diligent investigator; but at present our remarks will be limited to the study of the lunar surface, more especially with regard to its successful delineation. Much attention has of late been given to selenography, and very deservedly; but the practical results might be of more value, if operations were conducted on a more systematic plan, and with a more definite understanding of the possible causes of misconception or illusion, such as might easily influence the judgment of an inexperienced, although keen-sighted and careful observer. A few hints, therefore, may be permitted, which may be of advantage to the student at the commencement of his labours.

It may be assumed that no fresh attempt will now be made to represent any extensive area of the lunar surface. This would be only (except for practice) so much trouble thrown away. The broader features have been already abundantly delineated by Schröter, Lohrmann, and Beer and Mädler. Our immediate object is to fill in the outline, which they have given with so much general fidelity, but by no means a corresponding minuteness of detail. This, indeed, could not in fairness have been expected, and would naturally be left to the labours of the future. And now a single large walled-plain or crater, or insulated mountain-group, or definite portion of a level region, will provide sufficient occupation for many nights, till every detail which the telescope employed can grasp is identified and delineated with as much correctness as the present state of our knowledge may justly require. Much has been said of the value of photography in producing such representations. Nor is there the slightest intention of disparaging its just claims. Great honour is due to those eminent men who have carried it through such discouraging impediments: its results have already proved most valuable, and its peculiar advantages are otherwise unattainable. No eye can be so certain of including every visible feature; no hand can place every detail so accurately in its relative position. The superiority of the self-produced picture in each of these respects will be very evident to anyone who has remarked how often objects are unnoticed in sketching, the detection of which on a subsequent occasion may prove a source of error (Schröter's new crater in Hevel was probably a case in point), or how much drawings of the same objects by different hands differ in proportion and character, of which the various representations of the walled-plain Gassendi are an instructive example. But there is a sharpness and decidedness in telescopic vision, which we miss in photographic portraits; and from this cause the camera may fail to exhibit the existence, or at any rate the true character, of the minutest features. And besides this, whatever may be the perfection of the photographic apparatus, the nights in which the air is sufficiently steady to admit of the development of its full ability are few indeed, compared with those, so familiar to every experienced observer, in which hard, clear definition is combined with unsteadiness of image; the irregular refraction of the atmosphere producing the very same effect that the undulations of surface would on the position of an object seen, otherwise with great distinctness, in the bed of a running stream. In such a state of air—the best oftentimes that an observer is fortunate enough to meet with in the course of many nights—photography would be confusion, while good drawing is perfectly practicable.

But then, it scarcely need be added, it ought to be *good* drawing. Not that rough sketches may not prove occasionally of value, when they contain clear evidence of some previously unnoticed object; but the student ought to be especially warned against a facile carelessness of execution, which must prove unsatisfactory to others, and ultimately to himself. And the professed artist is perhaps especially likely to be thus betrayed into error. Of course, before he sets to work upon any celestial object, he will have laid aside all thought of making a pleasing picture; but he may still be misled from being habitually conversant with that essential principle of art, which teaches us that likeness is more connected with breadth of effect, than with elaboration of detail. In the present case, however, it is on accurate minuteness that we have to depend for our hope of discovery; experience contravenes all reasonable expectation of physical change on a great scale in our own days, and our knowledge of the real nature of the lunar surface, and any operations that may be in progress there, must depend on the faithful representation of the smallest objects that our telescopes are capable of showing with distinctness.

The principal requisites of good drawing, as applied to the lunar surface, may be easily specified. They are (1) correctness of form. It would seem almost superfluous to specify this, but for the glaring inaccuracy in this respect, which is occasionally apparent even in drawings which ought, from their advantageous circumstances, to take a high rank. And it is here that a knowledge of effect and perspective becomes of great value. Although we demand a resolved fidelity, which is determined to represent everything just as it appears, however anomalous that appearance may be, and although nothing could easily be worse than an attempt to force a delineation into accordance with the rules of art, yet it is certain that a previous apprehension of the real nature of what is seen will often give material aid in preventing mistakes and facilitating observation. When, for instance, we know that every circle lying in a certain direction as regards the line of sight must be projected into an ellipse of known proportion and position, we shall find it far more easy to draw with fidelity an obliquely viewed landscape, in which circular forms prevail, as well as to estimate correctly the amount and direction of such deviations from perfect circularity, as will probably be found. But (2) supposing correctness of form to be ensured, we have another point of equal or sometimes even greater importance to attend to, the relative proportion of size. The neglect of this has, as much as anything, retarded the solution of the interesting question whether volcanic activity is still in progress on the moon. The minute craters which abound in so many lunar landscapes have been often jotted down, as if the observer was quite satisfied with recording their existence, and attached little importance to their relative dimensions; yet this is the only criterion, as it is an equally easy and satisfactory one, of their activity or extinction. And (3) the relative position of objects should also be attended to. Less material than the two preceding, it must not be neglected, as an element in the required faithfulness of representation, and in some cases as avoiding considerable trouble in identification. And we may add here a caution against finishing off a careful design with a sketchy margin of general resemblance, which at some future time, when the limits of accuracy are no longer remembered, may prove a source of perplexity and annoyance.

There is some latitude as to the materials which may be employed. Those who can handle a pencil dexterously may find it answer well; but they should not forget to set the sketch afterwards. Delicate pen and ink drawing, in the manner of etching, may be made very effective, but is not easy of correction in case of mistake. With any one accustomed to the brush, watercolour lamp-black succeeds very well—not Indian ink, as it is troublesome to get it black enough for the deep shadows, and is too indelible in case of error. Professor Piazzi Smyth used oil colour; but this is less easily managed, excepting by a practised hand. Black and white chalk on a grey surface gives a striking effect, but independently of its great liability to damage, it requires an inconveniently large scale, or with these materials the requisite minuteness will be unattainable. Probably the most unexceptionable mode (I regret that I cannot speak of it from personal experience) would be the employment of tube-colours, consisting of black and white, and admitting of ready mixture, and correction where requisite, on a ground of neutral grey composed of the same materials. In this way there would be little difficulty in representing those 'half-tones,' or gradations of shade, the want of which is so apparent in ordinary lunar drawings to an experienced eye. The most essential purposes may no doubt be secured without them, and their introduction requires a good deal of time and some skill. But if conveniently attainable, they would add materially both to the accuracy and the effect of the resemblance. It is true that in consequence of the extreme tenuity of the lunar atmosphere, there is an entire absence of that diffusion and softening of light which so especially characterises the terrestrial landscape. With a daylight sky, resembling probably that of our midnight, and devoid of the mists of sunrise or sunset, every spot where the sun is not actually shining would of course be shrouded in intense blackness of shade; but there are abundance of banks and slopes lying in planes which intersect the solar disc, and consequently receive a partial or penumbral illumination, contributing greatly to the varied effect of the landscape, and to the truth and certainty of its relief. And the more fully these are exhibited in any mode of representation the better.

A very little experience in drawing will convince us of the expediency of confining ourselves to a limited area. It is very desirable not merely to be able to complete what we have undertaken, but to avoid the change of effect inseparable from a delineation protracted through many consecutive hours. The alteration in the amount of shadow, especially near the terminator, during a winter's evening, would strike an unaccustomed observer with surprise.

With respect to the choice of regions suitable for representation, especially for the commencing student, those approaching to the limbs must take decidedly the last place. Not only is the perspective foreshortening likely to cause perplexity and mistake among unknown objects, but, owing to the never-ceasing action of libration, that foreshortening is in a state of continual restlessness. Every night we look upon a fresh limb; a similar aspect is slow in its return; entire correspondence is not restored till after three years; and during the brief period of its continuance he must be a novice indeed in actual work, who would flatter himself, at least in an English sky, with the hope of similar atmospheric conditions. Regions near the centre of the disc are far more suitable, especially for early efforts; but it must not be forgotten that even such districts are not altogether free from the displacement occasioned by libration, and its effect in changing the relative proportions and situations of objects ought to be studied and allowed for. In fact a clear understanding of this cause of apparent variation must underlie any satisfactory investigation of the interesting enquiry already referred to, whether the convulsions which have in former ages shattered the superficies of the lunar globe have now sunk into entire quiescence, as well as that scarcely less curious question, whether physical change may not be detected, on or immediately above the surface, in connection with the varying temperature of different parts of the lunar day. Apparent variation may not unfrequently be perceived among minor details; but nothing satisfactory would result from the precipitate inferences which have been sometimes drawn from it, and a little further examination of this subject may be permitted, as it has not always been sufficiently considered in its full extent.

When there is evidence of want of correspondence in drawings made by ourselves or others at different dates, we have first to bear in mind the possibility of omission through defective attention—a not infrequent source of error, and one which is subsequently irremediable. Some observers, no doubt, are more liable to it than others, but none could claim absolute immunity; to photography alone is reserved the triumph over this form of error. Then as regards the minutest visible details, the state of our own atmosphere may exercise considerable influence. But besides these potent sources of discrepancy, others remain in reserve of a very different character. It need hardly be said that the true relief of any surface not viewed in profile is decided by the known and unalterable laws of light and shade. These laws indeed admit of no variation, but their application sometimes involves cases liable to misconstruction, from peculiarity of form in the projecting or receiving surfaces, and if the position of those surfaces is itself liable to change, either with regard to incident or reflected light, or both, it is evident how much the chances of some illusory effect may be multiplied. A few instances may be of use in the way of illustration.

No misapprehension could arise in the case of shadows projected from regular forms upon an uniform sphere. But it is needless to observe how far these conditions are from being fulfilled upon the moon; and not only are the shadows very irregular in their shape, but they are liable to many incidental causes of disturbance, partly of a real, partly of an optical character. Independent of their normal variation in actual length according to the height of the sun above the lunar horizon, they may also vary in actual length from the unevenness of the recipient surface. For instance, a shadow will be gradually shortened, or suddenly blunted, if its extremity falls on a rising slope, or against a rapid elevation; or it will be correspondingly extended under opposite circumstances; and thus the edge of the shadow of a long precipice of uniform height, instead of being bounded by a straight line, as it would be on a plain, may become curved in various directions, or even jagged, if falling on very irregular ground. An apparent lengthening or shortening may also take place in obliquely viewed regions, when illuminated objects are brought by change of libration between the spectator and the true end of the shadow, or are again removed out of the line of sight: a variation which it will readily be seen affects still more extensively the apparent breadth of shadows in these positions. Again, in certain cases shadows may vary in breadth and direction, or even visibility, according to the lunar change of season; for this, though small in extent, the axis being inclined only 1° 32′ 9″, may not be always imperceptible. It causes so much difference in the points of lunar sunrise or sunset, that a straight face of cliff running E. and W. might at one time be made visible by casting a broader, at another by a narrower shade; at another season, might be undistinguishable; at another, might come out as a white streak from being exposed to sunshine. And this real difference in illumination might, again, be masked by change of libration, if this happened to turn such a face of cliff, whether in sunshine or in shade, towards or from the spectator's eye. So the black spire projected by an insulated mountain may in some lunar seasons be carried fully out to its tapering extremity, passing close by the side of a hill, which at another time a slight change of direction in the solar rays brings right into its course, so as to shorten and square it off; and so, too, the brilliant point encompassed by darkness which denotes a summit on the night-side just touched by the rays of the rising or setting sun, may be visible or invisible at different times from a similar cause, the altered bearing of the sun in the lunar sky at one time throwing over it, at another beside it, the shadow of some object near the terminator. Other similar cases of illusion might be named. The end of a shadow may be apparently prolonged by its falling into a depressed and already darkened spot; or its form may be suddenly changed from pointed to round if the extreme apex cast from some sharp and prominent "aiguille" should, as the sun gains in elevation, cease to project beyond the shadow of the gentler slopes from which it springs. It would be easy to extend this list of causes of deception; but those here given may suffice as indications of the caution with which it is necessary to approach the much-disputed question of still existing physical change. In the answer to that question—the affirmative answer—undoubtedly lies a great part of the charm of selenography. Whatever may be the magnificence of the abrupter features of the lunar scenery, or the smooth and tranquil aspect of its gentler valleys and wide-extended plains, we shall contemplate them with a different amount of interest accordingly as we are obliged to consider them an inanimate and silent record of the worn-out and spent convulsions of bygone ages, and forces wholly extinct in selenological death; or whether we may detect if it be but the last feeble efforts of that marvellous working which once threw open such amazing gulfs, and piled up such terraces and towers and pyramids, and overspread such wide-extended areas of the globe with confusion and ruin. Some observers may have perhaps been precipitate in assuming the utter and final collapse of all those ancient and evidently long-enduring energies. It were safer to wait and see whether all is indeed so dead and cold. And, again, we must not assume, we have to prove—if it can be proved—the absence of atmospheric phenomena. This is not one of those cases where an undemonstrated negative may suffice. The burden of proof—or rather disproof—here naturally rests upon the opponent, when all analogy is in favour of some kind of gaseous envelope: and whatever may, or rather must, be its tenuity as compared with our own, its total absence would be contrary to all chemical and mechanical probability. Nor is it a mere theoretical question: indications are not wanting that the inferences of Schröter and Gruithuisen, to whatever exception they may be liable in their full extent, are at any rate deserving of some consideration. We may be called upon to make abundant deductions on the score of precipitancy and prepossession, and yet a residuum may be found to exist, small in amount, but refractory in character, which cannot be disposed of by any summary mode of treatment. Simple negation will not suffice, much less contemptuous neglect of the labours of those who have preceded us. The first general aspect of that great world lying in its confusion and desolation may indeed be, to some eyes, that of absolute quiescence and arid sterility; a wilderness of rock and sand, lifeless and even soundless, in its unclothed contact with the emptiness of boundless space. But the student, in proportion to his earnestness and perseverance, may see cause to be distrustful of first impressions; he will rather be looking out carefully for those minute indications—and experience has proved that only minute ones can be expected—which may yet show to a well-trained eye and cautious judgment that such a conclusion would be too precipitate. At any rate the question is not yet set at rest; and it can only be finally decided by the faithful carrying out, in very circumstantial detail and with scrupulous accuracy, that graphical representation of the surface which has formed the subject of the preceding remarks.

It need scarcely be mentioned that a record of time is an important element in the value of any such representations, as a few hours would occasionally be of considerable significance in a subsequent comparison; and in such comparison any difference of libration will have to be carefully allowed for at any material distance from the centre of the disc. Personal equation enters so much into all these matters, that it may be desirable in the first instance to institute comparisons between the different delineations of the same hand, for every observer has his own way of seeing and interpreting as well as of delineating what lies before him; but ultimately a more extended collation would be requisite. To Mr. Birt, as editor of the "English Lunar Map," now in progress, our own observers would naturally refer for the safe preservation and general comparison of their united labours; but it is obviously important that what is thus communicated should be the result, not of rough and hasty attempts, but of careful and attentive delineation. It is also very desirable that such a representation should be accompanied by a list, as well as by some description, of the objects delineated; this being the most effective method of ensuring certainty to the evidence, and making it fully dependable for future comparison and inference.

It may have been noticed that no allusion has been made to the representation of those well-known streaks and specks and clouds of white and grey which give so peculiar and unintelligible a character to the aspect of the Full Moon. The delineation of these would be found in one respect more difficult, as requiring wider gradation of tone; in another easier, from the greater permanency of the object. It has been hitherto little attempted in detail, but is well worthy of separate study. We have not space to enter now upon its characteristics, which indeed have been but very imperfectly investigated. Here also, however, indications of decided change have not been wanting; and the diligent and persevering explorer would probably be rewarded in the end.

MAN AND APES.

By ST. GEORGE MIVART, F.R.S.

PART II.

HAVING completed our survey of certain characters presented by the skeleton in different species of the order PRIMATES, other systems of organs may now be adverted to.

That system of parts which clothes and is attached to the various parts of the skeleton may be taken naturally after the skeleton itself.

This system consists of the flesh which, being divided into a number of segments and layers by intervening membrane, constitutes the muscles or active organs of motion.

The muscles, however, present few characters of any great value for our purpose, and this might be anticipated, since being the special organs of motion, they would naturally be expected to be peculiarly modifiable and to present every variety of adaptive modification.

Speaking generally, the Apes resemble man myologically more than do the Half-Apes, and the latter may present us with special aberrant modifications ; such *e.g.* as the presence of an extra muscle, called *rotator fibulæ*, placed between the shin-bone (*tibia*) and the adjacent small bone (*fibula*) of the leg.

It is the Latisternal Apes (*Simiinæ*) which approach man most closely in muscular structure, as we have seen they do in the bony framework which supports the muscles.

Amongst these higher Apes the Orang shows again a certain inferiority as to its muscles, reminding us of the aberrations we have already seen to exist in its skeleton.

Thus in its foot, the great toe, in spite of its small relative size, is furnished with a special, short muscle (called *opponens hallucis*) not found in other Latisternal Apes, any more than in man. This, indeed, is a special development, and is no approximation to an inferior type of structure.

On the contrary, both the great toe and the thumb have no distinct tendon sent to them from the deep long flexor muscles of the arm and leg respectively. In this respect we find an inverse difference to that precedingly noticed.

Again, the long muscle called *flexor longus hallucis* does not take origin, as in the other higher Apes, from the leg, but from the bone of the thigh.

But neither the skeleton, nor yet the flesh which clothes it, can be considered as the most important system of organs, nor that best calculated to manifest degrees of affinity or supremacy. It is not the pillars, shields, and levers of the body (bones), nor the cords and fastenings which brace together (ligaments), or by tension act upon (muscles) those pillars and levers which can rationally be regarded as supreme. Such supremacy must rather be conceded to the regulating and co-ordinating apparatus, by means of which the tensions are so varied and directed as to produce harmonious and consentient results. But this supremacy is still further manifest when we consider that the very integrity of these structures is maintained, and their repair effected, by the agency of that very same co-ordinating apparatus which is the controller of animal life, the lord of all within its own boundaries, and which says to every other system of parts, "Starve thou before me."

This supreme and dominant apparatus is the nervous system. The Ape which has this system—and especially the dominant part of this dominant system, namely, the brain—most in conformity with the same system in man, must surely be held to be the most materially man-like in structure.

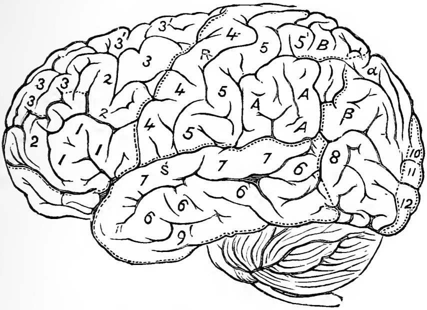
Now it is not the Chimpanzee, certainly not the Gorilla, nor yet the Gibbons which most resemble man as regards his brain. In this respect the Orang stands highest in rank.

In the first place, the height of the Orang's cerebrum in front is greater in proportion than in either the Chimpanzee or the Gorilla; while the brain of the last-named animal falls below that of the Chimpanzee, in that it is relatively longer and more depressed, as compared with man's brain.

Each half of the cerebrum is divisible into four parts or lobes. The first of these (marked 1, 2, and 3) is the "frontal." The second (marked 4, 5, and 6) is the "parietal." The third (marked 10, 11, and 12) is the "occipital;" and the fourth (marked 7, 8, and 9) is the "temporal."

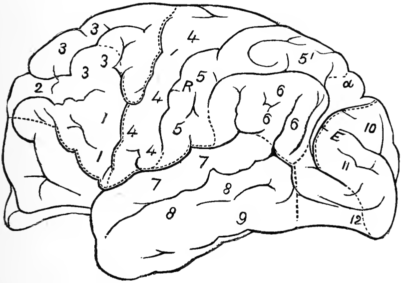
On comparing the brain of man with the brains of the Orang, Chimpanzee, and Baboon, we find a successive decrease in the frontal lobe, and a successive and very great increase in the relative size of the occipital lobe. Concomitantly with this increase and decrease, certain folds of brain substance, called "bridging convolutions" (marked a and β), which in man are conspicuously interposed between the parietal and occipital lobes, seem as utterly to disappear in the Chim-

Fig. 1.



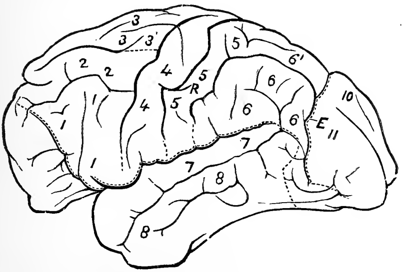
Brain of Man (*Homo*), left side.

Fig. 2.



Brain of Orang (*Simia*), left side.

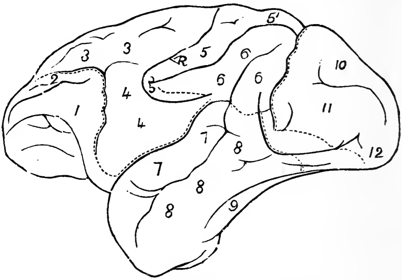
Fig. 3.



Brain of Chimpanzee (*Troglodytes*), left side.

panzee as they do in the Baboon. In the Orang, however, though much reduced, they are still to be distinguished. Besides these matters, the temporal lobe becomes less horizontal and more depressed, as we proceed from Man to the Baboon.

Fig. 4.



Brain of Mandrill Baboon (*Cynocephalus*), left side.

These distinctions, with some others, have been pointed out in France by the late lamented M. Gratiolet,* and in England by Professor Rolleston.† Mr. Marshall, F.R.S., has also given his verdict ‡ "on the interesting question of the relative superiority of the Chimpanzee's and Orang's brain" "in favour of the latter."

Messrs. Schroeder, Van der Kolk and W. Vrolik, the distinguished naturalists of Amsterdam, fully recognise the resemblance of the brain of the Orang to that of man to be closer than that presented by the brain of any other Ape.

The actual and absolute mass of the brain is, however, slightly greater in the Chimpanzee than in the Orang, as is the relative vertical extent of the middle part of the cerebrum, although, as before said, the frontal portion is higher in the Orang. When we turn to the Gorilla we find, from M. Gratiolet,§ that this much vaunted and belauded Ape is not only inferior to the Orang in cerebral development, but even to his smaller African congener—the Chimpanzee.

In the first place its brain scarcely equals (at least in some cases) that of the Chimpanzee in actual mass. It is also flatter, and its frontal lobe is less projecting in front of its temporal

* "Mémoire sur les plis cérébraux de l'homme et des primates."

† "Nat. Hist. Review," vol. i. p. 201, and in a Lecture at the Royal Institution, reported in the "Medical Times," for February and March, 1862.

‡ "Nat. Hist. Review," vol. i. p. 310.

§ See "Comptes rendus," April 30th, 1860, p. 801.

lobe. Altogether, M. Gratiolet tells us, its brain-characters make of the Gorilla—in spite of its size and strength—the lowest and most degraded of all the latisternal apes. Moreover, the disposition of its convolutions is such as (in the opinion of M. Gratiolet) to connect it with the Baboons, while the Chimpanzee is similarly connected with the Macaques. Our author suggests that if the Orang be considered as the head and culminating point of development, following the line of the Semnopitheci and Gibbons, then the Chimpanzee may be taken to be the head, or, as it were, the Orang, of the series of Macaques, while the Gorilla is but the culmination of that type of cerebral structure elsewhere exhibited by the relatively brutal and degraded Baboons.

This is an appreciation of the animal widely different from that still popular in England, in spite of Professor Rolleston's efforts to propagate the true Simian faith respecting this "would-be king of the *Simiadæ*."

The Professor expresses himself * as follows:

"In the world of science, as in that of politics, France and England have occasionally differed as to their choice between rival candidates for royalty. . . . If either hereditary claims or personal merits affect at all the right of succession, beyond a question the Gorilla is but a pretender, and one or other of the two candidates the true prince. There is a graceful as well as an ungraceful way of withdrawing from a false position, and the British public will adopt the graceful course by accepting forthwith and henceforth the French candidate, and by endorsing M. Gratiolet's proposal for speaking of the Gorilla as but a Baboon, of the Chimpanzee as a Macaque, and of the Orang as a Gibbon."

There can be no question, then, but that in this most important organ, the Orang is man's nearest ally, while the Gorilla is quite remarkably inferior.

This closeness of resemblance between the brains of the Orang and of man becomes yet more striking when we consider how great in this respect is the divergence between the Orang and those lowest of Apes—the Marmosets—in which the cerebrum is smooth and entirely devoid of furrows and convolutions. In the lower sub-order—the Lemuroids—the divergence is much greater still, so much so, indeed, that the Half-Apes, as to their brains, have far nearer resemblances to animals altogether below the order PRIMATES, than to the higher members of that order.

It must nevertheless be borne in mind, if we would estimate the value of these cerebral characters with perfect fairness,

* "Medical Times," for February 1862, vol. i. No. 608, p. 184.

that forms zoologically distant sometimes resemble each other in brain-characters, while closely allied forms strangely differ. Thus, as M. Gratiolet has pointed out, the "bridging convolutions" between the parietal and occipital lobes re-appear in the Spider Monkeys, while two species of Sapajou (*Cebus*), so closely allied as to have been sometimes treated as one species, differ strangely from each other in this respect.

Again, much stress has been laid, by some writers, on the great relative extension backwards of the hinder parts of the cerebrum and cerebellum in man. But in the little Squirrel Monkey of America the cerebrum extends backwards beyond the cerebellum, much more than it does in ourselves, while in that remarkable species of *Hylobates*—the Siamang Gibbon (which is so man-like in its chin, and which exceeds man in the breadth of its sternum)—the cerebrum is so short as to leave the cerebellum very decidedly uncovered at its hinder part. In the Howling Monkeys, again, this exposure of the cerebellum is yet greater, and, nevertheless, these monkeys belong to a family in which, as we have seen, the overlapping of the cerebellum by the cerebrum attains its maximum of development.

Yet the psychical powers of different Apes are very similar. Not only the lowest Baboons of Africa (as *e.g.* the famed "Happy Jerry" of Exeter Change) can be taught various and complex tricks and performances, but the less man-like American monkeys—the common Sapajous—are habitually selected by peripatetic Italians for the exhibition of the most clever and prolonged performances.

As to the two species of Sapajou, the brains of which are so different the one from the other, Professor Rolleston asks: "Will anybody pretend that any difference can be detected in the psychical phenomena, the mental manifestations of these creatures, at all in correspondence or concomitant variation with their differences of cerebral conformation?"

The difference between the brain of the Orang and that of Man, as far as yet ascertained, is a difference of absolute mass. It is a mere difierence of degree and not of kind.

Yet the difference between the mind of Man and the psychical faculties of the Orang is a difference of kind and not one of mere degree.*

Thus on the one hand we see that we may have great differences in brain development unaccompanied by any corresponding psychical diversities, and on the other we may have vast psychical differences which it seems we must refer to other than cerebral causes.

* See "Quarterly Review," July 1871.

Professor Huxley has sought to invalidate such inferences,* first by asserting, what is of course perfectly true, that intellectual power (as we daily experience it) depends not on the development of the brain alone, but also on that of "the organs of the senses and of the motor apparatuses." But surely to this we may reply that in these respects no one pretends even that there is much difference between man and Apes.

Secondly, Professor Huxley objects that the cerebral differences may be of so minute a character as to have escaped observation, and he compares the brains of Man and an Ape with two watches, one of which will, and the other will not, keep accurate time. He exclaims, "A hair in the balance-wheel, a little rust on a pinion, a bend in a tooth of the escapement, a something so slight that only the practised eye of the watchmaker can discover it, may be the source of all the difference."

It would be, however, to say the least, somewhat singular to attribute to *hypothetical* and *confessedly minute* differences effects which as yet we have *not* seen to accompany or be produced by *certainly present* and *confessedly considerable* differences which we *have seen.*

With how much force then does not the comparative anatomy of the present day re-echo the truth long ago proclaimed by Buffon,† that material structure and physical forces can never alone account for the presence of mind.

Speaking of the Ape, the most Man-like as to brain, he says:—

"Il ne pense pas: y a-t-il une preuve plus évidente que la matière seule, quoique parfaitement organisée, ne peut produire ni la pensée, ni la parole qui en est la signe, à moins qu'elle ne soit animée par un principe supérieur?"

In passing from the brain to the organs of sense, it may be remarked that the ear of the Gorilla is more human than that of any other Primate, in that it has a rudimentary *lobule*—that is to say, a rudiment of that soft depending portion into which the "ear-ring" is inserted.

The nose, on the contrary, exhibits a prominence slightly approximating to that of Man, not in the Gorilla but in one of the Gibbons, namely the Hoolock.

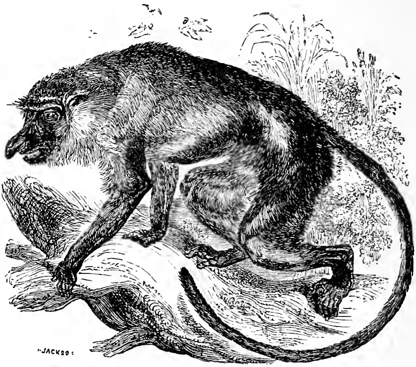
The projection of Man's nose is, however, exceeded by that of a long-tailed Bornean Ape, called the Proboscis Monkey on account of the length of its nasal organ. It belongs to the genus *Semnopithecus*. No other species of that genus exhibits any approximation to a similar nasal elongation.

* "Man's Place in Nature," p. 102, note.

† "Hist. Nat.," t. xiv. p. 61, 1766.

The tongue of the Orang is more like that of man than is the tongue of any other latisternal Ape, and the large papillæ of the back of the tongue (called *circumvallate*) more resemble

Fig. 5.

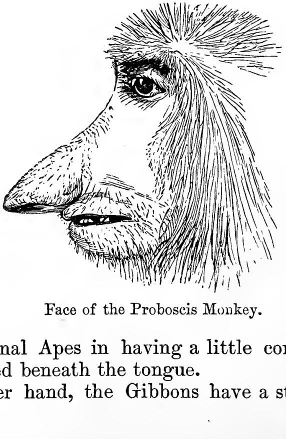


The Kahan, or Proboscis Monkey.

in arrangement even in the Gibbons the same parts in man than they do in the Chimpanzee, and very much more than in the Gorilla.

The Gibbons, however, differ from man and from all the

Fig. 6.



Face of the Proboscis Monkey.

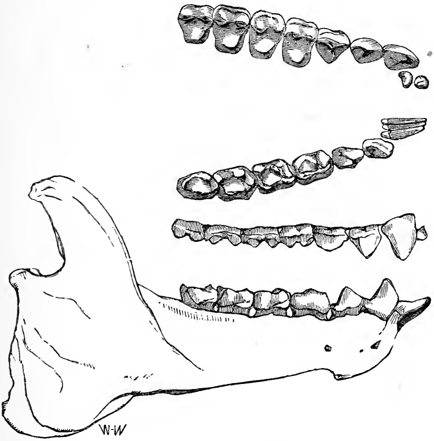
higher latisternal Apes in having a little conical bifid membrane developed beneath the tongue.

On the other hand, the Gibbons have a stomach which is very human, and a liver which is more like the liver of man than is that of any other animal whatever.

The liver of the Orang and the Chimpanzee is not very different from that of man, but, strange to say, in the Gorilla we meet with a very degraded liver, and one formed on the type of liver which exists in the lower Monkeys and the Baboons—with the lobes subdivided.

The teeth of Apes resemble those of man in varying degrees, and the several resemblances which may exist are by no means present at the same time in the dentition of any one of the latisternal Apes.

Fig. 7.



Dentition of *Hapalemur.*

1. One striking character of the human teeth is their almost equal vertical development. All the Apes, on the contrary, possess more or less projecting tusk-like "eye teeth," or "*canines*," as they are technically called, because similarly projecting in the dog.

Now in all the broad-breastboned Apes, the canines are both exceedingly long and powerful, and indeed the *Simiinæ* are almost like Baboons in this respect.

The nearest approach to man is found not in the Apes at all, but in the Half-Apes, where in some forms (as *e.g. Hapalemur*) the excess in length of the canines over the grinding teeth is very small indeed.

2. The second noteworthy character of the human dentition

is the close approximation of the teeth one to another serially, so that no vacant space (or, as it is technically called, *diastema*) is left between any two adjacent teeth.

To find a similarity to man in this respect we have again to descend through the whole series of Apes, till we come to the lower and more aberrant forms of the Half-Apes, and there alone, in the little Tarsier of Celebes, we once more meet with teeth placed in serial contiguity, as in man.

3. A third character which may here be mentioned, is one exhibited by the masticating surfaces of the larger grinding teeth of the upper jaw. We find in Man on the masticating surface of each of these teeth an oblique ridge, running from the front inner angle of such surface outwards, and backwards to its hind outer angle.

This character is found also in the teeth of the Orang, Chimpanzee, and Gorilla, but it does not exist in those of the Gibbons, nor in those of any of the lower Simiadæ. Here, then, we seem to come upon a striking character as to affinity with man—a character the more deep and significant, in that it is hard to see how the presence of this slight ridge should be so favourable in the life-struggle as to be independently developed in different forms by any mere action of natural selection.

Nevertheless, when we pass to the American Apes we find it reappearing in the Spider and Howling Monkeys, and, strange to say, even amongst the Half-Apes (*e.g.* in *Arctocebus*, *Microcebus*, and *Galago*) the same structure is distinctly developed.

4. The fourth character is one drawn from the order of the succession of the teeth. Each eye-tooth of the second or permanent set is cut in man before the hindmost grinder but one makes its appearance. In the Orang, Chimpanzee, and Gorilla, all the grinders of the second set make their appearance before the canines of the same set. In the Gibbons the canines accompany, if they do not precede, the appearance of the hindmost grinder, and so far, therefore, these animals seem to approximate to the human condition; but the resemblance is of no significance, since it is a condition often found in the lower Apes.

Most of the Gibbons, again, resemble man more than do the Orang, Chimpanzee, or Gorilla, or than many of the lower Simiadæ, in the absence of large saccular dilatations or pouches, in connexion with the larynx.

The shape of the stomach is more human in the Gibbons than in the other broad-breastboned apes.

The Orang has been said to have no uvula, but, as Professor Flower has pointed out, it is present, though disguised by the extent of development of adjacent membrane.

In man and in all Primates, the large intestine gives off a considerable blind off-shoot (the *cœcum*) which has attached to it a singular little worm-like process, called the *vermiform appendix*. This is not found in any apes other than the Simiinæ, and its development is most like man in the Gibbons.

It may be well now to recapitulate and group together the characters in and by which different Apes and Half-Apes resemble and differ from man.

Besides the highest Apes, certain of the lower and lowest forms have been seen to merit our attention.

The Gorilla resembles man more than does any other latisternal Ape, in the following points:—(1) The great bulk of its whole body; (2) the possession of a lobule to the ear; (3) the prominence of the upper part of the bones of the nose; (4) the development of a vaginal ridge beneath the skull on each side; (5) the shape of the blade-bone; (6) the relative length of the hand to the spine; (7) that of the fore-arm to the upper arm; (8) that of the thumb to the back-bone; (9) that of the thumb to the whole hand; (10) that of the ankle-bones to the whole foot; (11) that of the great toe to the spine; (12) the length of the neck of the thigh-bone.

The Gorilla differs more from man than do any other of the broad-breastboned Apes, in that:—(1) The bony muscular ridges on the skull are enormously developed; (2) the cerebrum is of relatively small vertical extent; (3) the brainfolds (cerebral convolutions) are formed on the type of brain found existing in Baboons; (4) the liver is Baboon-like in its subdivided condition; (5) the large papillæ of the tongue are scattered and not collected into a V-shaped aggregation.

It should also be recollected that there are characters by which the Gorilla differs more from man than does some one or other of the latisternal forms, whether it be the Chimpanzee, the Orang, or the long-armed Apes. Such are the non-development of a chin, the number of ribs, &c., &c.

The Chimpanzee is the most man-like of the Simiinæ in the following points:—(1) The shortness of the arms, compared with the length of the spine; (2) their shortness (the hands being included) compared with the legs and feet; (3) the length of the humerus compared with that of the spine; (4) the length of the radius compared with that of the spine; (5) the length of the longest toe compared with that of the spine; (6) the near approximation, in length, of the great toe to the absolutely longest toe; (7) the height of the frontal lobe of the cerebrum. On the other hand, the Chimpanzee differs from man more than do any other of the latisternal Apes in that the leg and foot (taken together) are so short compared with the length of the spine. Besides this, as we have seen in several important characters, the Chimpanzee is less human than is one or another of the Simiinæ. Such characters are *e.g.* the number of the lumbar vertebræ, the shape of the blade-bone, of the sacrum, &c., &c.

The Orang is most like man in (1) the development of the beard in the males; (2) in the development of the styloid process; (3) in the length of the leg and foot taken together compared with that of the back-bone; (4) in the length of the crest of the ilium; (5) in the development of the spine of the ischium; (6) in the length of the foot compared with that of the hand; (7) in the relative height of the cerebrum; (8) in the large proportion of its frontal lobe; (9) in the small proportion of its occipital lobe; (10) in the development of the "bridging convolutions;" (11) in the characters of the tongue; (12) in the high and rounded form of the skull.

The Orang, in addition to the characters before noted,* differs from man more than do any other of the broad-breast-boned Apes, in that (1) the breast-bone is formed of two series of pieces; (2) in the length of the leg, without the foot, compared with that of the back-bone; (3) in the length of the shin-bone compared with that of the femur; (4) in the length of the foot compared with that of the back-bone; (5) in the length of the foot compared with that of the shin-bone; (6) in the length of the foot compared with that of the spine; (7) in the shortness of the tarsus compared with the length of the whole foot; (8) in the shortness of the hallux compared with the spine.

Some or other of the Gibbons are most like man in:—(1) the breadth of the breastbone; (2) the shortness of the cervical spinous processes; (3) the development of a "chin;" (4) in the length of the leg, without the foot, compared with that of the spine; (5) the length of the blade-bone compared with that of the spine; (6) the length of the haunch-bone compared with that of the spine; (7) the breadth of the pelvis compared with the length of the haunch-bones; (8) in the length of the femur compared with that of the spine; (9) the length of the femur compared with that of the haunch-bone; (10) the relative slenderness of the thigh-bone; (11) the length of the shin-bone compared with that of the femur; (12) the length of the foot compared with that of the leg; (13) in the length of the foot compared with that of the tibia; (14) in the slenderness of the ankle; (15) in the length of the great toe compared with that of the whole foot; (16) the prominence of the nose; (17) the form of the stomach; (18) that of the liver; (19) that of the vermiform appendix; (20) the succession of the

* See "Pop. Sc. Review," No. xlvii., pp. 136-137.

teeth; (21) the absence of laryngeal sacs; (22) the quality of the voice.

All the Gibbons differ from man, more than do any other of the broad-breastboned Apes, in that:—(1) the length of the arms compared with that of the spine is so great; (2) in the excessive length of the leg and foot (taken together) compared with that of the spine; (3) in the length of the foot compared with that of the hand; (4) in the structure of the tongue underneath; (5) in the form of the upper grinding teeth; (6) in the smaller size of the body, and, in the Siamang, in the uncovered cerebellum.

We have seen also that some or other of the Baboons—the lowest of the Simiadæ—excel all the higher Apes in resemblance to man as to certain points. These are:—(1) the sigmoid curvature of the spine; (2) the lumbo-sacral angle; (3) the concavity of the visceral surface of the sacrum; (4) the convexity of the bones of the nose; (5) the development of the styloid process; (6) the transverse breadth of the pelvis as compared with its depth from the sacrum to the pubis; (7) the greater descent of the inner condyle of the femur; (8) the length of the foot compared with that of the backbone; (9) the angle formed by the axis of the cranium with the axis of the face.

The *Cebidæ* differ from both man and the *Simiadæ* in such important characters that they cannot but be considered to constitute a family decidedly more inferior and remote from man than that of the Old World Apes. Nevertheless, some or other of them resemble man more than do the bulk of the *Simiadæ* in the following characters: (1) no ischial callosities; (2) no cheek pouches; (3) copious beard and whiskers (Sakis); (4) hair of arms directed as in man; (5) cranium more rounded; (6) cranium higher; (7) face relatively smaller; (8) foramen magnum situate more forwardly; (9) the length of the thumb compared with that of the hand (*Hapale*); (10) the length of the thigh-bone compared with that of the back-bone (Spider Monkeys); (11) the greater descent of the inner condyle of the femur (Spider Monkeys); (12) the length of the shin-bone compared with that of the femur (Spider Monkeys); (13) the length of the hallux compared with that of the spine (*Pithecia*); (14) the presence of "bridging convolutions" (Spider Monkeys); (15) the very overlapping cerebrum (Squirrel Monkeys); (16) the oblique ridge on the upper grinders (Howling Monkeys).

The Half-Apes (*Lemuroidea*) differ, as before said, from both man and true Apes in points so numerous and so significant that there can be no question as to their great inferiority and the vast chasm which exists between the two sub-orders.

Nevertheless, we find amongst the Half-Apes certain characters which resemble those of man more than do most, sometimes even more than do any, of the characters exhibited by the true apes. Thus the typical Lemurs and the Indris have a more completely opposable and better developed thumb than any Ape. In the slender Loris we find an absence of the extra interlocking processes (metapophyses and anapophyses) of the back-bone, the spinous processes of which do not converge (fore and aft) towards a central point; the pisiform bone of the wrist is smaller than in any Ape; the proportion borne by the thumb to the hand in length is more human, as is the form assumed by the ischium, and the relative size of the foot compared with the leg. In the *Indrisinæ* and in Lepilemur we find but eight carpal bones (a character found in no other Primates save Man, the Chimpanzee and Gorilla), and the most human proportional length of both the thumb and the index finger compared with the length of the spine. We also find in the short-tailed Indris the length of the femur compared with that of the haunch-bone most human, as also the length of the foot compared with that of the hand, and the near approach made by the length of the "great toe" to the actually longest toe of the foot. In the typical genus *Lemur* we find the proportion (in length) of thigh-bone to the upper arm-bone most human, as well as that of the longest toe to the back-bone. In the Slow Lemur (*Nycticebus*), the length of the shin-bone bears a relation to that of the thigh-bone more human than in any other species below man, while in other kinds of Half-Apes we meet with a development of the anterior inferior spinous process of the ilium more like that of man than we find in any ape; also upper grinding teeth furnished with the "oblique ridge" as in man, and sometimes an almost equality of vertical development in the teeth, and even an absence of any diastema.

Having completed our survey and summary of the structural resemblances and differences presented by the different forms of Primates, we may now consider and endeavour to appraise their value, as bearing upon the question of the "Origin of Species," and especially upon the asserted "descent of man" from some "non-human" Ape ancestor. The question, that is, as to man's body; for as to the totality of his nature no mere anatomical examinations will enable us to decide—that is the task of psychology and philosophy generally.

In the first place it is manifest that man, the Apes, and Half-Apes cannot be arranged in a single ascending series, of which man is the term and culmination.

We may, indeed, by selecting one organ, or one set of parts, and confining our attention to it, arrange the different forms in a more or less simple manner. But, if all the organs be taken into account, the cross relations and interdependencies become in the highest degree complex and difficult to unravel.

This has been more or less generally recognised; but it has been put forward by Mr. Darwin,* and widely accepted, that the resemblances between Man and Apes are such that Man may be conceived to have descended from some ancient members of the broad-breastboned group of Apes, and the Gorilla is still popularly credited with the closest relationship to him which is to be found in all existing Apes.

As to the latter opinion, evidence has been here adduced to show that it is quite untenable.

As to Mr. Darwin's proposition, much remains to be said. But it is certainly true that on the whole the anatomical characters of man's body have much more resemblance to those common to the latisternal group than to those presented by any other section of the order Primates.

But, in the first place, we should consider what evidence of common origin does community of structure afford?

The human structural characters are shared by so many and such diverse forms, that it is impossible to arrange even groups of genera in a single ascending series from the Aye-Aye to man (to say nothing of so arranging the several single genera), if all the structural resemblances are taken into account.

On any conceivable hypothesis there are many similar structures, each of which must be deemed to have been independently evolved in more than one instance.

If the number of wrist bones be deemed a special mark of affinity between the Gorilla, Chimpanzee, and man, why are we not to consider it also a special mark of affinity between the Indris and man? That it should be so considered, however, would be deemed an absurdity by every evolutionist.

If the proportions of the arms speak in favour of the Chimpanzee, why do not the proportions of the legs serve to promote the rank of the Gibbons.

If the "bridging convolutions" of the Orang go to sustain its claim to supremacy, they also go far to sustain a similar claim on the part of the long-tailed, thumbless Spider Monkeys.

If the obliquely-ridged teeth of Simia and Troglodytes point to community of origin, how can we deny a similar community of origin, as thus estimated, to the Howling Monkeys and Galagos?

The liver of the Gibbons proclaims them almost human; that of the Gorilla declares him comparatively brutal.

The ear lobule of the Gorilla makes him our cousin; but his tongue is eloquent in his own dispraise.

The slender Loris, from amidst the Half-Apes, can put in

* "Descent of Man," vol. i. p. 197.

many a claim to be our shadow refracted, as it were, through a Lemurine prism.

The lower American Apes meet us with what seems "the front of Jove himself," compared with the gigantic but low-browed denizens of tropical Western Africa.

In fact, in the words of the illustrious Dutch naturalists, Messrs. Schroeder, Van der Kolk, and Vrolik,* the lines of affinity existing between different Primates construct rather a network than a ladder.

It is indeed a tangled web, the meshes of which no naturalist has as yet unravelled by the aid of natural selection. Nay, more, these complex affinities form such a net for the use of the teleological retiarius as it will be difficult for his Lucretian antagonist to evade, even with the countless turns and doublings of Darwinian evolutions.

But, it may be replied, the spontaneous and independent appearance of these similar structures, is due to "atavism" and "reversion"—to the reappearance, that is, in modern descendants, of ancient and sometimes long-lost structural characters, which formerly existed in more or less remote hypothetical ancestors.

Let us see to what this reply brings us. If it is true and if Man and the Orang are diverging descendants of a creature with certain cerebral characters, then that remote ancestor must also have had the wrist of the Chimpanzee, the voice of a long-armed Ape, the blade-bone of the Gorilla, the chin of the Siamang, the skull-dome of an American Ape, the ischium of a slender Loris, the whiskers and beard of a Saki, the liver and stomach of the Gibbons, and the number of other characters before detailed, in which the various several forms of higher or lower Primates respectively approximate to Man.

But to assert this is as much as to say that low down in the scale of Primates was an ancestral form, so like man that it might well be called an *homunculus*; and we have the virtual pre-existence of man's body supposed, in order to account for the actual first appearance of that body as we know it—a supposition manifestly absurd if put forward as an explanation.

Nor if such an *homunculus* had really existed, would it suffice to account for the difficulty. For it must be borne in mind that man is only one of many peculiar forms. The body of the Orang is as exceptional in its way, as is that of man in another. The little Tarsier has even a more exceptional structure than has man himself. Now, all these exceptional forms show cross relations and complex dependencies as involved and puzzling as does the human structure, so that in each several case we should meet with a similar network of diffi-

* "Nat. Hist. Review," vol. ii. p. 117.

culties, if we sought to account for existing structural characters through the influence of inheritance and natural selection.

It may be replied that certain of these characters have arisen in total independence, and this reply is no doubt true; but how are we to discriminate between those which are inherited and those which are independently acquired? Structures like strong teeth or powerful claws, obviously useful in the struggle for life, may well be supposed to have independently appeared, and been preserved time after time; but what characters could well be thought, *à priori*, less likely to be independently acquired than a more or less developed chin, such as Man shares with the Siamang alone, or a slightly aquiline nose, such as that found in the Hoolock Gibbon and often in the human species? Can either character be thought to have preserved either species in the struggle for life, or have persistently gained the hearts of successive generations of female Gibbons? Certainly seductiveness of this sort will never explain the arrangement of the lobes of the liver, or the presence of an oblique ridge on the grinding surfaces of the back teeth.

Again, can this oblique ridge of the grinding teeth be supposed to have arisen through life necessities? and yet, if it is a real sign of genetic affinity, how comes it to be absent from the man-like Gibbons, and to reappear for the first time in American Apes, and among others in the aberrant and more or less baboon-like Howling Monkeys?

The same remark applies to the condition of wrist bones of man, the Chimpanzee, and Indris. If this condition arises independently, and is no mark whatever of genetic affinity, what other single character can with certainty be deemed to be valid evidence of affinity of the kind?

But if the foregoing facts and considerations tell against a belief in the origin of Man and Apes, by the purely accidental preservation in the struggle of life of minute and fortuitous structural variations, do they tell against the doctrine of evolution generally?

To this question it must be replied that, if we have reason to think an innate law has been imposed upon nature, by which new and definite species, under definite conditions, emerge from a latent and potential being into actual and manifest existence, then the foregoing facts do not in the least tell against such a conception—a conception, that is, of a real and true process of "evolution" or "unfolding."

For there is no conceivable reason why these latent specific forms should not have the most complex and involved relationships one to another; similar structures independently appearing in widely different instances.

Analogy drawn from the inorganic world is all in favour of been created independently one of the other, and that the various common characters they exhibit are but paralle adaptive modifications, due simply to similarity as to the exigencies of life to which they are respectively exposed.

Fossil remains, as yet unknown, may bridge over the gulf at present existing between these families. It would be a bold thing to positively affirm that such will not be discovered when we reflect how very few are the extinct animals known to us compared with the vast multitudes which have existed, how very rarely animal remains are fossilized, and how very rarely again such fossils are both accessible and actually found. Nevertheless, the author believes that it is far more likely that tropical geological explorations may reveal to us latisternal Apes more human than any now existing, rather than that it will bring to our knowledge forms directly connecting the *Simiadæ* and *Cebidæ*.

To return from this digression, the question may be asked, "What is the bearing of all the foregoing facts on the origin and affinities of man?"

Man being, as the mind of each man may tell him, an existence not only conscious, but conscious of his own consciousness; one not only acting on inference, but capable of analysing the *process* of inference; a creature not only capable of acting well or ill, but of understanding the ideas "virtue" and "moral obligation" with their correlatives freedom of choice and responsibility—man being all this, it is at once obvious that the principal part of his being is his mental power.

In Nature there is nothing great but Man,
In Man there is nothing great but Mind.

We must entirely dismiss, then, the conception that mere anatomy by itself can have any decisive bearing on the question as to man's nature and being as a whole. To solve this question, recourse must be had to other studies; that is to say, to philosophy, and especially to that branch of it which occupies itself with mental phenomena—psychology.

But if man's being as a whole is excluded from our present investigation, man's body considered by itself, his mere "massa corporea," may fairly be compared with the bodies of other species of his zoological order, and his corporeal affinities thus estimated.

Let us suppose ourselves to be purely immaterial intelligences, acquainted only with a world peopled like our own, except that man had never lived on it, yet into which the dead body of a man had somehow been introduced.

We should, I think, consider such a body to be that of some latisternal Ape, but of one much more widely differing from all the others than such others differ one from another amongst themselves. We should be especially struck with its vast brain, and we should be the more impressed by it when we noted how bulky was the body to which that brain belonged. We should be so impressed because we should have previously noted that, as a general rule, in backboned animals, the larger the bulk of the body the less the relative size of the brain. From our knowledge of the habits and faculties of various animals in relation to their brain structure, we should be led to infer that the animal man was one possessing great power of co-ordinating movements, and that his emotional sensibility would have been considerable. But above all, his powers of imagination would have been deemed by us to have been prodigious, with a corresponding faculty of collecting, grouping, and preserving sensible images of objects in complex and coherent aggregations to a degree much greater than in any other animal with which we were before acquainted. Did we know that all the various other kinds of existing animals had been developed one from another by evolution; did we know that the numerous species had been evolved from potential to actual existence by implanted powers in matter, aided by the influence of incident forces; then we might reasonably argue by analogy that a similar mode of origin had given rise to the exceptional being, the body of which we were examining.

If, however, it were made clear to us—immaterial intelligences—that the dead body before us had been, in life, animated, not by a merely animal nature, but by an active intelligence like our own, so that the difference between him and all other animals was not a difference of degree but of *kind*—if we could be made to understand that its vast power of collecting and grouping sensible images served but to supply it with the materials made use of by its intelligence to perceive, not merely sensible phenomena, but also abstract qualities of objects—if we became aware that the sounds uttered by it in life were not exclusively emotional expressions, but signs of general conceptions (such as predominate in the language of even the lowest savage), then the aspect of the question would be entirely altered for us.

We should probably decide that if the body before us seemed to us to be so little related to the informing rational soul that its existence anterior to and independent of such rational soul was quite conceivable and possible, then its origin by process of natural evolution would, indeed, also be conceivable and indeed *à priori* probable.

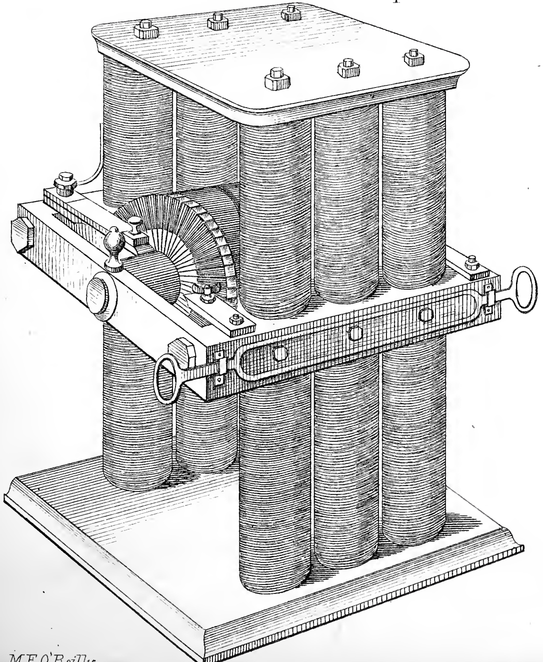
But if, on the other hand we were convinced, from whatever reason, that it was inconceivable and impossible for such a body to be developed or exist without such informing soul, then we should with perfect reason and logic affirm that as no natural process would account for the entirely different kind of soul—one capable of articulately expressing general conceptions*—so no merely natural process could account for the origin of the body informed by it—a body to which such an intellectual faculty was so essentially and intimately related.

Dropping now the metaphor of immaterial spirits, it seems that the answers supposed to be given by such spirits must be the answers really given by sincere and unbiassed investigators in the combined spheres of Zoology and Anthropology.

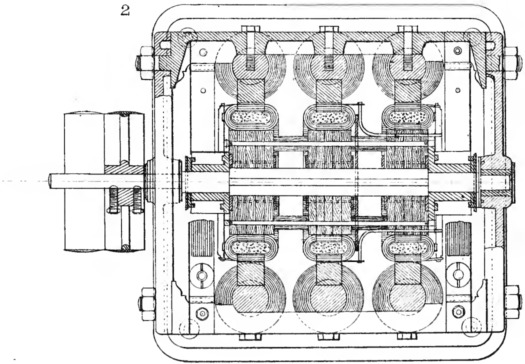
But however near to Apes may be the body of man, whatever the kind or number of resemblances between them, it should always be borne in mind that it is to no one kind of Ape that Man has any special or exclusive affinities—that the resemblances between him and lower forms are shared in not very unequal proportions by different species; and be the preponderance of resemblance in which species it may, whether in the Chimpanzee, the Siamang or the Orang, there can be no question that at least such preponderance of resemblance is *not* presented by the much vaunted Gorilla, which is no less a brute and no more a Man than is the humblest member of the family to which it belongs.

* "It is not emotional expressions or manifestations of sensible impressions, however exhibited, which have to be accounted for, but the enunciation of distinct deliberate judgments as to 'the what,' 'the how,' and 'the why,' by definite articulate sounds; and for these Mr. Darwin not only does not account, but he does not adduce anything even tending to account for them." "Quarterly Review," July 1871. Article, "The Descent of Man," p. 79.

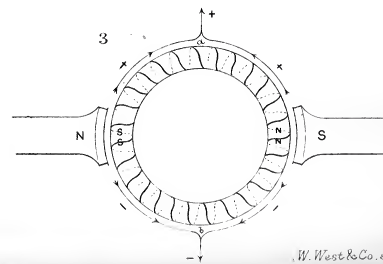
1



2



3



M.F. O'Reilly.

W. West & Co. sc

The Gramme Magneto-electric Machine

THE GRAMME MACHINE; OR, THE NEW ELECTRIC LIGHT ON THE CLOCK TOWER, WESTMINSTER.

By M. F. O'REILLY, B.C.S.

[PLATE CI.]

This is a magneto-electric machine, invented by M. Gramme, of Paris. It was first submitted to the Academy of Sciences in July 1871, when it elicited warm commendation from several members of that learned body. The novelty of its leading features is such as to excite the interest of the scientific enquirer, while its practical bearings strongly urge it on the notice of certain classes of specialists.

It has been introduced into this country by M. Werdermann, an eminent chemist, and has been exhibited for several weeks to various parties in the Engineering Works of Messrs. Whieldon and Cooke, Westminster Bridge Road. Public attention seems to be awakening to the advantages derivable from it, and no doubt further enquiry will be made into its characteristic merits, when, if it answer the expectations already entertained by many, it must play an important *rôle* in the development of the practical applications of electricity, and may indeed eventually supersede the machines actually in use. We intend in this paper to give as full an account of this new apparatus as the limits which have been prescribed to us will permit.

It is only about forty years since the principle of induction was discovered by that indefatigable researcher, Faraday; and the progress made in this new branch of electricity during the four decades in question, is quite astonishing. There is scarcely a parallel for it in the history of science. Nor has there been a halt in the onward movement; every year has brought its contribution—sometimes in the shape of a new application, occasionally in the extension of a principle, but generally in the introduction of more or less valuable improvements. Faraday's discovery threw open a very extensive region for exploration; and one too which promised to be amply remunerative.

Accordingly, we find many labourers in the field even from an early hour. Some centred their attention upon the inductive action of voltaic currents, and among the most successful of these as candidates for fame and fortune was Ruhmkorff. Others devoted their thoughts to the magneto-electric spark, and devised apparatuses, which, in their days, startled the scientific world. But such is the discarding nature of progress that the beautiful contrivances of Pixii, Saxton, and Clarke are now objects more of curiosity than utility, and are therefore relegated to collections of physical instruments. These expensive toys, as they were called, have been succeeded by machines which produce veritable streams of electricity. These changes have been effected rapidly indeed, but not *per saltum*; and it is as instructive as entertaining to follow up the steps which have led to these results.

The rationale of voltaic induction, as determined by the labours of Faraday, is that a current which begins or finishes generates in a neighbouring conductor currents whose directions may in every case be determined by Lenz's law. The transition from this to magneto-electric induction was comparatively easy, as Ampère had many years before propounded to the Academy of Sciences his famous electro-dynamic theory, which virtually identified magnetism and electricity. Experiment proved the accuracy of the Ampèrian theory, and Faraday was the first to elicit the spark from the magnet. Every tyro in science knows that the introduction of a magnet within a hollow coil produces an inverse current in the wire, as indicated by the oscillations of the galvanometer needle. These effects may be rendered much more striking by inserting within the coil a bar or a cylinder of soft iron, and then approaching and withdrawing a pole of a magnet. The pole acts inductively on the soft iron; the variation of distance augments or decreases its magnetic condition, and this fluctuation suffices to generate the induced current. The strength and continuance of the latter depend on the velocity and duration of the movement. It may be interesting to vary these experiments by winding a few turns of copper wire—the free ends of which are connected with a galvanometer—on a soft-iron bar, whose middle section is at right angles to a steel magnet, and then moving the helix from the centre to either extremity and back again, when it will be noticed that in the first case the currents are in the same direction, and if we call them direct, those in the second will be inverse.

Gauss and Weber were the first to utilise Faraday's discovery; they transmitted telegraphic signals by raising or depressing a wooden bobbin, wound with copper wire, through the centre of which passed two or three vertically placed bar magnets, with similar poles joined together. In Pixii's apparatus, which was invented about the time of these Göttingen experiments the magnet rotated before the coil. Later on, Saxton and Clarke improved upon this by fixing the magnet, and causing the double bobbin, which is much lighter, to rotate before it. Attention was now drawn to the production of copious magneto-currents. A new impetus was given; a great question was proposed, and a solution required. Genius and skill went to work, and it was not until several years had elapsed that the knot was severed. One of the most ardent and successful investigators of this subject was Professor Holmes. He struggled against difficulties and prejudices, and had at last the satisfaction of exalting the tiny spark of Faraday into a brilliant star,* and of giving to our coasts beacon-lights whose vivid flashes may be distinguished far out at sea by the storm-beaten mariner.

Mr. Wilde combined all valuable anterior facts and principles into a machine of unprecedented power. He rejected the coils of Clarke, and adopted the armature of Siemens, in which the transversal was replaced by the longitudinal system of winding the wires around the iron cores. The current from the upper armature, which revolved between the poles of permanent magnets, was transmitted round large electro-magnets, which, by their action on a second armature, produced the useful current.

The mutual action principle was the next valuable discovery in magneto-electricity. It seems to have occurred simultaneously to Siemens and Wheatstone, and consists in building up a powerful magazine from the very small amount of magnetism that remains in soft-iron when once a galvanic current has been sent round it. This beautiful principle was embodied by Ladd in his apparatus, to which a silver medal was awarded at the Paris exhibition of 1867.

However satisfactory were the effects obtained from all these machines, there was yet room for several improvements. The currents were instantaneous in duration, and alternately in opposite directions. This made no material difference in the production of electric light; but in electro-metallurgy it required a commutator, which is not always a convenient appendage. These imperfections were finally removed by the Gramme machine, in which we have absolutely continuous currents, and all in the same direction. This invention is thus among the most important of this prolific age ; it marks a new era in the annals of science.

We have already stated that its introduction into this country is due to the diligence and enterprise of M. Werdermann ; and

* "Michael Faraday," by Dr. Gladstone.

it may appear somewhat strange when we say that many months elapsed before that gentleman could get a competent firm to carry out his patent. People will sometimes be slow in yielding assent to anything that clashes with their natural conservatism. Franklin himself was made the object of some harmless pleasantry on account of his ideas about lightning-rods by one of the most distinguished bodies in Europe, our own Royal Society. But M. Werdermann ultimately found a firm able and willing to undertake the construction of his machines. Public interest was soon awakened by the results obtained by Mr. Conrad W. Cooke, in presence of some of the leading scientific men of the day and the representatives of the press. We had the privilege of examining the apparatus at our leisure, and of witnessing on three consecutive evenings a series of experiments, of which we shall speak after we have briefly discussed the technical parts of the apparatus.

It is necessary to premise that the construction of the machine depends upon the uses to which it is to be applied. If required for electro-chemistry, it must give quantitative effects; and if for illumination, tensional. As a general rule, these may be attained by varying the length and gauge of the wire and the connection of the bobbins; but besides these, other changes are introduced into this machine, which accordingly modify its appearance. The one shown in perspective on the accompanying plate (Plate CI. fig. 1) belongs to the second class. It consists essentially of several bobbins or armatures rotating before the poles of two rows of cylindrical electro-magnets. These occupy a vertical position, with similar poles opposite, but not in contact with, each other. They are 3 ft. $7\frac{5}{16}$ inches high, and $3\frac{5}{16}$ inches in diameter. The height of the machine is 4 ft. $1\frac{3}{16}$ inches, and its weight one ton. The armatures form quite a novel feature in magneto-electricity, and the idea is entirely M. Gramme's. It occurred to him that Siemen's long cylinder might be replaced by a ring. Accordingly, he coiled insulated copper wire around this core, and imparted to the whole a movement of rotation in a plane perpendicular to that of the adjacent electro-magnets, when he obtained unintermittent currents with maximum effect. Let N and S (fig. 3, Plate CI.) represent the north and south poles of one of the magnets. They will induce consequent poles at *ss* and *nn* in the adjoining portions of the ring; *b* and *c* on the magnetic equator will be the neutral points. The movement of the coil before N will induce in the wires currents which are positive in the upper quadrant, N*b*, and negative in the lower N*c*. Owing to the opposite polarity of S, a + current flows through S*b*, and a − through S*c*. As consecutive parts of the helices are constantly coming within the influence of N and S, it follows that the currents will flow on without interruption as long as the rotation continues. The familiar class experiments, of which we have already spoken, go far to explain most of the phenomena of magneto-electricity; it will not, then, be necessary to dwell further upon primary principles. However, as it may not appear obvious what cause is immediately concerned in the production of the Gramme currents, we shall mention an experiment made by M. Gaugain, which will give a clear view of the subject. That distinguished physicist procured a ring of soft iron, and wound it with silk-covered copper wire in such a manner that the helix and its core might rotate either separately or simultaneously. This done, it was observed, 1st, that the strongest current was developed when the helix alone was displaced; 2ndly, that the current was weaker when the helix and its core rotated together; and 3rdly, that a very feeble current, inverse of the other two, was produced when the ring alone revolved. From this we gather that the currents owe their origin less to the displacement of the consequent poles than to the rotation of the helix. It would even appear as though the changes constantly taking place in the magnetic condition of the ring oppose the development of the currents.*

The wire which covers the ring is not one continuous piece, but is wound in lengths of about 10 yards each. The ends of two contiguous lengths are brought out from the bobbin and joined to metallic sectors, which are connected to as many copper conductors, placed axially on the spindle of the machine. These are insulated from each other by layers of silk, and it is essential that they be sufficiently numerous to form a compact cylinder, and that the insulating material be very thin. The currents are collected at the neutral points on the axis by metallic brushes, consisting of silvered copper wires held together by adjusting screws. These accessories ensure good soft contact; and when duly attended to, prevent the occurrence of sparks from the extra-current, which are always injurious to an apparatus. There are four of these brushes; two to collect the current, which is made to circulate round the iron cylinders, and the other two to collect the useful current.

The horizontal section (fig. 2) shows the number and disposition of the coils. When these are set in motion, very weak currents are generated by the remanent magnetism in the soft iron. The current from the bobbin near the driving-wheel is transmitted round the cylinders, and thus augments their magnetisation. This new increment now induces a stronger current in the bobbin, which in its turn excites a

* Compare Dr. Ferguson, "Electricity," Appendix, p. 263.

greater intensity in the electro-magnets. This mutual action soon builds up a very powerful battery. The other two bobbins meanwhile produce the current which is used externally.

It is customary in other magneto-electric engines to excite the fixed electro-magnets once for all by means of a galvanic battery, the infinitesimal trace of residual magnetism sufficing to work the machine on subsequent occasions. Now a mere accident has led M. Gramme to dispense entirely with the use of the battery, for at the moment he was going to connect the electrodes of a few Daniell's cells with the machine—which had been previously set in motion by an attendant—he found it evolving a strong current. Terrestrial magnetism had here anticipated him, and elicited in the soft iron the power he sought to induce.

One of the great drawbacks in the machines of Wilde and Ladd is the heating of the armatures caused by the rapidity of their rotation, which varies from 1,000 to 2,400 revolutions per minute. This involves certain inconveniences, which have militated against their extensive adoption for practical purposes. The normal speed of the Gramme is only 300 revolutions per minute; and it may be noticed that it is only when the external work is not proportional to the current generated that the temperature of the coils is slightly raised. By a proper management of the driving-power, but little if any heat may appear in the armatures, and a large fraction of the motive force may be converted into useful work. In no case, evidently, can the energy derived from a magneto-electric apparatus exceed the power expended in producing it.

There is another striking feature in this machine besides the continuity of its currents, viz., the possibility of increasing the number of electro-magnets without material inconvenience. The advantage that may be drawn from this is that several distinct currents may be derived from a single machine and applied to different purposes.

The current produced is equal to that of a Bunsen battery of 525 cells, arranged in five rows. Its tension is therefore that of 105 cells, and its quantity that of five. The wire on the coils is No. 12, and weighs 165 lbs.—that on the electro-magnets is No. 11, and weighs 550 lbs.

A fair knowledge of the vast energy of this machine may be derived from the experiments to which we referred in a preceding paragraph. A platinum wire, No. 18 gauge and 15 ft. in length, was raised to a glowing heat, and the beautiful experiment illustrative of the specific resistance of platinum and silver was readily performed with 18 ft. of alternate pieces. Twenty-two and even 32 ft. of high conductivity copper wire, 96 per cent. purity, was stretched between the terminals—the middle portion being wound in the form of a helix—and easily brought up to a white heat. A round file, $\frac{1}{2}$ inch in diameter and 4 inches long, was burnt up in about five minutes, and a small diamond was volatilised in a few seconds. We had brought with us a De La Rue discharger, containing cylindrical pieces of zinc, steel, and copper ·475 in. in diameter and about 3 in. long. A dazzling light of various tints was instantaneously emitted as the different pairs of metals were brought into circuit, while large beads of the melting mass dropped down. M. Gramme records the following:—

Heated to	redness	40 ft.	copper wire,	·027	inches	in diameter.
,,	,,	17 ,,	iron ,,	·051	,,	,,
,,	fusion	8 ,,	,, ,,	·051	,,	,,

To give an idea of the efficiency of the machine for illuminating purposes, the electric light was projected into the York Road, when peculiarly dark and elongated shadows of vehicles and by-passers were cast on neighbouring houses. The street itself sparkled as though sown with a thousand oriental sapphires. The lamps grew dim, and shadows from the gas flames were in several instances cast on adjoining walls. The bobbins were making 300 revolutions per minute, and the brilliancy of the light was estimated nearly equal to 900 Carcel burners, or 8,640 sperm candles.

The image of the carbon points on the screen was highly interesting. One could plainly distinguish the white glow of the positive carbon, the frequent transport of incandescent particles generally in the direction of the current, and finally the sharp point of the negative carbon and the conical cavities of the positive—the whole lit up by that wonderful arch of flame, to whose excessively high temperature the most refractory metals must yield.

The principal spectra exhibited were those of platinum, silver, potassium, sodium, magnesium, and strontium. Some of the first authorities in spectrum analysis grew quite enthusiastic over the extraordinary brightness of several bands, and were able to detect many lines never before observed.

The Gramme machine has thus already contributed to extend the limits of science. What services it may yet render is a problem for the future. There are several physical questions that require to be investigated, and a few chemical controversies that need to be sifted and set at rest. Perhaps when the first excitement that is naturally caused by the introduction of a remarkable invention subsides, some attention may be paid to those subjects, and we should not be surprised to find the fallacy of certain hypotheses and the inaccuracy of certain numerical data clearly demonstrated. Nay more, we think that

Nature will not refuse to unfold some of her secrets to the new Davy who will best know how to use the great power placed at his command.

While on the one hand this apparatus affords new means of research, on the other it is itself a striking example of the conservation and correlation of forces, which it is the tendency of contemporary science to establish. The mechanical force that drives the coils is converted, under the eye of the observer, into a stream of electricity. Heat disappears in the boiler of the steam-engine, and Protean-like, reappears at the terminals as electricity, magnetism, light or heat. Here we have a strong argument for the dynamic theory, which would make four of the most important branches of general physics only different molecular modifications,—only different manifestations of the same cause.

Viewed from a utilitarian standpoint, we should say that the comparatively low price of this machine—about £400*—is a close approximation to the production of cheap electricity. Now-a-days, with our strikes and our unions, every one is more or less of a financier, and wants a full, often an ideal, equivalent for his outlay. This economical recommendation is then not one of the least cogent, and it only remains to be shown by actual work that this machine may be used with decided advantage in various departments of the arts. Its efficiency for a few of the most important electro-metallurgical purposes has been tested in the extensive and well-known works of M. Christofle, Paris. The tension of the apparatus used was equal to that of two ordinary Bunsen cells, and the quantity to thirty-two. The whole weighed 9 cwt., and a one horse-power sufficed to drive the coils at a rate of 300 revolutions per minute. At this speed, it was calculated to deposit at least 20 ounces of silver per hour. Two series of electro-plating experiments were made with a view to ascertaining the relative electrolysing effects of the Gramme and Wilde machines, and the result was decidedly in favour of the former. As this is a subject of interest to the general scientific reader, and of especial importance to the community at large, we shall give the details of the elaborate trials to which we refer.†

GRAMME MACHINE.

No.	Total deposit	Time		Surface of anode	Deposit per hour	Remarks
	oz.	h.	min.	sq. ft.	oz.	rev.
1	209·05	7	50	57·62	26·81	300
2	206·67	7	50	57·62	26·49	
3	209·02	7	50	57·62	26·81	

* This is the cost of the one which we have described. The demand will, of course, cause a great reduction in this figure.

† "Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences." Dec. 2, 1872.

Gramme Machine—*continued.*

	Total deposit oz.	Time h. min.	Surface of anode sq. ft.	Deposit per hour oz.	Remarks rev.
	214·09	7 50	57·62	27·44	
	69·30	2 50	38·41	24·74	300
	69·47	2 45	38·41	25·27	
	70·49	2 45	38·41	25·62	300
	54·50	2 35	28·81	21·10	
9	55·75	2 45	28·81	20·33	
10	53·90	2 40	28·81	20·23	

Wilde's Machine.

1	51·83	3 30	28·80	14·80	2,400
2	40·04	2 30	28·80	16·00	"
3	51·83	3 5	28·80	16·80	"
4	59·11	3 35	28·80	16·52	"

It may be worth noting that the minimum time in the first table is 2 h. 35 m., and the maximum in the second 3 h. 35 m. Now by referring to the fifth column, we see that the Gramme deposited 21·10 oz., and the Wilde 16·52. The last column shows in the one case a speed of 300 revolutions per minute, and in the other 2,400. The times are as 1 to 1·425, the velocities as 1 to 8, and the decomposed electrolytes as 1 to ·782. Remembering that the advantage is inversely as the time and velocity and directly as the deposits, we find in this particular case a resultant ratio of 11 to 1. By analysing the other data in a similar manner, we obtain a ratio of about 8 to 1 in favour of the Gramme.

But little attention has been as yet devoted to other electro-chemical problems, and we are not sure that such a trial would not lead to satisfactory results. We are glad to know that a large machine is now constructing by Messrs. Whieldon and Cooke, with which M. Werdermann intends to approach the subject. Among other things, he proposes, 1st, to purify iron by passing off the phosphorus and sulphur into the slag; 2ndly, to obtain aluminium from the double chloride of aluminium and sodium; 3rdly, to deposit copper directly on iron in the "dry way;" 4thly, to convert by a direct process chloride of sodium, or common salt, into caustic soda. If he succeed in his undertaking, as we sincerely hope he will, a considerable reduction must take place in the market price of some of our metals.

There is yet another department to which this invention may be usefully applied, viz. the illumination of lighthouses. The machines used for that purpose are those made in France by the Alliance Company, and in England by Professor Holmes. This beautiful piece of science and skill is, however, inferior in several respects to the Gramme. It takes up nearly four times as much room, produces but half the light for the same motive power, and for the same brilliancy of light is twice as expensive.* During the last two months the electric light has been exhibited from the Clock Tower, Westminster, in competition with Mr. Wigham's gaslight, the design of the Board of Works being to adopt that which will answer better as a signal light for the House of Commons. The machine is fitted up in the engine-room under the Peers' lobby, whence the conducting wires—·425 in. in diameter—leading from the terminals, are carried up to the lantern, a distance of 900 feet. Here the current is admitted into a Serrin's regulator, and the light is projected by one of Chance's holophotes in a beam of parallel rays. By a very ingenious contrivance, devised by Mr. Conrad W. Cooke—to whom the electrical arrangements on the Clock Tower have been entrusted—this pencil may be directed into any azimuth or angle of depression lying between certain fixed limits. This is effected by a horizontally-placed rotating-table, movable on a central pivot by means of a worm and worm-wheel. A second table is joined with the outward edge of the first, while the other may be raised or lowered by a vertical screw of considerable play. On this is adjusted a little trolley, on which two regulators are fixed, the whole being susceptible of a reciprocating movement, which is, moreover, so arranged that when one regulator is out of use, the other is brought into the focus of the holophote, and at the same time into connection with the machine. This latter is effected by providing each regulator with a pair of underlying metallic strips, which press upon a pair of copper studs in electrical communication with the polar terminals. The object of this arrangement is to prevent any sensible interruption in the light when, by their consumption, it becomes necessary to change the carbons. These are 8 in. long and ½ in. square; they last about four or five hours. At the end of that time, a slight rectilinear movement is imparted to the small rolling-table, and the second lamp comes into position. As this may be done very rapidly, the discontinuance in the light is scarcely perceptible.

On Monday night, May 26, we had, in company with several other gentlemen, an opportunity of judging of the intensity of this light. The coils of the machine were driven at a speed of 300 revolutions per minute, and the light emitted was estimated equal to that of 8,000 candles. The emergent rays formed a bright silvery beam, which reminded one, says a contemporary, of the lustrous appearance of Donati's comet when in perihelion. At Trafalgar Square, a black shadow of the pillar

* "Engineering." April 25, 1873.

was thrown upon the dome of the National Gallery. At the Duke of York's Steps, a very striking effect was produced by the sharp, well-defined shadows of trees and their foliage cast on the pedestal of the shaft and column. As we made no photometrical observations of the relative intensities of the gaslight and the electrical beam, we can merely record our impression, which to many may seem a rhetorical superfluity, that the latter was greatly superior to its fair rival in point of brilliancy. The one was dazzling and penetrating; the other, soft and comparatively feeble.

From the preceding pages, it must strike every one that the Gramme machine is unquestionably among the greatest inventions of our age. It would be premature to speculate as to what it may yet achieve, but the experiments detailed in this paper encourage the expectation of still greater results when its intrinsic merits becoming generally known and appreciated, will have secured it its fitting place in the practical applications of electricity.

MENTAL POWERS OF BIRDS.

By A. LEITH ADAMS, M.B., F.R.S.

THE mental faculties of birds are admitted to be greatly inferior to those of the higher quadrupeds, and such is the case no doubt; but, irrespective of their remarkable instincts, they display other mental qualities of no very mean order. These we shall now consider individually, along with their accompanying gestures and utterances, so that the reader may consider how far they allow of being associated with, for example, the instinctive impulses that prompt the bird to migrate, or other well-known phenomena in relation to their nests and habits.

In the first place certain mental powers in birds, as in higher animals, are improved by exercise, and many species and even individuals of the same species show a greater aptitude than others. Even instincts which are considered to be uninfluenced by teaching or example do often display variations expressive of both reason and judgment, whilst many acquired habits lapse after generations into instinctive actions. Fear is a good instance of an instinctive emotion which has been greatly strengthened by experience, and it is wonderful to observe the part man has played in increasing it in many birds. Let us compare the delineations on ancient Egyptian monuments, showing the fowler surprising flocks of water-birds among the tall papyrus swamps of the Delta, and dealing destruction among them by means of missiles made of small pieces of wood shaped like the letter S, and delivered with force and dexterity, with the practice now adopted, where, after all the caution possible, and aid of gunpowder, it is extremely difficult to get within even rifle range of such as the geese and ducks. But although these birds are much persecuted, there are others which contrast in this respect in a singular way with their brethren in other countries. The fearless habits of the kestrel of Egypt, as compared with its much oppressed brother in England, are notable. No one molests it, and in the days of the Pharaohs, as we learn from Herodotus, it was held sacred to the extent that whoever killed a hawk was put to death ;* so that it is possible the kestrel of the Lower Nile may have continued to enjoy a feeling of security up to the present day. The hooded crow is also very tame, as compared with its harassed brother in many other countries. The school-boy knows the effect produced by the report of his gun on many birds, and how other senses become sharpened in consequence; to wit, perception, as evinced by the crow and magpie perceiving the dreaded implement of destruction long before it can be brought to bear on them. Many birds acquire fear slowly; others are naturally timid. All gallinaceous birds are more or less fearless in their primordial states; and even partridges and grouse, only after weeks of constant persecution, acquire the alertness to enable them to be up and off before the sportsman gets within range. Even this lesson is forgotten during the close season. I was surprised both in the Himalayan and Canadian forests to find certain pheasants in the former and partridges in the latter quite fearless, more especially in secluded districts where they had not been molested by man. Indeed, so indifferent of danger were they, that beyond flying from the ground into the nearest branch, they seemed quite regardless of our presence. It was, moreover, a common practice with the first European settlers in many parts of America to knock the partridges off their perches by means of long wands. Then the only enemies of these birds were the sable and other martens, and the lynx, from which they escaped by simply flying into the nearest tree; however, as clearings were made, and the birds became more molested by man, they gradually took to longer flights, so that around the settlements it is somewhat difficult to shoot them. Birds that frequent mid-ocean islands, and have few enemies, are generally very tame. Such, however, as the grebes, guillemots, and awks, are low in the scale of ornithic intelligence; and probably on this account, and from its inability to fly, we might ascribe the extinction of the celebrated Northern Penguin or Great Awk, which may now be said to have disappeared, at all events from explored portions of the globe.

Again, the beautiful feathers of the monal pheasant of the Himalayas and American crested-jay have been long in request to decorate the heads of the ladies of Europe and North America; and, in consequence of constant persecution, both species have become so wild and wary, that in the case of the latter the denizens of the forest solitudes have inherited the timidity of their brethren of the settled districts. Here, no doubt, fear gradually attained has become a trait of character, seeing that

* "Euterpe," II. para. 65. The Ibis is also included; it is now extinct in Egypt.

in the instances quoted it is well known that both birds in their original state were the reverse of pusillanimous. Fear is depicted even in the nestlings of many much persecuted birds; but man also, when down-trodden for many generations, displays an inherited dread of the conqueror, as is well observed in the natives of the valley of Cashmere and other oriental races who have been long subjected to tyrannical governments. Fear of man has also changed the habits of many birds and beasts. Thus the geese on the Nile feed at night, and repair to the islands and sandbanks in the day, when they can easily observe the approach of the numerous fowlers who wage a constant warfare during the cold months; and the beaver now builds its lodge after dusk, whereas we read, in the accounts of the early settlers in North America, of the work having been executed during the day. But indeed we have only to observe the ploughman's companions in the furrowed-field, and the dread established by the presence of the gamekeeper, to become assured of the part played by man in developing fear in the lower animals.

As regards their natural enemies. The stoop and motions of the hawk are readily recognised, but the bird itself causes little or no pertrubation when brought close to any of the species on which it preys; whilst cats, weasels, and the like, incite marked dread. This may be explained by the circumstance that the former is only known to them on wing, whereas the feline animal is often seen prowling in search of them. The well known danger-signals produced by many birds when the hawk hovers near their haunts, and the subdued note that breaks the dead silence in the hedgerow the moment following the stoop of the sparrow-hawk, are familiar instances of fear and dread which the long-reclaimed poultry have not forgotten, although from inexperience they sometimes mistake the swoop of the harmless pigeon for that of a rapacious bird.

Violent dread, in fact terror, is displayed in many birds. This is evinced by the widely dilated eyelids, wild excited aspect, and loud, helpless screams of wounded eagles, parrots, and the like. Anger and sorrow are evinced by plaintive cries, and redoubled efforts to drive away the plunderer of the nest; indeed, instances of prolonged grief for the loss of a mate are recorded by several naturalists. Hatred is displayed by certain species towards their foes: for example, in the flocks of swallows chasing and tormenting hawks.

The perceptive faculty is seemingly demonstrated by the following:—A German piping bullfinch, taken from a cage containing other birds, showed no particular predilection for any of the numerous inmates of a family circle, until after being caressed and spoken to by a lady for a few weeks, when it singled her from all others by swelling out its feathers and chattering its bill whenever she came near the cage, whilst everyone else was greeted with evident signs of displeasure, as evinced by furious attacks, made with the desire to repel the intruder. On these occasions the mouth was open, and feathers adpressed, the little creature all the while digging at the wires and fluttering its wings in evident anger. The moment, however, its mistress's face appeared, all the symptoms of displeasure ceased, whilst the grotesque movements common to the wild bird during the love season took their place. These were evinced by the little creature swelling out its plumage, as, with tail awry, it fluttered from perch to perch, drawling forth the nature notes, or piping the acquired song, which consisted of a bar of "If ever I cease to love."

I tried various experiments by disguising the peculiarities of dress of its mistress, and introduced a number of female faces, but in every instance it recognised that of its benefactor. Now whether this lady had any resemblance to its original preceptor or not, the fact is that the bird showed considerable powers of perception and memory, for even the same face was at once known after a week's absence. The American Mocking-bird displays singular powers of distinguishing persons; I know an instance of one of these birds which invariably called to its owner whenever his voice was heard in the hall. I possessed a Carolina Mocking-bird, the natural call of which is so like the mew of a cat, that it is known by the name of Catbird. This individual, although reared from the nest, displayed an inordinate dislike for cats, whilst a bull-terrier never caused it any concern.

No doubt the higher animals dream, as shown by the tremulous startings and noises made by dogs when sound asleep; and birds would seem also to possess similar powers of imagination, as observed in caged individuals, which may often be observed to utter cries when the head is under the wing, and suddenly awake, as if the mental image had been the cause.

Such as the hooded crow and magpie do not break an egg to pieces, but make a small hole on the upper surface; and the same was noted by me in the case of the pine marten of India (*Martes flavigula*), which chips an opening just large enough to enable it to suck the contents. Now, in all these animals it is likely that the practice was first confined to individuals, and through example became general, and may now be instinctive; at all events it would indicate a glimmer of reason.

The excellence of bird architecture, and the efforts to conceal and place the nest in situations where enemies are not likely to rob it, furnish beautiful instances of instinctive intelligence; but surely there is also some dread of man or four-footed foes in the case of the weaver-bird of India (*Ploceus baya*). It is very social in habits, and builds in societies; but its very conspicuous and elaborately constructed purse-shaped nest would fall an easy prey to enemies did not the little architect, with surprising intelligence, place it in situations not easily accessible: hence several may be seen suspended from the tips of branches overhanging deep wells, or from the top branches of acacia and other thorny trees.

Many such examples might be furnished, indicating powers of reasoning. One of the most intelligent, at the same time finest songsters of North America, is the Brown Thrush (*Turdus rufus*). This bird is extremely pugnacious during the breeding season, and attacks all intruders on its haunts; even snakes are assailed; and should two males be engaged, they will suspend hostilities at once, and join in alliance against the common foe. Among other traits in an individual reared from the nest, was a habit of immersing dried crusts of bread in water so as to soften them; it also carefully removed the poison of wasps before swallowing them.*

A sense of the beautiful is surely present when the peacock displays his gorgeous attire before the hen, or when the chaffinch spreads out its wings in order to show off the rich colourings of his upper parts. The battling and rivalry among the males at the commencement of the breeding season, all show that the pairing of birds is not altogether futuitous. Sometimes it would appear that the female makes a choice; in other instances, that she is won by the stronger male driving away the weaker; and, perhaps in very many cases, the pairing is accidental; at all events it is the season when the passions and mental powers of birds are at their highest.

The facts, in relation to carrier-pigeons finding their homes after many months' absence, and swifts and swallows returning to the same nest for several years in succession, indicate, as will be noticed presently, that birds possess remarkable powers of memory and perception. But the mental powers of birds are extremely various, and even this is the case with species, individuals of which excel others in intelligence. There are individual nightingales, canaries, goldfinches, and thrushes, more easily tamed and taught than others, whilst in nature there are single instances of song-birds who excel their compeers in the richness and melody of their notes. Some male birds display their attractions more efficaciously before the female at wooing times; and in a flock of wild cranes, for example, there are, just as in a herd of ibexes, a few leaders who guide the flock and are the first to signal the approach of an enemy—all these

* "The Zoological Survey of the State of Massachusetts," p. 30.

super-excellent individuals being generally the largest and most richly attired males.

Curious instances of what might be called instinctive benevolence are displayed by the young of many sorts of birds. I have frequently noticed, when rearing individuals of the Migratory Thrush of North America, that when it so happened an unfledged bird was placed along with another just taught to feed itself, there was always a strong disposition on the part of the latter to become the foster parent; and so assiduous was it in feeding its younger relative, that I had to separate them,when the elder became quite disconsolate, and would hop from perch to perch for hours with a worm in its bill, its plumage ruffled, and evincing by plaintive calls that the separation was painful. Every "bird-nester" knows the parental affection of the chaffinch, and the desperate attempts of many birds to distract his attention when in the immediate proximity of the nest. The little ruby-throated humming-bird of Canada affords a good example of simulation. When captured, it feigns death by shutting its eyes and remaining quite motionless, then suddenly it will make a vigorous attempt to escape.

Social instincts are very strong in many sorts of birds, and there is much variety, some evincing remarkable affection for each other. There are several species of Bee-eaters—the little love-birds, and others—so fondly attached, that they huddle together on the same branch, and are utterly disconsolate when separated. Many birds, such as bullfinches and parrots, display in captivity remarkable sociability by demonstrations of satisfaction when a person enters the room, and cries of regret when left alone. Certain species of eagles and smaller birds pair for years in succession. Timidity among birds has nothing to do with size. Many of the largest show little courage, perhaps for the reason that they are rarely called on to exercise it. The rivalry of males at the breeding season, no doubt, develops bravery, which becomes established in the individual who proves himself the victor in battle, whilst even the vanquished learn to estimate its value. Among small birds few display greater courage when attacked than the Blue Titmouse, whilst warblers are generally very timid. Many gallinaceous birds are very combative, whilst water birds, except the Ruff and a few more, are, as a rule, rather pusillanimous.

The mental qualities of birds are progressive, as shown by the small amount of intelligence of the young bird. They soon, however, learn to avoid danger. Bird-catchers and Canadian trappers have informed me, that a bird which has escaped a lime twig, and the mink and sables who have chanced to get out of the trap, manage by certain means to make their misadventures known to others of their own species. This is done by some gesture or vocal expression. The cunning or intelligence of the fox has long passed into a proverb, not only applicable to the much persecuted animal of Europe, but also the unmolested species of foreign countries. Thus the red fox of the wilderness tracts of North America is just as wild and wary as its English compeer; so much so, that trappers find it useless to try and capture them alive, and therefore resort to poison.

The power of imitation, although strong in birds, is confined altogether to the voice. Every observer who has paid attention to their songs and call-notes will readily allow that they are great copyists. The piping bullfinch before referred to, when moulting, and during a serious illness, never attempted the acquired notes, nor even its native song; but afterwards, whilst the latter seemed to return without any effort, the former required days to become perfected; and after the sick attack it could not manage the two last lingering notes exactly, and used to constantly repeat inaccurate imitations, until I whistled them, when he followed my cue and seemed quite relieved that he had got into the right tune again, repeating it upwards of a score of times in rapid succession. Many of our common birds imitate call-notes of certain species, but of all others the thrush family present, in the Mocking-birds, the most perfect imitators. But although parrots are easily taught in captivity, they are not by any means given to copy the call-notes of other birds in their native woods.

The voice of birds is the nearest approach to language, and although decidedly instinctive, it is developed more or less by imitation. Indeed, although the young bird's essays are imperfect at first, and greatly assisted by hearing its own species, still a bullfinch or canary reared from the nest, and kept apart from its own kind, will sing just as perfectly as if it had been brought up in the society of its parents. It may be a question, however, if this hereditary instinct would maintain its exact character through many generations of canaries treated in the above way. No doubt birds sing from pleasure, sometimes to charm the female; at others, as in the case of the redbreast in autumn, chiefly in emulation of a rival, as may be observed when he stops to listen for the response, and then breaks forth afresh, as if he challenged all the robins within hail to equal his strains. Many birds utter certain low warbling measures to their mates, accompanied by love antics and gestures clearly indicating pleasurable excitement. Even the dirty town sparrow makes known his attachment by vocal sounds and grotesque movements. No doubt the female often looks on with indifference on such occasions, and among a flock of linnets it would seem that it is the more rosy breasted males that are the gallants in spring ; at all events they are the most assiduous in their love gambols and songs, as compared with the less brilliantly attired members. This I have repeatedly observed in other birds which get additional colourings at the breeding season, such as the redpole, American goldfinch, and the delicately coloured trumpeter bullfinch of Egypt.

The companion calls of a flock of geese on wing, and the hen calling her chicks ; the intercommunication by means of certain notes of a flock of finches in a forest, prior to departure, has seemingly a linguistic character. The beautiful pine bullfinch (*Tyrrhula enucleator*), found in northern regions of Europe and America, retires from the arctic circle in winter to less rigorous climates. Flocks of this bird may be seen in the Canadian forests in early spring feeding on fir-cones, when the rosy-coloured males commence a series of call-notes, which are taken up by the sombre-coloured females and young birds of the year (the species breeds in very early spring, long before the snow has disappeared). These whistlings increase until the trees seem alive with bullfinches ; when suddenly, as if by some preconcerted signal, the entire flock of several hundred birds fly off in a body. The quail, when about to migrate, repairs to dense covers, often of vetch, where the flock keeps up a sort of companion whispering very curious to listen to. This, as in the last case, is varied both in tone and intensity all over the field, from bird to bird, when, from these indications or others, they depart simultaneously.

The instinctive desire which comes over the bird at the migratory seasons, and compels it to depart, although apparently a blind impulse, and not influenced by judgment or reason, is assuredly awakened by many causes more or less adverse to the well-being of the species. Take, for example, such gregarious birds as swallows. The parental duties over, the gradual or sudden transition of temperature and consequent failure of insect life necessitate a change in the mode of obtaining subsistence. The insects that were wont to ascend to high elevations have now disappeared, and what remain are confined to lower levels. Hence the crowding together and ground skimming of old and young birds, until the supplies rapidly disappear and the weather gets colder, when they depart in a body before the north winds or in the face of the balmy southern breezes which indicate the route to Africa. It has been often observed that many migratory birds have been driven, through the instinctive impulse, to abandon their second broods and leave them to perish miserably. This is the case with swallows; and I noticed during two seasons in Canada the same in connection with the Carolina Waxwing, which arrives in the eastern provinces in June and departs abruptly in August ; but the pressure of circumstances, to wit, sudden change of temperature and failure of subsistence, compel them to sacrifice their offspring for their own own safety.

A remarkable circumstance in connection with birds' migrations is the regularity of their comings and goings. These are well estimated on the shores and islands of the Mediterranean at the spring and autumn equinoxes, when the vast hosts of birds of passage are on the move to and from their winter retreats in Northern Africa. Then one can almost calculate on the certainty of the arrival of many species which make either a lengthy sojourn, or only wait for a few hours to rest themselves. Some never halt, and are seen steering their courses at high elevations, evidently aware that the intermediate lands, beyond a mere resting-place, are not those they are seeking. Some birds recognise persons and objects after a length of time; indeed, the same individuals have been known to return to their nests year after year, as in the case of the swifts marked by Dr. Jenner.* Such instances are all the more remarkable that they occur in a bird in no way superexcellent in other mental acquirements, and of its tribe goes furthest into the interior of Africa during the winter months. The swifts, however, besides their almost unexampled powers of wing,† have a greater range of vision; so that, supposing the English home is readily discernible by certain physical characters, such as a particular mountain range, and the distance between it and the winter retreat is travelled over in a few hours, without a stoppage on the way, all that the bird has to treasure in memory is the general feature of the district it has left. This, however, has to be retained for nearly eight months, through daily-changing fortunes; and even when the landmark is re-discovered, still another mental effort is required before it finds out the nest of the previous year. No doubt winds and temperature, in connection with coast lines, &c., assist migrating birds in finding their way to and from their summer and winter retreats, and very likely certain mental powers are acquired and improved thereby; but the crediting of such an effort as the above to instinct alone is apparently incomprehensible. The desire to change residence, and the direction of the route, are indicated by seemingly natural causes, and there may be an instinctive disposition in every migratory bird to pursue a definite extent of journey; but in the face of wind and weather on the one hand, and the

* See Yarrell's "British Birds," vol. II. p. 234.

† Spallanzani estimated the rapidity of the swift at about 276 miles an hour, or three times greater than the swallow. Thus, according to his calculation, the former would traverse the distance between Great Britain and its winter haunts in 20° lat. in less than seven hours.

length of absence, it is scarcely credible, unless by the merest chance, that the same bird can hit off the exact haunt of the previous year. The swallows that resort regularly to the same nest, or even the thrush that builds always in the same fork, or the sparrow in the hole on the housetop, are not necessarily the exact tenants of the previous year. Each species gives a preference to one sort of situation over another, and the fact of seeing an unoccupied nest is, with many birds, an inducement to appropriate it; although, no doubt, among the indigenous avi fauna of every country there are generations upon generations of rooks and sparrows, for example, that build in the same tree. Now, notwithstanding the fact that mated birds soon forget one another, there is no reason why they should not possess, as in certain higher animals, a greater capacity of memory for places.

In conclusion, it is apparent from the foregoing that birds display emotions of a varied character by well-marked vocal utterances and gestures, and that although these and other mental qualities are to a great extent instinctive, there are at the same time clear indications of reason in many instances. We may believe, therefore, that although the intellectual powers of birds are generally much inferior to quadrupeds, they show the progressive development of their class, as do their organism; and as the corporeal structure is suited for the welfare of the species, so the instincts and other mental qualities are developed and modified.

REVIEWS.

THE ATMOSPHERE.*

IT is with a good deal of pleasure we observe that of the many scientific works addressed to the general population which are being published in this country, a considerable number are brought out under the superintendence and editorship of men whose knowledge of the subject on which the work treats cannot for a moment be questioned. And this is essentially requisite, for most assuredly it is better to have no knowledge of science whatever than such an one as is attainable by the readers of not a few of the works which are issued even in this country. And if we may lay down this a rule in regard to English writings, how much truer is it of those admirably got up volumes which make their appearance on the other side of the Straits of Dover. And by this—which may appear to some less experienced in the matter as a somewhat sweeping assertion—we mean to exclude those issued by German writers, which are particularly excellent and advanced. But assuredly there has very rarely been issued by any publishing firm a more excellent work in point of authorship, or a more admirable one in regard to the physical details of publication than the present one of M. Flammarion, which bears Mr. Glaisher's name upon its title page. And curiously enough this could not be said of the edition from which the book is produced. It required the combined qualities of editor, translator, and author, to bring the work to its present high standard of excellence. The reason of this may appear so obscure without explanation, that a few words are necessary in justification of what we have said. In the first place, as the editor very properly observes in the preface to the volume, many French works—and the present one is by no means an exception to the general rule—exhibit a tendency "to 'fine' writing, which ill accords with the precision and accuracy that ought to be a characteristic of scientific information, even when expressed in language free from technicalities. There is a good deal of this exalted kind of composition in M. Flammarion's book which—even in the French, not very agreeable to an English reader—becomes, when translated, intolerable. I have therefore

* "The Atmosphere." Translated from the French of Camille Flammarion by C. B. Pitman, and edited by James Glaisher, F.R.S., Superintendent of the Magnetical Department of the Royal Observatory at Greenwich. London: Sampson Low, and Co. 1873.

omitted these rhapsodies very freely, though traces enough of them will be found here and there to betray the French origin of the work." But even with this admission we should be doing Mr. Glaisher injustice did we not point out how successfully he has performed his editorial duties. Unfortunately it has not only occurred in the style of M. Flammarion that many of his phrases demanded an alteration, but it is also of considerable account in the matter with which he has furnished his readers. This, it must be confessed, is but too frequently erroneous. And here the path of a learned and judicious editor was a difficult one, for he has had frequently to deny point blank the statements of his author. We must give Mr. Glaisher credit for unhesitatingly performing his duty when called upon to rectify the errors of M. Flammarion, and we must regret that his pen has been called upon so often. It occurs to us that it is possible that this might have been avoided, as good taste would surely suggest, but not knowing the circumstances of the case we are bound to assume that Mr. Glaisher was left no other course than that of openly pointing out the errors into which M. Flammarion has been led. But assuredly it would have better pleased the requirements of the general reader, and we should fancy the *amour propre* of the French *savant* would also have been gratified by the adoption of a different course—such, for example, as the substitution of the correct for the inaccurate passages.

The editor has, we imagine, done wisely in materially curtailing the present work, for we imagine that a book of more than 800 pages would have been less acceptable to the English public, and we are also struck with the truth of his observation that the respiration and alimentation of plants are subjects which, though indirectly connected with the subject of the atmosphere, are really but incompletely united to the other questions dealt with by the author. The work is divided into six books, which all treat upon allied but different subjects, as they sufficiently show—thus the first has to do with our planet and its vital fluid, the second describes light and the optical phenomena of the air, the third is upon temperature, the fourth on the wind, the fifth upon water-clouds and air, and the sixth and last treats upon electricity, lightning, and thunderstorms. In this way we find all the subjects either directly or indirectly connected with the atmosphere fully and fairly dealt with. And perhaps, to many readers, as interesting a portion of the work as any other is that included in the end of the fifth chapter, and entitled "Prodigies: Showers of blood, of earth, of sulphur, of plants, of frogs, of fish, and finally of various kinds of animals."

Criticism of a severe kind is entirely disarmed by the character of the work, which is peculiarly elementary, and, by the reputation of its editor, as eminently philosophic. We may, then, simply commend the volume to our readers' notice, with the very highest commendations of its merit as a popular and withal accurate account of the various subjects connected with the atmosphere. The translator has effected his part of the duty with care and discretion. There are, to be sure, some passages which we fancy might be rendered in language less idiomatically French; but then, on the whole, the labour has been achieved satisfactorily and well. It but remains to say a word for the publishers, and this must be praiseworthy. In our long experience of the scientific publishing world we have rarely seen a work produced which could rival the present one in paper, binding, typography, or illustration. Some of the coloured illustrations are marvellous in point of execution.

ANIMAL MECHANICS.*

IF there is one Fellow in the University of Dublin who has assuredly a most wonderfully-developed brain, that Fellow is the Rev. Samuel Haughton, F.R.S., the author of the remarkable work which now lies before us. Few who are not intimately familiar with the list of working *savants* in these countries are familiar with his name; but those who are acquainted even slightly, no matter in what branch of science, with the workers, can have failed to mark out this man. As the joint-author of Galbraith and Haughton's well-known manuals of physical science, he has been known for many years. Again, as a most distinguished geologist and palæontologist, he is familiar enough to the great body of stone-men. As a clergyman he is known to many; and, lastly, as a physician and physiologist he has made an almost unsurpassed reputation within the past ten years. Assuredly one will say that the tales of "Admirable Crichton" are not far-fetched when the nineteenth century can produce a man who possesses nearly unsurpassed repute as a physicist and geologist, as a divine, a physician, and a physiologist.

The book which Dr. Haughton has now presented to the scientific world is essentially a new one, for the subject of it is a branch of anatomical and physiological science entirely novel, and one, too, which the author has almost peculiarly carried out. It is upon animal mechanism, or, in other words, it deals as a purely scientific physicist might with the question of the mechanical powers which various points of the animal economy present. Such, for example, as the question whether such and such a muscle is the best that can be adapted to do the work which it is expected to perform. And in working out these questions he has displayed the most profound patience, and has arrived at the most striking results. In fact, he has shown us the way to a new field of research, which will not long be untrampled by observers. The only difficulty is the fact that the man who follows out the study must unite to his merely anatomical and physiological knowledge an acquaintance with at least the simpler forms of mathematics. Such an union Professor Haughton possesses, and hence he has given us the capitally novel and interesting work now before us.

We differ from Dr. Haughton in regard to his views on the question of evolution, though we fancy his opinions more nearly approach some of Darwin's doctrines now than they did twelve years ago; but that need not affect us at all in our consideration of this admirable volume. For, no matter whether the muscles arrived at the excellence he proves them to possess by a gradual process, or were first so formed, it is, nevertheless, interesting

---

* "Principles of Animal Mechanics." By the Rev. Samuel Haughton, F.R.S., Fellow of Trinity College, Dublin, M.D. Dublin, D.C.L. Oxon. London: Longmans, 1873.

to peruse his account of the various ingenious and complex plans which he has adopted in order to make the research. Of the many questions discussed in the volume under consideration, not the least interesting is the chapter devoted to the subject of hanging as a mode of killing. In this portion of his book Dr. Haughton gives a number of calculations as to mechanical work done in the dropping of the sufferer, and he shows very clearly, from an investigation of the mode of hanging adopted in this country and on the American continent, that the latter mode has many advantages over the former. The writer of this notice of Dr. Haughton's book is particularly interested in one case of hanging mentioned by the author, as he was himself present at the operation, and he can fully substantiate the writer's remarks. All through, the book deals with the questions of mechanics, applied to the operations of nearly all purposes of the animal kingdom; and as the author has made all the calculations, all the dissections, and all the weighings with his own hands, with every precaution of which he could think, we may fairly suppose that the work is one whose importance, as the first essay in a study which must eventually assume considerable value, cannot be very much overrated. At all events, for ourselves we may say that we close the most pleasantly-written book we have met for some time with a hope that the author may again come before us ere long with another volume of his instructive and valuable essays.

HUMBOLDT'S LIFE.*

ASSUREDLY a life of Humboldt was required. Though many and many a biography has been issued by the press, we quite agree with the distinguished editor that all those sketches hitherto issued were in reality the merest outlines of this great man's life, and not a few were merely those collections of facts which anyone who was conversant with the scientific world of the first half of the present century could quite readily have put together. But the present history is, so far as it has been possible to make it, a perfect sketch, not only of Humboldt as a *savant*, but in his ordinary character as a man. However, this is but true to some extent of the English edition, which the translators inform us in their preface is but a portion of the work, it having been "deemed advisable to omit the third volume, devoted to a critical investigation of Humboldt's scientific labours," and also "the last section of the second volume, consisting of an elaborate catalogue of his voluminous works." The Misses Lassell think that these omissions have been wise, for that the book will thereby be enabled to appeal to a wider, if less educated, class. For ourselves, we must, at the outset, express our most decided difference of opinion. It seems to us that a life which has been sketched out so fully and so well by

* "Life of Alexander von Humboldt," compiled in commemoration of the centenary of his birth, by J. Löwenberg, R. Avé-Lallemant, and Alfred Dove. Edited by Prof. Karl Bruhns, Director of the Observatory at Leipzig; in 2 vols., translated from the German by Jane and Caroline Lassell. London: Longmans, 1873.

different scientific men, and which is almost certain to constitute the work which must for ages be regarded as the most exhaustive biography of a man whose life, save as a *savant,* is really worthless, is, to some extent, uncompleted in its English edition. For we believe that though a great many may be glad to know something of so eminent a philosopher, yet very few will devote themselves to the perusal of these two large volumes, save those who are either working at, or interested in, science, and to these readers no part of the volume could have been less wisely omitted than the portion which pre-eminently gives the subject of the Biography everything that so clearly distinguishes him from his fellows.

But on no other score can we raise objection to the labours of the English translators, who have discharged their task with an ability of no common order, and a keen discrimination between the duties of translating and of rendering into English. The first volume is from the pen of Herr J. Löwenberg, and deals with the earlier history of Von Humboldt. It treats of him from his birth at Berlin, through his childhood, to his experience of college life and his first attempt at an official existence and diplomatic service. Then comes the death of his mother, a sketch of the state of society in Weimar and Jena, and a tolerably long account of his connection with Goethe and of their disagreement, and of Goethe's subsequent recantations of his earlier opinions. In the next chapter we are supplied with long accounts of his travels in Asia and America, which are decidedly of interest. Here, also, we have a sketch of his landing at Teneriffe, a point at which he made those remarkable observations as to the close relation between latitude and height as to animals and vegetables. Next we are treated to his account of his wonderful journeys to the Orinoco, Cuba, and Quito, in the last of which occurs the expression of opinion as to the impressiveness of mountain scenery. It is in this chapter that Von Humboldt so vividly expresses his opinion of the effect produced upon him by Chimborazo, which he describes as the most interesting mountain in the world, and, to him at least, the most impressive from the colossal character and striking nature of its outlines. Having described his adventures in Quito, the writer then passes on to his stay at Mexico, and his explorations into the Carib and Inca languages. In this part of his journey Baron Humboldt likewise makes some valuable observations on the subject of guano as a manure; then he travels on to the United States, and stays some time with Jefferson at Washington, visits certain other of the States, and eventually returns home, after an absence of no less than six years. Some time after this comes the fall of Prussia, for which he consoles himself by the severe study of Nature, and after a time he studies Asiatic languages, preparatory to a journey eastwards, which he eventually undertakes. He intends pursuing his investigations in Asia, but other engagements prevent him, and so, having travelled to Moscow and St. Petersburg and journeyed through the Ural Mountains, he once again returns home to receive the honours he had so fully and thoroughly earned. And it must not be supposed that all these undertakings took but a short space of time: contrary to this they—while here only partially stated and in the merest outline—occupied the best portion of his working life. On his return from the Ural

Mountains he had already arrived at his sixty-first year. And though, of course, this was comparatively young for a man who reached his ninetieth summer, still it may be regarded as the terminus of Humboldt's travelling career.

The second volume of this very interesting work may be divided into two portions, each of which is written by a distinct author, the first three chapters being the composition of Robert Avé-Lallemant, and the last four being under the authorship of Alfred Dove. This portion of the English translation is by far the more interesting of the two volumes, especially the last couple of chapters. Of it we can give merely an outline of the contents, having, to use a technicality, "exceeded our space" already. The first part of the present volume, then, has to do with the publication of the results of his American expedition. This was an exhaustive work, and one which, as the reader will perceive, cost a vast sum of money. It extended to about twenty folio and ten quarto volumes, and the price of the entire set on America alone amounted to the enormous sum of more than 400*l.* Here is given also an account of the mode in which a large number of his books were destroyed. In Humboldt's words, "the whole stock of the German edition of my astronomical observations was thrown into the sea by order of the trade, in order to escape the duty on the books." In a note headed Potsdam, 4th December, 1850, he adds, in relation to this, "a memento of the barbarism of booksellers." Subsequently, in the other chapters, are detailed a list of Humboldt's friends at Paris, who were certainly numerous enough, and some of whom are still living and working at science, and a sketch of his characteristic traits, and personal incidents, which is very interesting. These end this part of the volume. Next in order comes Herr Dove's account, which deals with Humboldt's residence at Berlin till the Revolution of July, from this date to the death of Frederick William III., then from the accession of Frederick William IV. to the Revolution of 1848, and finally with the last ten years of the philosopher's career. This last portion of his life is not considered interesting by the writer (Herr Dove), but in our opinion it is not unlikely to be deemed of some importance by the general reader, especially as Herr Dove has written in a perfectly impartial spirit, giving praise and censure when he thought each was merited. In this part of the book more than in any other we see the author's real character displayed. And we must say we are greatly disappointed with it. For we should not have expected to meet with so much vanity, poverty of spirit, and little-mindedness in one who had at least the opportunity so rarely given to men of being placed above the small things of this world. So that we fancy the reader will be almost more pleased with Herr Dove's sketch of Humboldt's "appearance and reality," and "his position at home and before the world," than with any other portion of the volume. And this closes the sketch of his life in this the English edition, and completes a book which, with certain disadvantages that we have already alluded to, must be regarded—with the three excellent portraits which accompany it—as infinitely the best work which has appeared in this country upon the life and doings of Humboldt, a man who, however great he may seem, will not be remembered a few centuries hence.

HELMHOLTZ'S SCIENTIFIC LECTURES.*

DR. TYNDALL certainly did not err in advising the Messrs. Longmans to publish the work which is now before us. For though it is but a portion, and that a very small one, of the subject of Natural Philosophy, still it is so charmingly written, and has been translated with so much ability by Dr. Atkinson, that we doubt not it will receive a considerable share of attention from educated Englishmen. Of the lectures now translated, two have appeared in an English print already, that on the "Physiological causes of Harmony in Music," translated by A. J. Ellis, M.A., F.R.S., and on the "Interaction of the Natural Forces," translated by Professor Tyndall, F.R.S. The others are entirely new to the English public, and are some of them of the highest interest. Of these we may especially mention two—that on "Ice and Glaciers," translated by the Editor, and that on "The Recent Progress of the Theory of Vision," which is rendered into English by Dr. Pye-Smith, B.A., F.R.C.P. These are unquestionably the most interesting papers in the work, and if we were to say which of the two is the most instructive with reference to novelty of facts and record of work done by the older writers, we should select Dr. Pye-Smith's. But both are full of interest, and they are also amply illustrated, and with the other able essays they form a volume most creditable to the author, who, a profound physicist and physiologist, has descended to the popular level, with the most winning style, and with the most happy results.

ON FOODS.†

IT is certain that much as has been written on the subject of food there is still a great deal of ignorance, even among medical men who are placed in the position of *medical* officers of Health, as to the relative value of certain varieties. Knowing this to be the case we hope to see this want of knowledge removed by a reference to the volume now before us. For whatever we may think of certain of Dr. Smith's theories there cannot be a doubt that in the volume which he has just written there is put together, both from original experience and from very careful compilation, an amount of information, which is very large, regarding the relative value of the several different forms of food—including air and water—which are used by man not only in the civilized but in the uncivilized parts of the world. In regard to the several subjects treated upon of course it is not to be expected that we shall touch. We may, however, notice one or two points which strike us as of interest. In regard to Liebig's extract of meat, the author maintains his former view, and expresses a very decided opinion

---

* "Popular Lectures on Scientific Subjects," by H. Helmholtz, Professor of Physics in the University of Berlin. Translated by E. Atkinson, Ph.D., F.C.S., Professor of Experimental Science, Staff. College, with an Introduction by Professor Tyndall. London: Longmans, 1873.

† "Foods," by Edward Smith, M.D., F.R.S., Inspector for Poor Law purposes of the Local Government Board. H. King and Co., London, 1873.

against its use. For example, he says, "it should be classed with such nervous stimulants as tea and coffee, which supply little or no nutriment, yet modify assimilation and nutrition. Used alone for beef-tea it is a delusion." We are sorry the author's prejudice should have carried him so far as this. To compare Liebig's extract simply with tea or coffee is manifestly and painfully absurd. Fortunately the English people have got sufficient experience of this form of food to enable them to set aside the opinion thus expressed. We ourselves know, from a considerable experience of invalids, that the Liebig beef-tea is an invaluable restorative, and we have seen cases in which strength and weight have been recovered almost exclusively by its use. And we are equally certain that either tea or coffee would in such cases have been almost equivalent to rank poison. In some other parts of his work, too, we find points on which we differ from the author; still we cannot but thank him for the book, for it is a most valuable one, and one which we doubt not will, as it merits, command a very large circulation.

STONE IMPLEMENTS.*

OWING to some mistake on the part of the publishers, this splendid work only reached us a few days ago, although it seems to have been published nearly a twelvemonth since. This must be an excuse for so short a notice of a work which otherwise should have had a long review. It is without a doubt the most complete book of its kind which any language possesses, and its illustrations are most numerous. Further, it must be said that these are excellently done, the blocks having been most carefully cut by Mr. Swain, of Bouverie Street, and in number they almost reach to five hundred. The book, too, is a large 8vo, of over 600 pp., and it is printed in two distinct types, the more generally readable matter being set up in the larger print. In this way ample provision is made for both the professional and the general student of the volume. Mr. Evans is regarded—and very fairly so—as the first authority in the world on the subject of flint weapons. It is well, therefore, that we have an opportunity of deciding by his expressed opinions the many questions which arise as to flint weapons. For we know that of many collections, unquestionably a certain portion are merely accidental fractures of flint, and were never used by man. But this splendid work will put all these difficulties to an end. It is, without the least doubt, the first and most important treatise on this subject.

A COMPANION TO THE COMMON TELESCOPE.†

THIS Companion of Mr. Webb is now so well-known that it is only necessary to say that a third edition has appeared to make the student

* "The Ancient Stone Implements, Weapons, and Ornaments of Great Britain." By John Evans, F.R.S. London: Longmans. 1872.

† "Celestial Objects for Common Telescopes." By the Rev. T. W. Webb, M.A., F.R.A.S., Vicar of Hardwick, Hereford. Third edition, revised and enlarged. London: Longmans. 1873.

purchase it. Unquestionably it is an excellent little volume, much increased in size, and with a vast deal of new matter which is of the utmost importance. The author addresses it to the beginner, but we know that though it is unquestionably a book which is of the most infinite service to the unlearned observer, and which is specially written to supply his wants, very many experienced observers have it constantly on the table of the observatory as an invaluable companion. The present edition has its lunar map greatly improved, thanks to Mr. Birt's kindness; its contents are enriched by the addition of 70 fresh sidereal objects, and the declinations now added to the Right Ascension Index will make it *tout entier* a most valuable companion. In Appendix I. the author has supplied, in condensed form, much information as to the most recent researches in Venus, giving a cut representing Bianchini's diagram of the spots. Altogether the book is made most useful both to astronomers and amateur telescopists.

WASHINGTON OBSERVATIONS FOR 1870.*

APPENDIX I. of these important observations contains Prof. Harkness's "Report of the Difference of Longitude between Washington and St. Louis." The observations described in the Report were initiated by the United States Coast Survey, and the Observatory took part in them at the request of that institution, with the understanding that the observations at St. Louis should be made by Coast Survey officers, and those at Washington by Observatory officers; and that at the conclusion of the campaign complete copies of the observations and reductions should be exchanged. The electro-magnetic apparatus employed at Washington was entirely automatic; that employed at St. Louis was the ordinary Morse receiving magnet, sounder, and key, together with a break-circuit key. The difference of longitude finally deduced is thus expressed by Prof. Harkness (we invite special notice to the wording of the result):—"The Observing-station at St. Louis, in the Washington University grounds, on St. Charles Street, between Seventeenth and Eighteenth Streets, is west of the centre of the Dome of the United States Observatory at Washington,

0h. 52 m. 36·90 s. $\pm$ 0.026 s."

Appendix II. relates to the observations of Encke's Comet, during its return in 1871, by Professors Hall and Harkness. These observations and their analysis are characterised by the care and abundance of labour usually found in American work of the kind. The results arrived at are thus summed up by Prof. Harkness:—"(1) Encke's Comet gives a carbon-spectrum; (2) from November 18 to December 2 the wave-length of the brightest part of the second band of the comet's spectrum was continually increasing; (3) no polarisation was detected in the light of the comet; (4) the mass of Encke's comet is certainly not less than that of an asteroid; (5) the density of the supposed resisting medium in space, as computed from

---

* "Reports of the Washington Observations for 1870:" Washington Government Printing Office, 1872.

the observed retardation of Encke's Comet, is such that it would support a column of mercury somewhere between $\frac{220}{1017}$ and $\frac{285}{1020}$ of an inch high; (6) there is some probability that the electric currents which give rise to auroras are propagated in a medium which pervades all space, and that the spectrum of the aurora is in reality the spectrum of that medium; (7) it is not improbable that the tails of all *large* comets will be found to give spectra similar to that of the aurora, although additional lines may be present." It will be seen from this that the discussions in the body of the paper are of great interest.

MEMOIR OF THE FOUNDING AND PROGRESS OF THE UNITED STATES NAVAL OBSERVATORY.*

THIS is an exceedingly interesting account of the events which have happened since 1810, when proposals were first made for a Government observatory in the United States, to 1842, when the Washington Observatory was founded, and thence to the present time, with a general description of the instruments in use, &c. In concluding this memoir, its author, Prof. Nourse, remarks with great justice, that the position now accorded to the U. S. Naval Observatory, "by the free tributes of scientific men in the Old World, as well as at home, is not without honour to America, and this notwithstanding the comparatively recent founding of the institution, and the as yet limited appropriations sustaining it." We regret, however, to see that the somewhat excessive respect with which Americans are too apt to treat European science (to which American science is certainly not inferior), has led Prof. Nourse into the mistake of quoting measures which had been *proposed* within the Astronomical Society when his paper was written, but have since been rejected with something resembling contempt by an all but unanimous vote of the Council of that body.

PAPERS ON THE TRANSIT OF VENUS IN 1874.†

THESE papers contain the discussion of the circumstances of the approaching transit, by Professors Newcomb, Coffin, and others. The results are indicated in our summary of Astronomy. Very beautiful and exact charts illustrate Part II.

PHYSICAL SCIENCE.‡

WE have before us two books, the one on electricity and magnetism, the other on general natural philosophy, which are as different in point of value as it is possible to conceive. That by Prof. F. Jenkin is, without

---

* "Washington Observations for 1871, Appendix IV.:" Washington Government Printing Office, 1873.

† Washington Government Printing Office, 1872.

‡ "Electricity and Magnetism," by Fleeming Jenkin, F.R.S., Prof. of Engineering in the University of Edinburgh. London: Longmans, 1873.

the least doubt, the first of its kind, and splendidly done. The author has been at pains to produce a work which will be really a compound not before brought out, and he has, in our opinion, succeeded thoroughly. He has attempted to produce a work which will not only make the student familiar with the abstract science, but with the everyday application of it. This a reader of the former works for students could not obtain, and he found that when he came to read a book like that of Culley, he was unable to understand it. By the assistance of this excellent manual he can now grasp both the science of the professor's lecture-room and that of the practical worker of the telegraph.

Mr. G. F. Rodwell's little book * is a very poor effort to teach students Natural Philosophy. In about 150 pages of duodecimo size the author deals with Statics, Dynamics, Hydraulics, Hydrostatics, Pneumatics, Light, Heat, Magnetism, and Electricity. If these are the lectures delivered at Guy's Hospital, we recommend the author to enlarge them very considerably for the future.

GOSPEL HISTORY.†

ASSUREDLY those who have doubts as to the foundation of many parts of the *Christian Religion* should obtain this remarkably clever book and study it. It is by the author of a work of great importance, and, like its predecessor, it displays a knowledge of Biblical events and Church history which seems quite marvellous. This is not the place, to be sure, in which we could review this volume; but we commend it to the serious consideration of educated people. They will find it a calm and learned disquisition on the subject of Gospel History, and of the period at which the New Testament was first printed.

A GOSSIP ABOUT SCIENCE.‡

THESE essays will appeal to those who have read the author's former series. They are both terse and pleasant in point of style, and interesting in their scientific aspect, while at the same time they are perfectly intelligible to any person of ordinary education. Among several papers of interest in the present volume, two are worthy of special merit; the one is a sketch of the life of Mary Somerville, and the other is upon the coming transit of Venus. The latter is an important paper, and in it Mr. Proctor makes an appeal to the Government to be more generous in

---

* "Notes of a Course of Nineteen Lectures on Natural Philosophy, delivered at Guy's Hospital, 1872–1873," by G. Rodwell, F.R.A.S. London: Churchill, 1873.

† "The Gospel History and Doctrinal Teaching, critically examined," by the author of "Mankind, their Origin and Destiny." London: Longmans, 1873.

‡ "Light Science for Leisure Hours," 2nd series, by R. A. Proctor, B.A., Hon. Sec. R.A.S. London: Longmans, 1873.

their provision for its observance. He shows fully how liberally the American Government and even the Russian have dealt in the matter, and he urges upon our own *Liberal* Government to give more money, so as to fit out more observers for the Southern posts. He also asks that the Government expedition to Rodriguez should be given up, and the money which would be expended on it devoted to an expedition to Possession Island. At all events, Mr. Proctor must be gratified that he has induced the Astronomer Royal to urge the appointment of a station in the north of India. We hope he may experience further conversions of the Government to his views. At all events, his book is calculated to bring about that end.

THE LAST GLACIAL EPOCH.*

WE fancy that the author has gone astray in his search after knowledge. He thinks he has found a satisfactory clue to the cause of the glacial epoch, and he endeavours to prove its truth. We certainly are not satisfied with his reasoning. Nevertheless, some of our readers may be, and as we have not anything like the requisite space to put the author's arguments forward, we shall merely content ourselves with the expression of opinion that his view is an unnatural one. Still, we recommend those of our readers interested in the matter to read Col. Drayson's book.

SANITARY MATTERS DURING THE AMERICAN WAR.†

A CURIOUS book, full of interesting and harrowing details, showing us how much misery was suffered during that fearful war in the United States, and how far the Sanitary Commission extended its researches, and how many people were often restored to life by its agency alone. It is a most readable book, and shows us better than anything we have yet seen even in the records of the Franco-Prussian war, the trials and difficulties which always accompany a vast campaign. It testifies fully to the infinite advantages of having women to attend to the sufferers who are brought in from the battle-field. It is a large book, excellently printed, and containing a quantity of very important matter.

SHORT NOTICES.

Chronos's Mother Earth's Biography, by Wallace Wood, M.D.: London, Trübner, 1873. This is a book which must have sprung from an intense amount of self-conceit. It is, we think, absolutely aimless, and intensely

* "On the Cause, Date, and Duration of the last Glacial Epoch of Geology, and the probable Antiquity of Man," by Lieut.-Col. Drayson, R.A. London: Chapman and Hall, 1873.

† "The U.S. Sanitary Commissioners in the valley of the Mississippi during the War of the Rebellion, 1861–1866." Final report of Dr. J. S. Newberry. Cleveland: Fairbank, and Co., U.S.A.

stupid. We had almost believed that the author must have been lunatic. We cannot comprehend the meaning of the work, which, so far as Science is concerned, is "fearfully and wonderfully" written. It seems to have sprung, as the author admits, from a conversation with a lady on the subjects of "Daisies, cuttlefish, the immortality of the soul, and Platonic love."

Science and Humanity; or, a Plea for the Superiority of Spirit over Matter, by Noah Porter, D.D., President of Yale College, U.S.A. The author here gives us about 90 pages of the largest type and the smallest sized volume in defence of his views. He condemns Professor Huxley and Mr. Spencer, and doubtless he expects by that to be read. His plea has not much force in it: it is merely as Hamlet says, "words, words, words."

The Noaic Deluge. By the Rev. S. Lucas, F.G.S. London: Hodder and Stoughton, 1873, is a well-meaning attempt to prove the truth of the general idea of the Deluge in which Noah floated. It may interest some of our readers; but many of Mr. Lucas's arguments will not "hold water," as the saying is.

A Table of British Strata, showing their order of superposition, and their relative thickness, for the use of schools; by H. W. Bristow, F.R.S. London: Chapman and Hall, 1873. This is a capital geological chart. It is about four feet by two, is very well coloured, and shows, what most charts do not, the relative thickness of the deposit, and is arranged to include all, even the most recent deposits.

The Saturday Half-Holiday Guide, edited by H. Walker, F.G.S. Kent and Co., London, 1873. This is a very good little guide for the naturalist holiday maker, who cannot get beyond the neighbourhood of London. Its different authors—Mr. Ed. Newman, F.G.S., Mr. Walter Reeves, F.R.M.S., Mr. J. English, and the Editor, have all done their work of describing the several places where plants, animals, and fossils are to be found.

Tablets of Anatomy and Physiology, by Thomas Cooke, F.R.C.S. London: Longmans, 1873. These are at present only in part issued, but such as they are they are good. We do not mean for the better class of students, but for such men as will be likely to use them.

Comets' Tails no longer a Mystery, by J. A. R. London: Reeves and Co., 1873. A tolerably clever little volume, though we do not agree with the author.

Annuaire de Thérapeutique, Paris, 1873; by Professor A. Bouchardat. Paris: Baillière, 1873. This is a special edition for this country. Still it is in French. It is tolerably complete, but very small.

An Essay on the Physiology of the Eye, by Salom H. Salom. London: Salom & Co., 1873. This is a tolerably clever book. Many of the ideas are novel, but not proven. Still, as we believe the author deals in spectacles and glasses, his being his own publisher must bring him a certain amount of readers.

SCIENTIFIC SUMMARY.

ASTRONOMY.

CHANGE in the arrangements for observing the approaching Transit of Venus.—The Astronomer Royal has at length yielded to the pressing arguments which have been urged in favour of an extension of the arrangements for observing the approaching transit of Venus. It has for some time been known that Prof. Adams, the discoverer of Neptune, had taken Mr. Proctor's view of the subject; and we believe we are right in saying that Prof. Adams had been for some weeks in correspondence with Mr. Proctor on the one hand and the Astronomer Royal on the other, with the object of effecting a change in the proposed schemes. This correspondence bore fruit at the recent visitation of the Royal Observatory, when Prof. Adams proposed to the Board of Visitors that the Government be requested to provide the means of organising some parties of observers in the southern hemisphere, to employ Halley's method. This was carried unanimously, and the Astronomer Royal expressed his perfect acquiescence in the result. The final decision will rest with the Admiralty and the Government. Thus has been brought to a close, so far at least as scientific resolutions are concerned, a contest which had long been strenuously maintained by argument on one side, and by a somewhat persistent silence on the other.

We would fain pass from the subject without any further reference to the circumstances which preceded it, and still less to the individual astronomers who took part in the discussion. The great end which has been so long sought for has been attained, and it really matters very little through whose exertions this has been accomplished. But we are compelled to notice (because partly affecting our own veracity) a passage in the pages of a weekly contemporary, which adopts a singularly contemptible method of treating the matter. "In coming to their decision," says 'Nature' of the Board of Visitors, "it is proper to add that the Board was in no degree either influenced or assisted by certain discussions which have taken place out of doors; their decision would have been just the same whether these discussions had or had not taken place; and the Board came to their conclusion under a full knowledge of the very peculiar climatic and navigational difficulties which seem to attend on the roving expeditions which they recommend. It is, in fact, only a realisation of an old proposal by the Astronomer Royal himself, which seems to have been set aside on account of the many serious practical difficulties attending it." Of the first part of this passage little need be said; it is aptly described by a contemporary as worthy of a squabble in some village school, and coming as it does from one who is known to entertain angry feelings towards Mr. Proctor, it should be regarded as simply beneath contempt. But the statement that the present plan is a realisation of an old proposal by the Astronomer Royal requires to be met, because we have ourselves more than once in these summaries indicated the true state of affairs in this matter. It is the fact then that the only proposal ever made for Antarctic expeditions by the Astronomer Royal related to the transit of 1882, and he expressed his opinion as positively as words could express it, that no such expeditions would be of use for the transit of 1874. Of the very method which is now proposed to be employed in 1874, Sir G. Airy said that it "fails totally" in the earlier transit; and so late as last February (see a letter dated February 28 in the "Monthly Notices" for March last) he definitely "declined to sanction" Antarctic expeditions. The statement of our contemporary is in fact altogether untrue from beginning to end. Even the setting aside of the Astronomer Royal's proposed expeditions was due to Mr. Proctor's distinct protest against sending ships on so dangerous a voyage when the prospects of success (in 1882) were so minute.

Appeal to America in the matter of the approaching Transit.—At the instance of a distinguished European astronomer (Prof. Adams we believe), Mr. Proctor has addressed to the Americans an urgent appeal to undertake the work (we may now say to *join in* the work) of finding and providing for an adequate number of Antarctic or sub-Antarctic stations.

American Preparations for the approaching Transit.—The following is extracted from a letter addressed by Rear-Admiral Sands, of America, to the Astronomer Royal on the subject of the American preparations for observing the transit of 1874:—" The favourable Northern stations will all be selected on the coast of China, Japan and Siberia; one probably at Wladiwostok (Lat. 43° 7′; Long. 8h. 48m.); one at or near Yokohama; one near Pekin, or between Pekin and the coast; and the fourth somewhere in Japan, China, or the adjacent islands. In the Southern hemisphere satisfactory stations are much more difficult to find. Our choice seems to be confined to Kerguelen Land, Tasmania, Southern New Zealand, and Auckland or Chatham Island, subject to the consent of the British Government. The most favourable of these stations is probably Kerguelen Land, which you mention among those you purpose to occupy yourself, and which I believe the Germans also intend to occupy. It is a delicate question whether there are not very grave objections to having so many stations together, the answer to which must mainly depend on whether similar methods of observations are to be employed by the different parties. The force of the objection is greatly diminished by the circumstance that our method of photographing is not to be employed by any other nation. Still the comparative inaccessibility of that point allows me to speak with little confidence of our ability to occupy it. In addition to these photographic stations, it is our wish to comply with your desire that we should occupy a contact station in the Pacific. Here we prefer one of the Sandwich Islands, as distant as possible from the point which you may select. The objection to occupying a station so near yours seems to be counterbalanced by the very favourable conditions of that group, both astronomically and meteorologically, and by its accessibility from our western coast. As both contacts will be visible from all the photographic stations, it is intended to observe them with 5-inch equatoreals, with clock-work and micrometer for measuring cusps, one of which will be sent to each station. As the factor for 'ingress accelerated' will be about as great at Wladiwostok and at Yokohama as it will be at Tahiti, it does not seem necessary to occupy the latter station in addition, and besides, only one contact can be seen either at Tahiti or Marquesas, while the Asiatic stations are about equally favourable for both contacts. Each station will also be furnished with a portable transit, accompanied by clock and chronograph, for the determination of local time. This transit will be supplied with a fine spirit-level and declination micrometer for use as a 'zenith telescope.' For longitude, we shall probably depend mainly on occultations of small stars to be observed with the 5-inch telescopes. It is hoped by careful watching to observe eight or ten occultations per month, mostly when the Moon is near her conjunction, and while she is passing the Milky Way. It is believed that occultations are much more free from systematic errors than Moon-culminations. The numerous old determinations of the Transatlantic longitudes by the latter method, most of which may be found in Gould's paper, do not encourage us to rely upon it."

Russian Preparations for the Transit of 1874.—The following is a corrected list of stations for the observation of the Transit of *Venus*, as fixed at the General Meeting of the Russian Committee held on March 22, 1873:—

Station	Latitude	Longitude E. of Greenwich	Instrument to be employed	Proportion of Clear Sky in beginning of December
	° ′	h m		Per Cent.
1. Nakhodka .	42 48	8 51·4	6-in. refractor	80–85
2. Port Possiet .	42 40	8 43·0	Photoheliograph; 4-in. telescope	80–85
3. Hanka . .	45 4	8 50·0	Heliometer	80–85
4. Busse . .	46 24	9 15·0	3-in. telescope	unknown
5. Jeddo . .	35 36	9 19·0	4-in. telescope	unknown
6. Pekin . .	39 54	7 45·7	4-in. telescope	·80
7. Habarowka .	48 16	8 58·8	3-in. telescope	80–85
8. Nertschinsk .	51 18	7 58·5	Heliometer; 4-in. telescope	70–80
9. Tschita . .	52 1	7 34·0	4-in. telescope	90
10. Kiakhta . .	50 20	7 6·7	Photoheliograph; 4-in. telescope	70–80
11. Blagoweschtschensk	50 15	8 30·5	Heliometer; 4-in. telescope	80–85
12. Omsk . .	56 30	5 40·3	3-in. telescope	below 50
13. Taschkent .	41 19	4 37·3	6-in. refractor	60
14. Fort Perowski .	44 51	4 21·9	4-in. refractor	80
15. Fort Uralsk .	51 11	3 26·4	6-in. refractor	60
16. Orenburg . .	51 45	3 40·5	3-in. telescope	below 50
17. Krasnowodsk .	40 0	3 32·0	Photoheliograph; 4-in. telescope	70–80

Station	Latitude	Longitude E. of Greenwich.	Instrument to be employed	Proportion of Clear Sky in beginning of December
	° ′	h m		Per Cent.
18. Aschuradeh .	36 54	3 35·8	6-in. refractor	80–90
19. Naktritchevan .	39 12	3 1·6	4-in. refractor	90
20. Erivan . .	40 10	2 58·1	6-in. telescope	90
21. Tiflis . .	41 42	2 59·3	4-in. telescope	below 50
22. Jalta . .	44 30	2 16·7	4-in. telescope	60
23. Kertch . .	45 21	2 25·9	3-in. telescope	60
24. Kazan . .	55 47	3 16·5	9-in. refractor	
25. Nicolaiew .	46 58	2 7·9	4-in. telescope	
26. Odessa . .	46 29	2 3·0	6-in. refractor	
27. Kharkow . .	50 0	2 24·9	4-in. refractor	

One station on the Russian territory will probably be occupied by American astronomers, namely,

	° ′	h m		
28. Wladiwostok	43 7	8 47·7	American Photo-heliograph	80–85

At Nertschinsk and the other stations of Eastern Siberia the cold is rather strong; but, according to Professor Schwarz, who has spent ten years in those parts, that cold is commonly accompanied with a completely calm and dry air, and thereby it is not unpleasant for astronomical observations; with this conviction, Professor Schwarz has selected for himself the station of greatest cold, Nertschinsk.

For nearly all the stations the observers are already designed, and will practise themselves this summer at Pulkowa in the use of their instruments. All the telescopes will have an equatorial mounting; those designated as refractors are provided with clockwork and micrometrical apparatus for measuring the cusps, or the distances from the Sun's limb. Personal equations will be determined by help of an artificial transit apparatus.

The telegraphic longitude determinations through Siberia will be executed in the course of the next two years. The stations selected for that purpose comprehend several *Venus* stations, namely, Nertschinsk, Blagoweschtschensk, Habarowka, Wladiwostok, and Taschkent. The other stations can be easily joined with these by chronometric operations. For the stations near the Caspian and Black Seas, the longitudes are already known with sufficient accuracy. All the observers will be provided with instruments for the determination of time and latitude.

Procyon as a Double Star.—Whilst M. Otto Struve was observing Procyon on March 19 last, under exceptionally favourable atmospheric conditions, he detected a faint point of light which followed *Procyon* at a very small distance, nearly on the same parallel. After ascertaining that this object was visible in the same manner in all parts of the field, and with eye-pieces of different power, he compared it micrometrically with the principal star. Three determinations of the position-angle, three measures of distance, and finally three more determinations of position-angle gave, with excellent agreement, distance = 11″·68, position-angle = 86°·8. The brightness of the small point of light (henceforth to be considered a companion of

Procyon) was estimated at about two classes of magnitude less than the companion of *Sirius* discovered by Alvan Clark, of which the author had succeeded in obtaining a good measure only a few minutes before, *Sirius* being scarcely 13° above the horizon; a sufficient proof that the *Procyon* companion was not a false image produced by impurity of the object-glass or other defect.

Transmission of Free Messages on Astronomical Subjects over the Transatlantic Cables.—A very important concession has been made to the Smithsonian Institution by the Directors of the Associated Transatlantic Cable Companies, who have agreed to transmit gratuitously between Europe and the United States a limited number of short messages on astronomical subjects. Under this arrangement two telegrams have already been received from the United States by the Astronomer Royal, who on his part has undertaken, at the request of Dr. Henry, Secretary of the Smithsonian Institution, to forward from Europe any message announcing an important astronomical discovery. The Directors of the Associated Companies have consented that ten messages, of ten words each, may be sent free over the cables annually. This liberal concession on the part of the Directors cannot be too highly appreciated by astronomers generally, and especially by the Fellows of the Astronomical Society.

Sun-spot Observations at the Kew Observatory.—Mr. De La Rue gives the following as the summary of the Sun-spot observations at Kew during 1872:—

Months.	Days of Observation.	Numbers given to the New Groups in the Kew Catalogue.	Number of New Groups.	Days without Spots.
January	10	1800 to 1820	21	0
February	14	1821 „ 1843	23	0
March	10	1844 „ 1850	7	0
April	15	1851 „ 1872	22	0
May	18	1873 „ 1891	19	0
June	16	1892 „ 1905	14	0
July	14	1906 „ 1918	13	0
August	14	1919 „ 1927	9	3
September	13	1928 „ 1949	22	0
October	10	1950 „ 1961	12	0
November	13	1962 „ 1979	18	0
December	6	1980 „ 1985	6	0
Total	153	No. 1800 to No. 1985	186	3

The above, which is a continuation of former tables given in the "Monthly Notices," has been but partially compiled from the photographs taken with the Kew heliograph.—[Over from last No. P. S. R.]

BOTANY AND VEGETABLE PHILOSOPHY.

A new Mycological Herbarium.—We learn from Mr. Cooke's excellent little periodical "Grevillea" [March], that a very admirable work on this subject is just being issued by Baron Thuemen of Teplitz. Mr. C. B.

Plowright, who gives an account of the work says, that its first fasciculus, comprising specimens of fifty species of those fungi which exert a baneful influence upon agriculture and horticulture, and also those which take part in the administration of household economy, has just been published. The aim of the editor has been to give ample and characteristic specimens in order that the study of those species of fungi which are hurtful to our cultivated plants or forest trees may be facilitated, as it is only in this way that we can hope to combat the ravages of our numerous enemies. Consequently the greater portion of this fasciculus consists of those species which have their abode upon living plants. Pucciniæ, Uredines, and Peronosporæ find several representatives. Amongst the more interesting species contained in this fasciculus are, *Ureda sorghi* (Pers.), *Puccinia Helianthi* (Schw.), *P. maydis* (Pötsch.), *Ustilago destruens* (Schl.), *Uredo cichoracearum* (D.C.), var. *Endivæ*, *Phacidium medicaginis* (Lasch.), *Exoascus pruni* (Fckl.), *Septoria oleæ* (D. & M.), *Septoria Mori* (Lèv.), *Hysterium nervisequum* (D.C.), *Oidium lactis* (Fr.), *Saccharomyces apiculatus* (Rees), and several others. The specimens are very good in quality and abundant in quantity; each species being enclosed in a separate paper wrapper, their examination is greatly facilitated. Upon the whole, the author, Baron Thuemen, must be congratulated for the eminently practical turn this publication gives to the study of Fungology.

The Self-division of Diatoms.—Professor Smith writes lately to the editor of the "Lens," saying:—"It may be objected that if by self-division the frustules become smaller, then the persistent filamentous forms, at least some of them, should, upon measurement, actually exhibit this gradation in size." I reply that this is the case, and in a filament of thirty-seven double frustules of a large *Melosira moniliformis*, I find the middle frustules larger by ·0001″(with the ⅛″ objective 30 divisions of my Powell and Lealand thread micrometer), and so repeatedly of other chains of frustules. It would at first appear that the largest frustules should be at the ends, and not the middle of a filament. We must remember, however, that although the two larger primary valves may be carried to the ends if the filament remains unbroken, yet all the time self-division is occurring between; so that a series of nodes, or swellings, will exist all along the chain. For example, if after the formation of, say, half a dozen frustules, so nearly the same size that we may consider them equal, we now suppose self-division to occur simultaneously, so that each frustule produces six others, then these latter, smaller than the older ones, would be distributed throughout the chain, and these again, all simultaneously dividing, would give rise to still smaller ones interposed; and it is manifest that a chain would very likely be severed at the smaller frustules, and the partial filaments would have the larger and older (perhaps thus more siliceous) frustules, near the middle, unless we should chance to find one of the ends with the valve of the primary frustule, which would rarely happen.

A new British Nitophyllum has been found. "Grevillea" for January says that Dr. J. E. Gray has drawn the editor's attention to a recent and valuable memoir by J. G. Agardh, entitled "Bidrag till Florideernes Systematik," with which algalogists in this country should make themselves acquainted. Apart from the new and systematic arrangement of the

Florideæ which it contains, descriptions of new species are interspersed, and one of these is from our own coasts. The specimen was communicated to the author by Mrs. Griffiths, under the name of *Nitophyllum Hilliæ*, and is here described in full.—[This note was crushed out of the last Number of P. S. R.]

The "Yellows" of the Peach.—This is a disease very common in American plants, and which may not be unknown to our gardeners at home. It has been ably investigated by Mr. Thomas Taylor, Microscopist to the Department of Agriculture at Washington, U. S. A., who tried a great many experiments on the leaves in carrying out his researches. The following is the result of his analyses of healthy and unhealthy leaves.

	Healthy.	Unhealthy.
Moisture . . .	29·20	36·9
Organic matter .	63·22	59·4
Ash	7·58	3·7
	100·00	100·0

He then observes that the fact of the absence of ash or solid matter, and of the increase of moisture in the unhealthy leaves, would of itself account for their greater tendency to mould. Since leaves do not absorb earthy matter from the atmosphere, it is evident that the cellular structure of the tree has in some way failed to perform its functions; for, had the ascending sap carried with it potash, lime, or other earthy matter, the leaves would have been stored with them, since the leaves have no power to evaporate them. The deficiency of earthy matter in the leaves may also account for the absence of ash in the fruit. If the theory is well founded that the leaves elaborate juice for the growth of the fruit, the leaves being deprived of proper nourishment, the fruit cannot mature. It has been long observed that trees affected with the yellows fruit earlier and mature prematurely, and soon decay. The presence of a larger amount of sap in the unhealthy than in the healthy, indicates an earlier and greater flow than in that of the healthy tree. The presence of watery sap in the leaves, twigs, and buds, would induce naturally an early growth of fruit and premature decay. From these and other observations the disease seems traceable to the body of the tree or roots. Applications of washes in this case to the leaves would probably prove useless, but if applied to the bark and roots, might prove curative; and for that purpose, judging from microscopic observations, he would recommend the frequent application of hot lye as the best substance.

The Variations of Plants.—This subject has been well illustrated by Mr. Thomas Meehan, at a recent meeting of the Philadelphia Academy of Science. He says that in a handful of specimens gathered in an afternoon's walk, he found the following marked variations:—In regard to the spur, which is generally as long as the main portion of the corolla, some have them only one-third or one-fourth as long; and in one instance the plant bears flowers *entirely spurless.* Dr. James Darrach, a member of the Academy, informs me that he believes he has, in years past, gathered a spurless form, but has neglected to place it on record. Then some plants bear flowers with spurs thick, and others with narrow ones; and while some have spurs quite straight, others curve so as to describe the half of a circle. The lobing of the lower lip is various. In some cases the two lateral ones spread away from the small central one, leaving a free space all around it; at other times they overlap the central one, so that it is scarcely seen. Sometimes the small central lobe is nearly wanting—often not more than half the depth of the two large lobes, and at times quite as full, when it may be linear, ovate, or nearly orbicular. The *palate*, as the deep coloured process attached to the lower lip may be called, also varies. In colour it is pale lemon, but often a brilliant orange. Sometimes it is but about the eighth of an inch in thickness; at others one-fourth, in flowers of the same size. In the case of the shallow flat palate, the attached lobes are patent, or even incurved; while in the thick ones they are very much reflexed. These two forms, when the extremes are selected, are as strikingly distinct as two species often are. Again, the palate is rounded and blunt at the apex; at other times almost wedge-shaped, or at least narrowing to a blunt point. The upper lip varies in proportionate length, sometimes not extending much beyond the palate, sometimes half an inch more; then the margins are sometimes bent down like the wings of a swooping bird; or upwards as in those of a rapidly descending one. Sometimes they are united and turned abruptly up at the apex, like the keel of the garden pea.

The Structure of the Cystidia.—This is discussed very fully in Mr. Cooke's *Grevillea* (June), in a translated paper by M. A. de Bary. The structure of the cystidia, he says, offers a few peculiarities; in the greater part a delicate and colourless membrane surrounds sometimes a similarly colourless plasma, full of vacuoles, and sometimes a perfectly transparent liquid. He has observed in the hymenium of *Coprinus micaceus* which had not yet attained its maturity, that the cystidia enclosed a central plastic body, irregularly elongated, which sent in all directions towards the sides of the cell a multitude of filiform processes, branching and anastomosing amongst themselves. These processes changed their form with astonishing rapidity, after the manner of the *Amœbæ.* The older cystidia were entirely transparent. The contents of the cystidia of *Lactarius deliciosus*, and allied species, are granular and opaque. In this respect the cystidia resemble the laticiferous tubes or filaments, and often when a thick slice of the substance of the fungus is observed, it seems that they are branches from these filaments, the more so since they bury themselves deeply in the weft of the lamellæ, underneath the subhymenial tissue. Still he has never seen them spring except from filaments of the weft deprived of latex, of which they seemed to be branches. The cystidia of *Agaricus balaninus*, Berk., are of a dark purple colour. According to Corda and the uncertain opinions of anterior authors, the cystidia eject their contents under the form of a liquid drop and that by their summit, which is represented as open. He has not, any more than M. Hoffmann, been able to convince myself that this phenomena is produced spontaneously. He has, indeed, only very rarely seen the cystidia burst in the water, which the same author says takes place very irregularly. If their surface is damp, and often bears liquid drops, this is a circumstance which is common to them with all fungoid cells that are full of juice.

The Ebenaceæ: a very large family.—Mr. W. P. Hiern has published in the "Transactions of the Cambridge Philosophical Society," a most elaborate memoir upon this family. He enumerates 260 species, of which one hundred are new or not previously described. Of the five genera recognised, *Tetraclis* has been established for an undescribed Madagascar plant in the Paris Herbarium. The order has its focus in the East Indies, where 86 species of *Diospyros* and 19 of *Maba* occur; *Euclea* and *Royena* are confined to Africa. It is interesting to note that the order is unrepresented in New Zealand, Tasmania, and the Andine region—countries the vegetation of which has many interesting points of contact. Generally speaking, *Ebenaceæ* are strongest in the tropics in both the old and new worlds. *Diospyros lotus* is an Asiatic species naturalised along the Mediterranean; *D. virginiana*, which is well known in the United States as Persimon, is nearly allied. Throughout the memoir any tendency to do more than carefully ascertain facts has been studiously suppressed. This becomes somewhat tantalising in the account of the supposed fossil species. The author has been at the pains of drawing up a *clavis* of all the fossil remains which have been assigned to this order, good, bad, or indifferent—including even those for which it appears to him that *Ebenaceæ* is not the probable family.

Silicified Plants of the Coal Measures.—Among the silicified vegetable remains from the Coal Measures found in the soil near Autun, occur amorphous siliceous masses which enclose small fragments of the stems, roots, and other parts of plants, mostly Cryptogams. M. B. Renault, continuing his researches upon these interesting remains, refers ("Comptes Rendus," 1873, part 13, 811, *The Academy*, May) some of the small detached stalks to the imprints known as *Sphenophyllum*. They are from three to fifteen mm. in diameter, and present on the exterior nodes which correspond to leaf-whorls, as in *Sphenophyllum*. In the centre is a vascular axis of a triangular form consisting entirely of tubes diverging from the centre, scalariform or spiral at the angles, where they surround a cylindrical lacuna. This axis is enclosed by a tissue resembling that surrounding the vascular bundles in ferns and some Lycopods. Outside of this, the ligneous axis of M. Renault, are layers of cellular tissue belonging to the bark, which are traversed by eighteen vascular bundles proceeding towards the leaves. The nodosity of the stems and the verticillate disposition of the appendicular organs, as well as the probable number of these parts, are points of resemblance with *Sphenophyllum*, while their internal structure indicates the relations of these plants to the *Lycopodiaceæ* and *Marsileaceæ*. M. Renault also describes the structure of a fragment of a silicified fructification spike, referred to *Annularia longifolia* and found in the same place. The stem is thick and slightly striated, bearing whorls of bracts, very different from the leaves of the sterile branches. Alternating with these are whorls of pedicels, to which are attached two sporangia, above and below; these occupy the whole space between the pedicel and the bract, and contain a large number of minute spherical spores. The axis of the fruit spike shows a broad central lacuna surrounded by a lengthened cellular tissue, containing from sixteen to twenty cylindrical lacunæ placed at regular distances apart.

The Fovilla of Pollen.—Signor Saccardo states in the "Nuovo Giornale Botan. Ital.," that botanists are agreed that the minute grains in the contents of pollen consist of starch-granules, oil-globules, sugar, and nitrogenised compounds, but, so far as he is aware, no observer has yet noticed among them certain minute bodies of well-marked and constant shapes. He detected, in June last, very small oscillating bodies which make up the bulk of the fovilla, and to these he gives the name *Somatia.* The form of the somatia is invariable in the same species of plants, and in plants of the same genus the forms appear to be nearly identical. The plants most carefully studied were *Cucurbita Pepo, Eschscholtzia crocata, Onagraceæ, Portulaca grandiflora, Althæa rosea,* whose *somatia* are figured as fusiform, discoid, &c. To observe these small bodies to the best advantage the author advises that a drop of distilled water should be placed on a few grains of the pollen on a slide, and then the cover should be pressed down so as to crush them. The somatia are seen under a magnifying power of 800 to 1,000 diameters to have an oscillating motion which may be referred to the "Brownian movement." Treated with a solution of iodine, the colour of these somatia becomes blue; but this tint is marked only in the central portion, while the outer part remains clear.

Nervation of the Coats of Ovules and Seeds.—A brief article by Van Tieghem in "Comptes Rendus," August 14, 1871, and "Ann. Sci. Nat.," November, 1872, and a long one in the latter Journal by LeMonnier (apparently Van Tieghem's pupil), develope clearly the former's view respecting the morphological nature of the ovule. He deduces the foliar nature of its envelope from its "libero-vascular system," which is that of the leaf. It answers, as has been before explained, to a marginal lobe of a carpellary leaf transformed and convolute around the nucleus, which, being destitute of vascular tissue, is a "parenchymatous excrescence," a *trichome,* to use the recent term of the Germans. Le Monnier sums up the conclusions thus: 1. The ovule always consists of a lobe of a carpellary leaf, folded around a cellular *mamelon* inserted upon the medial line of the lobe: 2. in Angiosperms upon the upper or *trachean* face of the leaf; in Gymnosperms upon the lower or *liberian* face. 3. The embryo, although discontinuous from the tissues of the mother-plant, has determinate relations of position; not only is the radicular extremity always directed to the micropyle, but its principal plane is generally perpendicular to or parallel with that of the seminal lobe. 4. The primine, characterised by the presence of vascular bundles, is commonly the only membrane which persists in the mature seed; the secundine, except in rare cases (*Euphorbiaceæ*), is only a deduplication of the primine, and is mostly transitory.—(Professor Asa Gray, in "Silliman's Journal," June.)

CHEMISTRY.

Action of Sulphuric and Hydrochloric acids on iron and steel.—At a comparatively recent meeting of the "Manchester Literary and Philosophic Institution" Mr. William H. Johnson, B.Sc., called attention to the action of sulphuric and hydrochloric acids on iron and steel. If after immersion for, say, ten minutes in either of these acids, a piece of iron or steel be tested, its tensile strength and resistance to torsion will be found to have diminished. Exposure to the air for several days, or gentle heat, will, however, completely restore its original strength. On breaking a piece of iron wire after immersion in sulphuric acid, and gently moistening the fracture with the tip of the tongue, bubbles of gas arise, causing the wetted portion to appear to boil. The most careful washing and coating with lime, after being dipped in the acid, and even its subsequent drawing, in which process it is reduced in diameter by passage through a die, does not interfere with either of these phenomena, which only gradually disappear by exposure to the air, or more quickly by gentle heat. Prolonged immersion in acid has a tendency to produce a crystalline structure in even the best wrought-iron.

The Chemistry of the Sugar-forming Powers of Liver.—This is stated somewhat briefly by M. Nencke in the "Chemical News." The quotation refers especially to the withdrawal of water, which, the author says, in non-nitrogenous substances is at present only known in one instance, with formation of anhydride, viz., in the conversion of grape sugar into glycogen. According to researches made by Dr. Schöpfer in the laboratory at Bern, which fully confirm the exhaustive ones of Dr. Bernard on this subject, solutions containing 15 per cent. of grape sugar, and injected into the branches of the vena portarum, are retained by the liver, while, if the same solution is injected in any other vein of the body, two-thirds of the sugar injected is emitted with the urine. Dr. Schöpfer calculated from his experiments that the liver of a medium-sized rabbit can in one minute convert about 0·12 grm. of sugar. It is scarcely possible to assume that the sugar should not be retained in the shape of glycogen, since he says that he has found that when substances containing sugar have been given as food, the blood of the vena portarum always contains sugar, while glycogen is simultaneously largely generated in the liver. The formation of the cholesterine of wax, and that of the fats from carbohydrates in the animal organism, can only be explained by the elimination of O in the shape of OH_2, aided by a partial oxidation of the original substance.

The Chemistry of the Allyls Compounds.—The "Proceedings of the Chemical Society of Berlin" for April 28 contain a paper on this subject, by M.M. A. Kekulé and A. Rinne. It seems that allyl alcohol is readily attacked by dilute chromic acid. Even in the cold the odour of acrolein is observed, and carbonic acid escapes. If the liquid is distilled, after some time formic acid is detected in the distillate, but not acetic acid. If the same alcohol is treated with nitric acid, there is no odour of acrolein. Formic acid without acetic appears in the distillate, and there is much oxalic acid in the residue. The behaviour of the iodide and cyanide of allyl with chromic and nitric acids was also examined.

Examination of Air by means of Cold.—Professor Smee recently, at the Berlin Chemical Society, proposed a method for detecting organic matters contained in the air, and for effecting at the same time a kind of distillation by cold. A glass funnel, closed at its narrow end, is held suspended in the air and filled with ice. The moisture of the air is condensed in contact with the exterior surface; it trickles to the bottom of the apparatus, and falls into a small basin placed for its reception. The liquid obtained in a given time is weighed. It generally contains ammonia, which is determined by known methods. Distillation by cold may be employed for separating volatile substances which might be injured by heat. Thus if flowers are placed under a large bell-glass along with the refrigerating funnel, a liquid is obtained in the basin saturated with the odorous principles of the flowers.—See *Les Mondes*, May 15.

Gelatinous Silica made into Stalactites.—Mr. E. Thompson (says "The Chemical News"), of the Franklin Institute, U. S. A., in experimenting with silicate of soda solution, found that when such solution is placed in a small porcelain capsule or other suitable vessel, and to it is added about an equal volume of concentrated sulphuric acid, taking care not to add to it too suddenly, the silica deposited prevents the thorough mixing of the acid and silicate. If now the vessel be inclined so as to allow the liquids to run as a stream from the vessel, the deposition of the silica takes place in the form of an icicle or stalactite depending from the lip of the capsule. On close examination, it is found that the acid runs upon the outside of the stalactite, whilst the silicate flows down the centre or *vice versâ*, the mass growing by successive additions to the lower extremity. The experiment is at once both pleasing and instructive.

A new Detonating Experiment.—Mr. Elihu Thompson has made the observation that tin-foil, if wrapped about a few crystals of chlorate of potassa, can be made to detonate loudly upon being struck smartly with a hammer upon an anvil, or in a mortar. The phenomenon being precisely analogous to the well-known experiment of triturating sulphur and the chlorate. To the best of our knowledge, says the "Chemical News," the observation that such metals as tin can be oxidised in this way is a new one and worthy of notice.

The mode of action of Sulphur on Arsenic has been investigated by M. Gelis, who has published a paper on the subject, which was recently read before the French Academy.—The author has obtained the sulphides of arsenic by direct action. On heating sulphur with an excess of metal there is formed a single product, the bisulphide S_2As. It is red, opaque, and crystalline, and is distinct from the "false realgar" of commerce. With an excess of sulphur we obtain the pentasulphide S_5As. If one part arsenic is heated in a flask with seven to eight parts of sulphur, the metal disappears, forming a transparent liquid, which when cooled takes the consistence of india-rubber; in time it becomes brittle. Ammonia separates it into pentasulphide, which dissolves, and free sulphur. On distillation we obtain first sulphur, then sulphur containing arsenic. The pentasulphide remains, but it is not stable, for at high temperatures it is resolved into sulphur, and a trisulphide S_3As. The sulphide of carbon acting upon the arsenical sulphur presents curious phenomena. It abandons at first all the common sulphur which it contains, and the liquid becomes coloured. At each new treatment it removes a little sulphur without becoming saturated. Artificial realgar and orpiment are mixtures of the various sulphides of arsenic.

A mode of fusing Platinum.—"M. Violette," says the "Journal of the Franklin Institute," "communicates the fact that he has succeeded in fusing platinum. The draught of the furnace employed was very powerful, and the Hessian crucibles employed for the purpose, though lined with plumbago, were partially fused. The results of the experiments were as follows:—In a crucible of this kind 50 grms. of platinum were placed, partly spongy and partly in fragments, and after an hour's stay in the furnace the crucible was withdrawn, and at the bottom there was found a perfectly melted button of platinum of the same weight."

The speedy Solution of Iodine.—Dr. J. Walz says, in a tolerably late communication, "I find that glacial acetic acid is an excellent solvent for iodine, certainly not inferior to alcohol. On heating acetic acid with excess of iodine to boiling, and then allowing to cool slowly, beautiful large, slender crystals of iodine will form (sometimes half an inch long). The crystals formed from super-saturated alcohol solution of iodine are short, of arrowhead shape, and by no means so abundant, for glacial acetic acid takes up far more iodine hot than cold. I hope you will make this easily-executed experiment, and you will then see the finest iodine crystals yet produced. If saturated alcoholic and glacial solutions of iodine are mixed in equal proportions, and allowed to stand, *acetic ether* is formed. The presence of a little MnO_2 and a drop of SO_4H_2 seems to promote the formation, but is quite unnecessary.

The Analysis of Charcoal.—This has been recently done by Mr. A. S. Wilson, who has published his account of it in a long paper in the "Chemical News." It may be stated that the method of analysis pursued gives the following results:

Insoluble carbonaceous matter	10·75
Nitrogen removed by dissolving in acid	0·13
Carbon (nitrogenous)	10·88
Water by direct estimation	7·48
Unaccounted for	0·66
Loss on ignition	19·02

According to Mr. Patterson's method, we should have—

Carbon, including some insoluble organic matter	10·75
Organic matter dissolved	3·54
Water at 212°	4·73
Loss on ignition	19·02

GEOLOGY AND PALÆONTOLOGY.

A New Fossil Fresh-water Crustacean has been described by Professor Dr. Anton Fric. It was found in a fresh-water deposit near Bilin, in Bohemia The thorax is eight mm. long, and three mm. broad; the mesial line of the front part shows a high crest, which bears six spines, pointing towards the rostrum. On each side of the crest are situated what appear to be the eyes; the facettes of which, however, cannot be identified. The inner antennæ have a three-jointed basal portion; only two of the whips (Geissel) are preserved. These are of the length of the thorax, the outer one being considerably stronger than the inner one. Of the third whip (Geissel), which true Palæmons do not possess, Dr. Fric can only detect a rudiment. The outer antennæ have a large scale at their base, which covers about ten joints of the antennæ. The whip is much stronger than those of the inner antennæ. The first pair of legs is small. The second is the strongest, and bears small chelæ, and projects five mm. beyond the margin of the thorax. The third and fourth pairs are weak; the fifth of double the strength and size of the previous one. The abdominal segments agree exactly in outline with those of Palæmon; as also do the five-leafed tail-fin.

The Immense Coal-area of the United States.—Professor Hitchcock gives in the "Geological Magazine" (March) a good sketch of the vast coal deposits of America. He states that the total area amounts to 230,659 square miles; no notice being taken of any coals which do not belong to the Carboniferous system. There are many others of commercial importance, as the Triassic of Virginia, the Cretaceous of the Territories west of the Missouri River, an immense amount in California, Alaska, &c. These facts will afford data for those who are interested in estimating the amount of coal in different countries by the number of cubic miles or tons. The statements are too brief to permit any notice of the best or of the inferior coal.—[Over from the last Number of P. S. R.]

Limuloid Crustacean Footprints.—Dr. J. W. Dawson, writing on this subject in an American Journal, says, that as these crustaceans are well known in the carboniferous beds of Europe and America, their footprints might be expected to occur in rocks of this age, but the first he has met with were sent to him last summer by his friend Mr. Elder, of Harvard College, who found them quite abundantly in dark-coloured flag-stones belonging to the Millstone Grit formation at McKay's Head, in Nova Scotia. The animal which produced these marks must have been of small size (about half an inch in breadth), in this agreeing with the usual size of the Coal-formation Limuloids; and like the ancient Protichnite-makers, it left no trace of the edges of the carapace, but a very distinct impression of a sharp-pointed tail. Its posterior feet had three or possibly four sharp toes. There were besides several pairs of sharp-pointed walking feet. On the same slabs there are some series of marks, evidently made by the same kind of animal, which have no tail-mark, and there are tail-marks with only traces of those of the toes. It is worthy of notice that, though these tracks indicate the presence of the animals, no crusts of Carboniferous Limuloid crustaceans have yet been found in Nova Scotia. The sand in which the tracks now referred to were made was probably too hard to permit the swimming feet to make any impression. With respect to the absence of the marks of the sides of the carapace, he considers that the genus *Belinurus* of the Carboniferous had the sides of the carapace less deep than that of the modern Limulus, and this may also have been the case with the more ancient Limuloids of the Potsdam. See as to this subject a letter by Prof. Hall in the "Canadian Naturalist," 1862.

The Rate of Growth of Coral Reefs has been recently attempted to be ascertained by the researches of M. N. Le Clerc and De Bénazé, who have published a small work on the subject in French [Publisher, Lainé, rue des Saints-Pères 19, Paris]. They attempted to ascertain the rate of growth of the coral reef at Tahiti, called the Dolphin Shoal, by measurements from the level of the stone planted on the shore on Point Venus by Capt. Wilkes, and comparing their results with his. They made measurements: but they observe that Wilkes does not state whether he measured from the top of a head of coral or from the solid bank on which the corals were growing: and further, that the use of an "excellent spirit level," from a stone of so little length, is not sufficiently exact for correct results. Hence they draw no conclusion from their results. Before leaving the region they made the following arrangements with reference to future measurements. They planted two blocks of coral, cementing them below and nearly burying them in the soil, placing them 0·21 metres above the Wilkes stone, which is between them; they then put a mark upon them on plates of metal, directed towards the place of observation on the shoal. A third stone was placed 40 metres from the south-west angle of the Point Venus Lighthouse, in order to give a second observation on the position of the spot on which soundings were to be made. This spot was found to bear from the two new stones N. 77° 30′ E.; from the third stone N. 70° 55′ E.; from the bell of the new mission church S. 81° 40′ E. A horizontal line passing from the mark on the new stone is 7·460^{m} above the madreporic heads. This observation they leave for comparison with future measurements. They observe that the principal coral of the bank is the *Madrepora plantaginea.* They farther made observations that satisfied them that Tahiti was not at present undergoing any general elevation. Two maps accompany the pamphlet: one is copied from Wilkes; the other is from a chart by MM. Le Clerc and Minier, lieutenants of the vessel.

Relics of a Stone-age Homestead.—Dr. Charles C. Abbot has written an able paper on this subject in the "American Naturalist" for May, 1873, in which he describes some very interesting relics recently found by him. These were met with in a circumscribed spot of about thirty feet in diameter, and some twenty inches below the surface of the ground. The floor of this "homestead," as we have called it, was very hard and compact; the soil being of a darker colour than the superincumbent earth, and well mixed with small oval gravel stones, of a noticeably uniform size. At one side of the nearly circular spot was a well-defined fire-place, marked by a circle of oval white stones, six to eight inches in length, and half that in thickness. Within this circle was a layer of ashes and charcoal, seven inches deep in the centre, and three at the margin of the fire-place. This coal and ash deposit showed, on careful examination, a considerable percentage of minute fragments of mussel shell, and of small fragments of bones, too much splintered to identify, but apparently the long bones of wading birds and of the larger fishes. Several other remains were also found, and have been well described by the author, who, in conclusion, asks the following question:—"Whence came the people who once occupied this spot, and left these abundant traces of their sojourn here? Marking the degree of civilisation, or rather, of its absence, as estimated by these relics, does it, indeed, seem possible, as sketched by Haeckel, that from hypothetical Lemuria, in the Indian Ocean, a being worthy *then* to be called a man, could finally, after many ages, reach North-west America, and then cross our broad continent, to reach the Atlantic coast, in a state of advancement only equal to the production of such rude stone implements as we have described? We do not doubt the correctness of the theory of the evolution of man from creatures not men, but that the ancestors of the American red-skin lived nearer home than the Indian Ocean, we cannot but think."

Professor Cove's (America) Labours.—We have received such a large number of Professor Cope's works within the last quarter that we cannot possibly notice them separately. The only thing that we can do is to put them together and speak briefly of them. The most important is that on "The Short-footed Ungulata of the Eocene of Wyoming," which was read before the American Philosophical Society on the 21st of February, 1873. This is a long and well-illustrated memoir, and it deals especially with *Loxolophodon cornutus*, a species which the author especially claims. It deals very fully with the subject and its allied forms, and must be read by all who are interested in the subject. The other papers of this author are "On the Flat-clawed Carnivora of the Eocene of Wyoming," read (to the same Society) April 4th; "The Osteology of the Extinct Tapiroid Hyrachyus;" "On Some of Professor Marsh's Criticisms;" and lastly "On the Primitive Type of the Orders of Mammalia, Educabilia." We fancy that Professor Cope does too large an amount of work, for we imagine that of all subjects that of geology requires the utmost consideration, which we think he hardly gives to all his subjects. Nevertheless, we thank him for sending us these several valuable works.

Implements in the River Drift at Trenton, New Jersey.—Dr. C. Abbott has sent us a paper on this subject, which he has reprinted from the "American Naturalist" (April, 1873). It is of considerable interest, and we think it establishes its author's ideas.

The Lateral Branches of Halonia.—In a paper in the "Geological Magazine" for April, by Mr. Carruthers, F.R.S., on Halonia and Lepidodendron, the author says that a fine specimen from the Dudley Coal-measures, now in the collection of the British Museum, shows the nature of the branches of Lindley and Hutton's original species of Halonia. Mr. Dawes considered the alternate branches to be merely the impressions of the tubercles which characterise the other species of Halonia. The specimen which Mr. Carruthers has figured shows that these lateral branches attained to some length. In none of them is the natural termination shown. The size and form of the scars at the broken ends indicate that the branches were prolonged.

The Bearing of the Lakes of the North-Eastern Alps on the Glacier-erosion Theory.—A valuable paper was that read by the Rev. T. Bonney, M.A., F.G.S., on this subject, at the Geological Society, April 9th, 1873:—The purpose of this paper was to test, by the Lakes of the Salzkammergut and neighbourhood, the theory of the erosion of lake-basins by glaciers, which has been advanced by Prof. Ramsay. The author premised—1. That an extensive glacier could not exist without a considerable area to supply it. 2. That under no circumstances could a glacier excavate a cliff of considerable height (say 1,000 feet) approximately vertical. 3. That owing to the proximity of the regions, a theory of excavation which applied to the Western and Central Alps ought to be applicable also to the Eastern Alps. Since then these lakes either had at their heads preglacial cirques (the very existence of which was incompatible with much erosive power on the part of a glacier), or were beneath sharp and not greatly elevated ridges of rock, the author concluded that they had not been excavated primarily by glaciers. He considered a far more probable explanation to be, that the greater lake-basins were parts of ordinary valleys, excavated by rain and rivers, the beds of which had undergone disturbances after the valley had assumed approximately its present contour. He showed that the lakes were in most cases maintained at their *present* level by drift; and that, while in a region so subject to slight disturbances as the Alps, positive evidence for his theory would be almost impossible to obtain, no lake offered any against it, and one, the Königsee, was very favourable to it.

Death of Lady Lyell.—On the 24th of April, died Mary Elizabeth, the wife of Sir Charles Lyell, Bart., in the 65th year of her age. Lady Lyell was the eldest daughter of Leonard Horner, Esq., F.R.S., a prominent member of the Geological Society from its foundation down to his death in 1864. In 1832 she was married to Sir Charles, then Mr. Lyell, and ever since constantly accompanied him in his several geological visits to North America, as well as on almost all his journeys on the Continent of Europe as well as in England. Lady Lyell entered warmly into the scientific pursuits of her husband, and keenly appreciated the continual changes and advances in geological knowledge. By her energetic assistance in writing from dictation, the labour of bringing out the several editions of the works on Geology, by Sir Charles Lyell, was materially lessened; and scarcely a proof sheet was finally sent off to the printer without being first submitted to her for criticism and approval. In this way one of the last acts of her life was to read over the concluding chapter of the fourth edition of the "Antiquity of Man," just published.—*Geological Magazine.*

On Holaspis sericeus, and on the Relationships of the Fish-Genera Pteraspis, Cyathaspis, and Scaphaspis, is a paper in the "Geological Magazine" for June, by Mr. E. Ray Lankester, B.A. It is a paper of some length, and of such a nature that it could not be abstracted in a convenient space. But it is a paper well worthy of perusal, and it will be found, we think, that Mr. Lankester is fully justified in the somewhat severe terms he uses in speaking of Dr. A. Kunth's labours.

The Ancient Glaciers of the Sierras.—Professor J. Le Conte, of California, has an excellent paper on this subject in "Silliman's American Journal" for May last. It has a map, and is worthy of perusal. The author himself says that during the past summer, in company with several young men, mostly students and graduates of the University of California, he spent some four or five weeks in camp, among the high Sierras, examining the traces of the ancient glaciers of that region. Two years ago he carried a similar party over nearly the same ground. In addition to what has already been made known by the Geological Survey, he observed many phenomena which he thinks cannot fail to interest geologists and physicists.

MECHANICS.

A Novel Traction Engine, which seems to do work over a considerable space of ground, and yet has no ordinary steam-producing power, has been described in a recent American Scientific Journal. The machine consists of a strongly made cylindrical reservoir, enclosed in a very thick clothing of felt and other material to prevent loss of heat by radiation. Connected with the reservoir is a steam engine which actuates the axle of the driving wheels. Before starting the reservoir is charged with very highly heated water from a stationary steam boiler, the heat being such that a high steam pressure is generated in the reservoir. As this pressure is relieved by the exit of the steam into the engine, a portion of the water in the reservoir is converted into steam by the heat with which it is surcharged. This conversion continues until the temperature of the water falls to 212°, and the machine can therefore be operated during the interval until nearly that point is reached. The experiments which were made consisted in charging the reservoir of the machine with hot water having a temperature of 360°, which yielded a steam pressure of 145 pounds per square inch, and then running the locomotive for a distance of six miles on the track of the Coney Island Railway. During the first half of the journey, which was accomplished in 15 minutes, the pressure fell to 90 pounds; and at the expiration of the trip, which occupied 33 minutes, the gauge showed but 65 pounds, the rate of diminution being much more rapid under high pressure than when the same had become lowered. The speed attained was twelve miles per hour, the burden being a single six ton car for 35 passengers; we were assured, however, that the same time had been made with two carriages containing 70 persons. In actual use it is proposed to locate, at the termini or other points of the line, a sufficient number of stationary boilers from which the locomotive may be charged or its power renewed when exhausted.

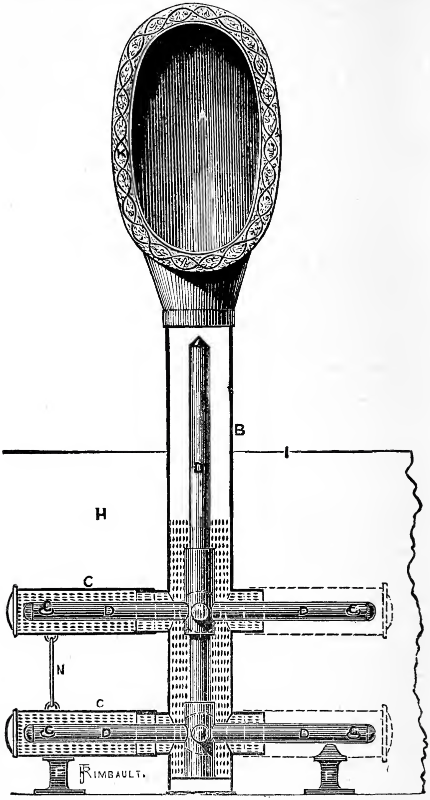
An Instrument for Measuring Fibres.—Herr J. Bohm communicates to the "Industrie Blätter" particulars of an instrument invented by him for measuring the diameters of fibres of wool, silk, and substances of a similar nature. The method of cutting across the fibre cannot be relied on, as it is almost impossible to make the cut perfectly vertical, and the slightest deviation towards obliquity will give an erroneous result. A better mode is to stretch the fibre to get rid of the kinks, and to turn it on its axis, as it were, under a microscope, so that the variations in its diameter may be distinctly observed, and measured with the micrometer; its whole length also, should be passed under the object glass. For this purpose an ingenious little instrument has been constructed by Mr. Bohm. The inventor states that it not only has answered all the purposes for which he designed it, but has been useful in ways that he did not expect. It was found, for instance, that a hair ordinarily appeared to be unequally thick in various parts of its length; this was owing to the long and short diameters of its oval section coming alternately under the vision, and the cause of the appearance was at once revealed by the instrument. And, again, the uniform decrease in the diameter of a hair towards its point, and the irregularity and inequality of fibres of wool from sick sheep, have been rendered visible. It has been found, too, that swellings and knots in otherwise straight fibres are produced by overstretching in the instrument, and the value of the arrangement for untwisting the fibres was here shown, for the knots began to uncurl the moment one end of the fibre was turned. A figure of this instrument is given in a recent number of the "Scientific American."

The Resistance of the Hulls of Ships to Rolling Movements.—A memoir on this important subject has been presented to the French Academy by M.

Bertin, and it is thus reported on by the Committee appointed to sit upon it. The author gives in his memoir the results of experiments made on the decrease of rolling in calm water resulting from the passive resistance referred to, and the measurement of this resistance. He points out that the maximum amplitude of rolling is not sufficient to characterise ships with regard to the importance of their oscillations. Distinguish between the maximum amplitude, which M. Bertin proposes to call the *mobility*, and the mean and habitual amplitude which he calls the *agitation*, and which, relatively reduced, may be called by contrast the quietness (tranquillity). There are ships of great maximum rolling and of small maximum rolling, agitated and quiet, which must not be confounded with ships unstable and very stable: for very stable ships are in general very much agitated by rolling. To ascertain the laws of quietness in ships, it is necessary to measure both the waves and the rolling; and the instrument M. Bertin uses for this is one somewhat similar to that used by Mr. Froude. It consists of two pendulums, one of which takes 50 seconds and the other half a second in oscillation. Suppose a wave of 5 seconds, the period of the large pendulum will be ten times its duration, that of the smaller a tenth. If they are not too far from the axis of rotation of the rolling they will mark with reference to the ship's vertical longitudinal plane, the first one the absolute rolling, the second the relative rolling of the ship on the normal of the wave; provided always (for the second assertion) the dimensions of the wave are considerable with reference to the volume of hull carried by it. The difference of these two angles will be the inclination of the waves. Tracing pencils fixed at the extremities of equal radii give two curves which can be easily examined and discussed. The Committee, says the "Chemical News" of May 30, speak of M. Bertin's memoir as being one of considerable interest.

A New Form of Mitrailleuse.—We are informed by the "Scientific American" of April 12th, that some interesting trials have quite recently been made at the Holske Machine Works, 279 Cherry Street, in New York city, of a new mitrailleuse invented by Mr. J. P. Taylor, of Tennessee. The experimental gun, the first constructed, was built at the above establishment, and possesses a number of entirely novel features, well calculated to make it a very formidable weapon. It has twenty-four barrels, which by simply turning a crank may be discharged *en fusillade* or all at once. The loading mechanism is especially ingenious, and consists in a magazine of cartridges, placed in rear of the gun, from which four rotating chambers are fed in succession. The contents of each chamber, as it comes even with the ends of the barrels, are discharged in turn until the reservoir is exhausted, when a new and filled receptacle may be quickly substituted; 700 rounds per minute can be fired by fusillade, or 1,000 in broadside. The machinery is simple, and so arranged as to be well protected from the effects of shot striking it. The gun, which is exciting no small degree of interest in military circles, is at the present time undergoing a series of careful tests, the results of which, together with a full description and engraving of the piece, will shortly be published.

Preservation of Corn, Grain, Hay, and Seed from Mildew, Heating, &c.—The object proposed to be effected by this invention is the important one of protecting corn, seed, and similar commodities stored in bulk from heat mildew, mustiness, &c., which occasion the loss of thousands of pounds annually to those concerned in such produce. This apparatus, which is



A. Funnel-shaped ventilator. B. Section of perpendicular cylinder with small holes or perforations. C. Sections of horizontal cylinders with same. D. Interior pipes for keeping up the circulation. E. Mouth or opening of pipes D. F. Standards for supporting lower horizontal pipes and apparatus generally. G. Inner openings of pipes D. H. A compartment in the ship or other place containing the grain, seed, &c., with the apparatus introduced therein. I. Deck of ship. K. Sponges chemically prepared for purifying the air as it passes into the cylinders. N. Supports for the upper horizontal pipes. A cap is provided for the cylinder B when the funnel ventilator is removed.

most successful and simple, is termed the "Anti-Mildew" Grain and Seed Protector, and was introduced a short time ago (twelve months) by Messrs. Adutt Finzi, & Co., 24 Mark Lane, London, being the invention of Mr. Jean Methodios Joannides, a Greek subject, agricultural engineer and late Greek consul of Guirgevo, in Wallachia, and for many years connected with the corn trade. The value of this apparatus is considerably enhanced by its capability of being employed at the present time for three distinct purposes, namely:—1. In ships on their voyages. 2. In granaries, warehouses. 3. For stacks of hay or clover.

Are Hot-Air Stoves Injurious to Health—This question is answered by the "Scientific Press" of San Francisco, which alleges that they are when made of cast-iron. It says, "Furnaces for heating dwellings should never be made of cast-iron, as is generally the case, for the reason that the unhealthy gases of combustion—carbonic acid and carbonic oxide—readily permeate such iron when hot, and are thus distributed through the dwelling to the great detriment of health. The furnace should be made of wrought iron exclusively—boiler iron, through which, when properly put together, not a trace of those deleterious gases passes. The expense is greater, but not sufficient to outweigh the health consideration. Wrought-iron furnaces are largely supplying the place of cast-iron ones in our Eastern cities. In cold countries, especially, this matter, as a sanitary question, rises to great importance; and, indeed, it is quite time that more regard was paid to the character of the air we breathe in our dwellings, school-rooms, and public buildings."

MEDICAL SCIENCE.

Poisonous Inoculation with Dead Blood.—The "Lens," in a recent number, quotes M. Davaine's experiments on this subject. It is well known that medical men are often seriously injured by accidentally cutting themselves with instruments that have been recently used for dissecting purposes. The wounded part swells, and mortification often ensues, necessitating amputation and sometimes causing death. In order to determine the poisonous properties of this putrid blood, M. Davaine communicates the result of several experiments upon rabbits. The liquid used was the blood of an ox that had been ten days slaughtered. This, by subcutaneous injection, he administered to his subjects in varying quantities, obtaining by successive dilutions with water the most infinitesimal attenuations. Killing one animal, he would take its infected blood and force the same into the veins of another, and so on until he reached what he terms the twenty-fifth generation. On this last experiment he says: "Four rabbits received respectively one trillionth, one ten-trillionth, one hundred-trillionth, and one quadrillionth of a drop of blood from a rabbit belonging to the preceding generation that had died from the effects of a one-trillionth dose. Of the four, but one animal died—that which received the one ten-trillionth. It appears then, that the limit of transmissibility of the poison in the rabbit reaches the one-trillionth part of a drop of decayed blood."

The Election to the Royal Society.—This is not strictly medical, for many other professions besides medicine supply candidates for the fellowship of the Society. Still, as we have no general summary of events into which the list should come naturally, we take this opportunity of publishing it. It is one that contains some names which we did not expect to see, and others which we as certainly did, but which have not been yet enrolled. The following is the list:—William Aitken, M.D.; Sir Alexander Armstrong, M.D.; Robert Stawell Ball, LL.D.; John Beddoe, B.A., M.D.; Frederic Joseph Bramwell, C.E.; Staff-Captain Edward Kilwick Calver, R.N.; Robert Lewis John Ellery; Lieut.-Colonel James Augustus Grant, C.B., C.S.I.; Clements Robert Markham, C.B.; George Edward Paget, M.D., D.C.L., LL.D.; George West Royston Pigott, M.A., M.D.; Osbert Salvin; Hon. John William Strutt; Henry Woodward, F.G.S., F.Z.S.; James Young.

Artificial Fibrin as a Dietetic Substance.—The "Chemical News" of May 23 publishes a letter by Dr. John Goodman, on this compound, which he thinks of considerable value as food. It is formed by exposing albuminous material to the operation or influence of cold water for a given period; and, on account of its great plenteousness, he employs the ordinary hen's egg for its production. When the shell is broken and removed, and its contents are immersed in cold water for some twelve hours or so, it is found to undergo a chemico-molecular change, and to become solid and insoluble. This change is indicated by the assumption, by the transparent "white of the egg," of an opaque and snowy-white appearance, which far surpasses that of the ordinary egg. The product and the fluid in which it is immersed must now be submitted to the action of heat to the boiling-point, when the fibrin will be found ready for use.

Experiments on a Guillotined Subject. — The French "Gazette Hebdomadaire" (in an early number) contains an account of M. Onimus' experiments, detailed this year to the Paris "Société de Biologie:" M. Onimus mentioned that he had had an opportunity to verify several physiological facts on the body of a man who had been guillotined. The external intercostals raise the ribs, the internal intercostals lower them, demonstrating the correctness of Bamberger's theory. The peronæus longus brings down the internal edge of the foot, at the same time acting to some extent as an extensor and abductor, as Duchenne has shown. The loss of contractility in the muscles takes place in the following order: The muscles of the tongue, the diaphragm, and those of the face, are the first to fail to react to electric excitement, though the masseter holds out a long time; in the limbs the extensors fail before the flexors; the muscles which preserve their excitability longest are those of the trunk. The form of muscular contraction varies as the contractility lessens. It is interesting to remark that the order in which the muscles become inactive is analogous to that of lead-paralysis.

Can the Infant digest Starch?—This very important question is answered in the negative by an Italian Physician. It has been known that the saliva of newly-born animals has not the power of transforming starch into sugar. A recent experimenter has taken the pancreas from kittens and puppies, and has ascertained that the pancreatic juice in these animals when young is, like the saliva, incapable of converting starch into sugar. The bearing of this fact on the practice of giving starchy food to very young infants is obvious.

Analysis of the Air of Public Schools in America.—The "Sanitarian," a New York Journal, of which the present is the first number, and is most creditably got up in every respect, says that from their public schools Dr. Endemann obtained seventeen samples of air, the examination of which determined the presence of carbonic acid, varying in amounts from 9.7 to 35.7 parts in 10,000; or, in other words, from more than twice to nearly nine times the normal quantity. The ventilation in these buildings is generally faulty, and can be obtained only by opening the windows—a practice detrimental to the health of the children who sit near or directly under them. The following experiment, made in the Roosevelt Street School, shows the inefficiency of ventilating flues in the wall unprovided with means for creating an upward current. An examination of the air in one of the class-rooms provided with a ventilating flue was made while one of the windows was opened, and yielded 17.2 parts of carbonic acid in 10,000. The window was then closed, and after the lapse of ten minutes another examination gave 32.2 parts of carbonic acid, or an increase of 15.6 parts. The experiment now became to the teacher and children so oppressive that it was not continued. Dr. Endemann says: "If the accumulation of carbonic acid had been allowed to continue, we might have reached within one hour the abominable figure of 110."

Measuring the Chest.—Dr. Fröhlich, of Dresden, gives the following simple rules for measuring the chest, with the useful object of securing uniformity of proceeding, whether for recruits, for statistical purposes, or for personal examinations: "Medical Record," March 26th.—The person to be examined should stand in an unconstrained position before the physician, breathing with his mouth shut, and should raise both arms, stretching them out horizontally. A tape not broader than 1 cm. (about $\frac{2}{5}$ of an inch) should be placed around the chest directly under the inferior angles of the scapulæ behind and the nipple in front, and should then be read off, first after the deepest inspiration and then after the deepest expiration, and both data recorded. The author then sums up the results which he has obtained by this method of observation, of which some of the more important are as follows. The average circumference of the chest measured in 725 healthy men, twenty years of age, was, after deepest inspiration, 89 cm. (about 35 inches), and after deepest expiration, 82 cm. (about $32\frac{1}{4}$ inches), the average play of the chest being thus 7 cm. A circumference of only 75 cm. ($29\frac{1}{2}$ inches), indicates what the author calls an unripe chest, and should exclude the person from military service. A circumference of 750-759 mm. should, under, exceptional circumstances, be considered sufficient for military service, but when it reaches 760 mm. (30 inches), if the person is otherwise healthy, then it ought to suffice.

Death of Baron Justus von Liebig.—It is with the deepest and most sincere regret that we have to announce the death of this celebrated chemist, whom our readers will remember by the fact that the articles which introduced the now well-known "Liebig's Food" into this country were written for this journal by the Baron himself. We have, therefore, much sorrow in announcing the death of this well-known and distinguished *savant*, whom we saw quite well about a year since in a trip to Bavaria. Baron Liebig died on Friday, April 18th, at the age of sixty-nine, in Munich, where, for the last twenty years, he had been Professor of Chemistry. Having attracted the notice of Alexander von Humboldt by a paper on Fulminic Acid, he was appointed in 1824 extraordinary professor, and in 1826 ordinary professor of chemistry in the University of Giessen. There he established a school for practical chemistry which obtained a world-wide reputation, and was attended by large numbers of pupils, many of whom have since become distinguished. In 1852 he became Professor of Chemistry, with charge of the chemical laboratory, at Munich. His works and papers on subjects connected with chemistry are very numerous. In this country, his "Organic Chemistry in its Application to Physiology and Pathology," "Organic Chemistry in its Applications to Agriculture," "Familiar Letters on Chemistry," and his "Natural Laws of Husbandry," which appeared in 1863, are among the best known. The hereditary dignity of baron was conferred on him by the Grand Duke of Hesse in 1845. In recent years, his name has become familiarly connected with the utilisation, in the form of the well-known "Liebig's extract of meat," of the meat of animals slaughtered in large numbers in South America for the sake of their hides and fat. His funeral was attended by all the civil and military authorities of Munich, including the judges and magistrates, and the professors of the colleges in the city, as well as by a large concourse of the inhabitants.

METALLURGY, MINERALOGY, AND MINING.

Analysis of an Aventurine-Orthoclase.—This orthoclase, which has been found by Professor Leeds and is fully described in a late number of "Silliman's American Journal," is of a delicate flesh-red hue, which is due entirely to the embedded crystalline scales of what has been supposed to be göthite. The stone itself is translucent and quite colourless. The results obtained in two analyses were:—

	1	2	Mean
Silica,	64·80	64·82	64·81
Alumina,	19·02	} 19·25 {	19·02
Ferric oxide,	0·23		0·23
Lime,	1·29	1·23	1·26
Magnesia,	0·61	0·58	0·59
Potash,	15·22	13·38	14·30
Ign.,	0·26	0·26	0·26
			100·47

African Diamond Dust.—At a recent meeting of the California Academy of Sciences Mr. Hanks presented samples of the diamond deposit of South Africa, brought from thence by J. H. Riley—one of the first layer which has to be pierced to get to the diamond deposit, another of the deposit in which the diamonds are found, and another of pebbles found associated with the diamonds. The last, it was remarked, bore great similarity to the pebbles found at the mouth of the Klamath river, where microscopic diamond dust was found; also at the Pescadero, Santa Cruz county.

Finding a Corundum Mine.—In a late number of the "Proceedings of the Academy of Natural Science," Philadelphia, it is stated that Professor Leidy remarked that he had visited a corundum mine, recently opened on the farm of Mr. George Ball, in the vicinity of Unionville, Chester Co., Pa. The accumulation is perhaps the most extraordinary discovered, and its extent yet remains unknown. Detached crystals of corundum have often been found in the ploughed fields and roadsides of the neighbourhood, and also masses or boulders of the same material have been discovered on the surface of the ground or buried in the local drift covering the deeper rocks. In several instances boulders of nearly pure corundum have been found in the locality up to several tons in weight. The corundum, as exposed to view at the bottom of a trench, appears as the crest of a large body or vein lying between a decomposing gneiss and a white talcose schist. The vein appears to extend in a western direction, and towards the east turns at an obtuse angle to the north-east. The exposed portion may probably reach twenty or more feet, and averages about six feet in depth and five feet in thickness at bottom, and is estimated to contain about fifty tons. How much further the vein extends west and north-east, and how far it reaches in depth and thickness, can only be determined by future mining. It looks as if it promised to be the most valuable deposit of corundum ever found.

A Prize for an Improved Mode of Burning Coal.—The Council of the Society of Arts has had placed at its disposal the sum of 500*l.*, by an anonymous person, through Sir W. Bodkin, for encouraging the discovery of improved modes of using coal. The Council, on this account, have offered the following prizes:—1. For a new and improved system of grate, suitable to existing chimneys as generally constructed, which shall, with the least amount of coal, answer best for warming and ventilating a room.—The Society's gold medal and fifty pounds. 2. For a new and improved system of grate, suitable to existing chimneys as generally constructed, which shall, with the least amount of coal, best answer for cooking food, combined with warming and ventilating the room.—The Society's gold medal and fifty pounds. 3. For the best new and improved system of apparatus which shall, by means of gas, most efficiently and economically warm and ventilate a room.—The Society's gold medal and fifty pounds. 4. For the best new and improved system of apparatus which shall, by means of gas, be best adapted for cooking, combined with warming and ventilating the room.—The Society's gold medal and fifty pounds. 5. For any new and improved system or arrangement not included in the foregoing, which shall efficiently and economically meet domestic requirements.—The Society's gold medal and fifty pounds.

Tables for the Determination of Minerals.—This excellent work, which is a German one, is by Franz Von Kobell, and is published at Munich (München), by Herr J. Lindauer. It is now in its tenth edition, and is invaluable to the student of mineralogy.

Diamonds in Californian Sands.—The "Chemical News" of May 30, says that Professor Silliman, having received from Mr. Trendwell, of San Francisco, a small parcel of the sand resulting from the hydraulic treatment of ores, found, on examination with the microscope, that they abounded in fine colourless zircons of the form of those of Expailly, along with crystals of topaz, fragments of quartz, grains of chromic acid (chrome-iron ?) and titanic acid, and globular bodies of a very high refractive power, which he believes to be diamonds. Mr. J. Torry, in a single sample of the sands washed from the gold ores of Nicaragua, found twenty mineral species, some of them very rare.

A Huge Diamond.—We learn from "Silliman's Journal" for April, that a diamond weighing 288½ carats, and of the first water, was found Nov. 6, 1872, at Waldeck's Placer, Vaal river, South Africa, by Robert Spaulding's party. It is stated to measure about $1\frac{1}{8}$ inch in diamater. If this statement is confirmed, the Waldeck-Spaulding diamond is among the largest rough diamonds of which we have mention. The Regent weighed 410 carats ($136\frac{14}{16}$ cut), and the Great Mogul 780½ carats ($279\frac{9}{16}$ cut). A diamond in the possession of the Rajah of Maltan, in Borneo, weighs 367 carats; the Nizam belonging to the King of Golconda weighs 340 carats. The "American Mining and Scientific Press" of Feb. 22, gives a figure of the Waldeck-Spaulding stone, taken from a photograph, which shows its form to be an irregular octahedron.

Herr F. Hessenberg's Mineralogical Researches are of great interest and are not yet completed. In No. 11 (which is in vol. viii. of the "Proceedings of the Senckenberg Nat. Hist. Society of Frankfort"), he continues his crystallographic researches. He describes crystals of perofskite from Pfitschthal, of calc spar from Iceland and Andreasberg, and others of sphene and axinite; indicating for sphene some evidence of hemimorphism.

MICROSCOPY.

Structure of Eupodiscus Argus.—According to Mr. Samuel Wells (U.S.A.), who has a paper on this subject in the "Monthly Microscopical Journal" for March. He says that the valve of Eupodiscus Argus is remarkable for its opacity, its thickness being about $\frac{1}{4000}''$; it presents therefore, a beautiful appearance as an opaque object with a binocular. The structure of the outer or convex surface can be readily made out with a low power. It is dotted with depressions irregular in size, shape, and arrangement; between these depressions the surface rises in ridges, which glisten and sparkle like fresh snow. No arrangement of light (except transmitted) varies this appearance. The depressions are unmistakable, and, as appears by the use of the binocular, and the examinations of the edges of fragments, are pockets extending nearly, but not quite, through the valve. The average diameter of these depressions is about $\frac{1}{8000}''$. The inner or concave surface is much more difficult of resolution; its structure is quite different to that of the convex surface. It is nearly smooth, has no ridges, and (probably) no granulation. It is covered with round dots, radiating irregularly from the centre, and leaving irregular blank spaces between the rows. It is probably this surface that is figured by Mr. Slack, who makes no mention of any difference between the two surfaces, but appears to have made the drawing from a specimen on Möller's typen platte. In my typen platte there are the eighteen-corner Eupodisci, and three others, and all were mounted *concave* side up, which is the easiest mode of making them stay in place. Mr. Slack has, however, expressed his own views in a letter to the same Number of the "M. M. J."—[This note was crushed out of the last Number of P. S. R.]

Microscopical Papers of the Quarter.—The following papers have appeared during the quarter in the "Monthly Microscopical Journal" for April, May, and June:—

Some Remarks on a Minute Plant found in an Incrustation of Carbonate of Lime. By R. L. Maddox, M.D., H.F.R.M.S.—Notes on the Micro-Spectroscope and Microscope. By E. J. Gayer, Surgeon H.M. Indian Army.—On the Structure and Function of the Rods of the Cochlea in Man and other Mammals. By Urban Pritchard, M.D., F.R.C.S., Demonstrator of Physiology, King's College, London. —A New Formula for a Microscope Object-Glass. By F. H. Wenham.—Professor Smith's Conspectus of the Diatomaceæ. By F. Kitton, Norwich.—Hair in its Microscopical and Medico-Legal Aspects. By Dr. E. Hofmann.—A New Callidina: with the Result of Experiments on the Desiccation of Rotifers. By Henry Davis, F.R.M.S.—On Agchisteus Plumosus. By E. Parfitt.—An Apparatus for Obtaining the "Balsam" Angle of any Objective. By Robert B. Tolles, U.S. America.—On Bog Mosses. By R. Braithwaite, M.D., F.L S.—Binoculars for the Highest Powers. By F. H. Wenham, Vice-President R.M.S.—Professor Smith's Conspectus of the Diatomaceæ. By Professor H. L. Smith.—A New Method of Preserving Tumours and certain Urinary Deposits during Transportation. By Joseph G. Richardson, M.D., Microscopist to the Pennsylvania Hospital.—On an Entozoon with Ova, found encysted in the Muscles of a Sheep. By R. L. Maddox, M.D., H.F.R.M.S.—On the Development of the Face in the Sturgeon (Accipenser Sturio). By W. K. Parker, F.R.S.—On Cutting Sections of Animal Tissues for Microscopical Examination. By Joseph Needham, F.R.M.S., &c., Demonstrator of Histology at the London Hospital Medical College.—Remarks on the Aperture of Object-Glasses. By Assistant-Surgeon J. J. Woodward, U.S. Army. With a Note by F. H. Wenham, V.P.R.M.S.—Remarks on Mr. Henry Davis' Paper "On the Desiccation of Rotifers." By C. T. Hudson, LL.D.

A New Microscopic Object Glass.—A paper of Mr. Wenhams, V.P.R.M.S., on this subject, has appeared in the "Monthly Microscopical Journal" for April. It is of considerable interest and of some length, but the author says that "it is of necessity incomplete, for want of definite information concerning the optical properties of various kinds of glass. Data obtained from working them into small lenses furnish only a rough approximation to the mean dispersive power of the combined flint and crown having the best apparent effect. Of the intermediate rays, little can be known beyond the mere appearance of more or less of a secondary spectrum. Nothing of importance has been published since Fraünhofer's Table, containing the refractive indices for each of the seven primary colour-lines of the spectrum for ten kinds of glass: great advance has been effected since that date in the manufacture of optical glass, a most complete collection of which of every variety has been made by the Rosses up to the present date. Selected specimens from this will be worked into prisms, and the relative spectra mapped out by the Fraünhofer lines, leading, it is hoped, to the discovery of a combination of crown and flint glass which shall be free from secondary spectrum or absolutely achromatic. The result of this investigation will be the subject of a future communication."

PHYSICS.

What is a Tachymeter?—This question is answered by a paragraph in a recent number of "Les Mondes," in which M. Dupont gives an account of an instrument which appears to be devised for the purpose of rendering the teaching of geometry a rapid and pleasant course at schools. M. Lagout has given some lectures to prove this at Clermont-Ferrand, the result being that the *Maire* and the *Recteur* have decided that tachymetry shall be introduced into the schools under their control. The instrument is made in three different sizes, at the price respectively of 10, 21, and 100 francs; it is for sale at 41, Rue J. J. Rousseau, Paris.

Temperature of Arctic Sea near Spitzbergen.—Captain J. C. Wells gives the results of his experience on this subject to the "Proceedings of the Royal Society" (141). He records a very curious result, viz., gradual increase of temperature at great depth. On July 12th, when in 80° 17′ N., and when the vessel was fixed in the ice, the temperature gradually increased to 64° F. at a depth of 600 fathoms. These facts indicate the southward flow of a vast body of warm water. It cannot be said that the heat is derived from the Gulf-stream, because nowhere in its course, even in such latitudes as 50° or 60°, does it acquire so high a temperature, even at the surface; and it is highly improbable that the general warmth of the ocean along the west coasts of North Europe, on the shores of Norway, could possibly be supplied by the limited body of warm water which leaves the Gulf of Florida. If the whole of the Gulf-stream water were spread over the warm-water area in the north, its depth, even allowing the most liberal estimate for its volume, would not exceed 10 fathoms; whereas warm water of 42° F. occurs to the depth of 400 fathoms in this region, and north of Spitzbergen it is found as high as 64° F. at 600 fathoms. If it be said that this temperature is due to the northward drifting of the Atlantic from warmer localities, we are met by two difficulties, of which one is, that the soundings obtained by Carpenter and others gave temperatures much below 64°, and the other is, that the waters flow south, not north. Volcanic action, or a warm mineral spring rising from the ocean-bottom, may by some be imagined to be the cause of the temperature of 64°; but there is no evidence of either of these agencies, and it is quite reasonable to suppose any other feasible cause. Passing over the discovery of 64° F. at this depth, we still have to account for the water of 42° F. flowing southwards as evidenced by the increase of its temperature as we proceeded northwards.

Wave-lengths of Sound in Gases.—Professor S. M. Mayer says that he has hung up in his lecture-room before the students a series of gum-tubes having lengths of $\frac{1}{2}$, 1, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, &c. wave-lengths of different notes. The tubes forming any one of these series, are used with the organ-pipe and resonator corresponding to their note; and as they are successively adapted to the resonator, they cause the serrations of its flame successively to coincide with and to bisect those of the organ-pipe flame. Students, he says ("Silliman's American Journal"), after such exhibitions do not depart from the room with their usual scepticism as to the existence of an acoustic wave-length, but look upon the tubes as measures of actual entities.

The Blue Colour of Sky; its Cause. M. Colas (in "Les Mondes") first refers to the blue colour exhibited by the pure water of certain lakes, and says that it is due to the therein dissolved or very minutely divided gelatinous silica, quoting as instances the lake of Geneva, the water of the d'Huis, and more particularly the water of a source near to the Mont-Dore (Département du Puy-de-Dôme), which water is even bluish-coloured when placed in a white glass decanter. The blue colour of the sky is referred by the author to the same cause, viz., very finely divided gelatinous silica (hydrated silica) kept in suspension in the clouds on account of its great lightness.

Spectrum of the Aurora Borealis.—An attempt has been made by Herr Vogel to identify the spectrum of the aurora with that of air, and he has arrived at results which, if not absolutely conclusive, render the identification at least probable. The author employed a direct vision spectroscope with five prisms, collimator and observing telescope, which last by means of a micrometer screw could be moved so as to bring different parts of the spectrum into the centre of the field of view. The distances between the spectral lines could be read off in fractions of a revolution of this screw. By repeated measurements of about 100 lines, aided by Angström's atlas, the micrometer readings could be converted directly into wave-lengths. With this instrument Vogel determined the wave-lengths of 7 lines with the following results:

Wave-length	Probable error	Remarks
0·0006297	0·0000014	Very bright band.
0·0005569	0·0000002	Brightest line.
0·0005390		Very faint line.
0·0005233	0·0000004	Pretty bright.
0·0005189	0·0000009	Bright where the red line appears; otherwise faint.
0·0005004	0·0000003	Very bright.
{0·0004694, 0·0004663, 0·0004629}	0·0000003	Broad band somewhat less bright in the centre; very faint where the red line appears.

Pogg. Annal. CXLVI. 569.

The Relation between Heat and Electricity.—This subject has received discussion from Mr. F. Guthrie in a paper which he presented to the Royal Society, and which is published in an early number of the "Chemical News." The author says that it is found that the reaction between an electrified body and a neighbouring neutral one, whereby the electricity in the neutral body is inductively decomposed and attraction produced, undergoes a modification when the neutral body is considerably heated. Under many circumstances it is found that the electrified body is rapidly and completely discharged. The action of discharge is shown to depend mainly upon the following conditions:—(1). The temperature of the discharging body, and its distance from the electrified one. (2.) The nature (+ or −) of the latter's electricity. With regard to (1), it is shown that the discharging power of a hot body diminishes with its distance and increases with its temperature. But, concerning the temperature, it is proved that the discharging power of a hot body does not depend upon the quantity of heat radiated from it to the electrified body, but chiefly upon its quality. Thus a white-hot platinum wire connected with the earth may exercise an indefinitely greater discharging power, at the same distance, than a large mass of iron at 100° C., though the latter may impart more heat to the electrified body. The rest of the paper is of too great length to admit of a brief abstract.

A neat mode of employing Bunsen's Flame for Testing Purposes has been suggested by Mr. C. Huson in a letter to the "Chemical News" (May 23rd). In principle, this method is similar to that of the Bunsen-stick recommended in some of the recent text-books, but, he thinks, will be found to be an improvement on it, both in neatness and delicacy, and also in expeditiousness. A thin piece of platinum wire is taken, and a small double loop or cage two or three mm. in diameter made at one end. This loop is moistened with water and then dipped into powdered cream of tartar, a small portion of which will adhere. On heating for a few seconds in the reducing zone of the Bunsen flame, the cream of tartar will, of course, be converted into a mixture of carbon and potassium carbonate. All that now remains to be done is to dip this porous mass of carbon into a solution of the substance to be tested, or (in the case of a solid body) to moisten it with water and attach a grain or two of the assay to it, and, having first driven off the moisture by holding the wire at some distance above the flame, to insert the carbon tip into the upper reducing flame for a few moments. If the solution of the assay be concentrated, or if a solid portion be used, the reduced metal will be plainly visible to the naked eye; but, in the case of a dilute solution being used, the metallic grains can only be seen by rubbing the carbon tip in a small agate mortar with a few drops of water.

An Improved Optical Saccharimeter has been devised by M. Prazmowski, and is described by him in the "Comptes Rendus" (May 12th). His paper has been abstracted by the "Chemical News," which says that Soleil's instrument requires considerable perfection in the visual organ to appreciate exactly the uniformity of colouring in the two halos of the field; and, in view of this, some have sought to improve on it by making the observation depend on perceiving a slight difference between two luminous intensities. M. Frellet and M. Cornu have suggested means of effecting this. M. Prazmowski's method is to use a bi-plate of spar (in place of Soleil's plate with two rotations), the face of separation being placed in the principal section of the prism. He utilises Soleil's compensator.

The French Academy's Report on M. Boussinesq's Essay on the Theory of Water Currents is to be found in the "Comptes Rendus" of April 14th. The committee gave a somewhat lengthy analysis of this important work; in which M. Boussinesq treats of the motion of water in pipes and in open channels—considering fluid sections of various forms, especially those which are rectangular and of considerable breadth, constant, or gradually variable, and the circular or semicircular. Also cases in which the bottom of the channel presents longitudinally a sensible curvature—non-permanent movements, such as those in rivers at times of flood—the laws which regulate the propagation of waves at the surface of flowing water, with the influence of slopes, friction, curves, &c. The committee remark on the agreement between the author's theoretical results and those of actual experience, and regard the treatise as one of much practical value.

Can One Neutralise Irradiation?—M. F. P. Le Roux states in the "Comptes Rendus" of April 14th, that he can at will neutralise irradiation. Thus, he can see the circumference of the luminous part of the moon continuous with that of the dark part; or see a flame no longer encroach on a screen placed beside it; the angles of white squares on a chess board no longer joined by a white ligament (indeed, the appearance may be reversed, and dark squares be seen joined by a dark ligament). He points out that for the field of distinct vision, about the *fovea centralis*, there is no irradiation. From this spot outwards the distinctness of perception rapidly decreases, and we naturally tend to equilibrate the sensations at the periphery of the object. If one of the horns of the lunar crescent is brought into the field of the *fovea centralis*, the irradiation there disappears; but by a peculiar compensation that at the other horn appears more than doubled. M. Le Roux further discusses the case of observation with the naked eye (as well as with telescopes when observing transits of Venus) of a dark ligament between two opaque bodies on an illuminated ground, and says that by sustained attention he can make these disappear. The ligament is not a phenomenon of irradiation, but of imperfect accommodation.

The Absorption Bands of Chlorophyll have been also studied by M. Chautard, who (according to the "Chemical News" of June 12th) divides the chlorophyll bands into three distinct categories. The first contains simply the band in the middle of the red; this he calls the *specific band*. In the second he includes all bands which have been observed in chlorophyll solutions, new or old, neutral, acid, or alkaline; these he calls *supernumerary bands*. The most remarkable is that which results from division of the specific band in the red, under the influence of alkalies. The third category comprises *accidental bands*, not having the permanent character of the preceding, and being produced in special conditions. Of this kind is that from a division of the specific band through acids. The additional band here seems to arise from the less refrangible side, while in the alkaline solution it arises from the other. M. Chautard gives several particulars as to the method of treating chlorophyll in order to obtain various bands.

Comparing Electrical Machines.—This has been done by M. Muscart, who says, in a paper before the French Academy, that an electric machine may be characterised according to two constants—(1) the difference of potential which it is capable of producing between two conductors; (2) the quantity of electricity which it can yield in a given time. The writer has made comparison of eleven different kinds of machine, comprising three Ramsden, one Van Marum, one Nairne, three Holtz, one Carré (with caoutchouc plate), one Armstrong, and the induction coil. A table gives the diameter of the plate, the production per turn, and the production per second.

A Spectral Illuminator is described in the "Comptes Rendus" and also in the "Chemical News" (May). It has been devised by M. Le Roux. It is an instrument by which one may vary almost instantaneously the nature of the light illuminating the slit of a collimator. The rays emergent from a prism are received on a moveable mirror, and the simple ray required is sent in the proper direction. The prism and mirror, with two collimators in the positions of the incident and emergent rays, are fixed on an articulated parallelogram composed of two lozenge-shaped frames.

The Solar Cyclones.—In the "Comptes Rendus" for May 14th, some matter appears which relates to the above. M. Respighi, in a letter, asserts the excellence of his telespectroscope (called in question by P. Secchi). The chromosphere may appear, as P. Secchi says, more elevated where the spots are by a simple effect of perspective, the surrounding faculæ being projected on each other; but having carefully watched the progress of the spots in periods of quiet especially, he (M. Respighi) had often observed depressions at the spot, the red layer being almost interrupted. He also urges that the rarity of reversal of spectral lines in the nuclei is a proof of the small thickness of the chromosphere there; if it were as thick and as largely mixed with luminous jets as neighbouring parts, one should be constantly seeing a reversal of the lines. The reversal when observed is doubtless due to the projection of an intense jet or protuberance on the spot. M. Faye remarks on the complexity of the spot phenomena; including faculæ, jets emanating from them, depression at spot axis, the spot itself, and the solar rotation causing it, all in mutual dependence.

A Novel Sensitive Flame is described by Mr. G. J. Warner, F.C.S., in the "Chemical News," May 9th. It seems to be obtained from a peculiar gas-burner devised by Mr. Wallace, of which he gives the following account:—It consists of a hemispherical chamber, into which the gas is introduced through a cone fixed horizontally at a tangent, the position of the jet with regard to the cone being so adjusted that the quantity of air injected by the velocity of the gas at all ordinary pressures is always the proportion required for its perfect combustion. The upper part of the interior of the chamber is lined with wire gauze, and from it issue one or more tubes, at which the gas is burned. The burner which he has used had only one tube. At ordinary pressures the flame is of the colour of a Bunsen burner, but with a central cone, clearly defined, of pure green, whether it be turned high or low. But if the gas be reduced below the ordinary pressure on the main, the flame becomes white-tipped, and there is no longer perfect combustion, as in a defective Bunsen. It is then found that the flame is sensitive to sound, to all sound in fact, but to high notes particularly. He considers this a curious fact, as he believes it has been generally supposed that a high pressure is necessary to produce such a flame. The first effect of the sound is to elevate the flame several inches, after which, if the sound be prolonged, it shrinks down, producing the same perfect combustion as at ordinary pressures, and this continues as long as the sound. It would appear, therefore, that the gas at a very low velocity does not carry with it sufficient air, and that the effect of the sonorous vibration is to increase the velocity of the gas so long as the vibration continues; so that by sound, by the rattling of a bunch of keys at a distance, we can bring the flame from a state of "imperfect" to one of "perfect" combustion. Of course the burner is small, burning only about $1\frac{1}{2}$ or 2 cubic feet per hour; but he has a larger one in course of manufacture, which he expects will be infinitely more sensitive.

Peculiarities of Spectrum Analysis.—In passing the induction spark between two metallic pieces, M. L. de Boisbaudran says that the spectral lines are chiefly or exclusively obtained at the negative pole; but with aluminium the contrary occurs. Certain solutions examined with the spark only give the air spectrum, even when negative; by moistening the exterior platinum wire this may be avoided. The presence of metallic molecules in the interpolar space enfeebles the air spectrum. The exterior wire may be brought nearer the solution when the latter is positive than when it is negative, in the latter case the liquid tends to meet the wire. The projection of the liquid in droplets; its *pulverisation* increases so rapidly with the length of spark, and varies with the liquid. The dilution of liquors influences the relative intensities of the lines. When, after long calcination in a gas-flame, there is hardly a trace of matter on the platinum wire, it is not always the lines originally brightest which persist longest. With the spark many metals do not give lines when in the compact state, but furnish beautiful spectra when finely divided. It would sometimes be of advantage to mix the metals with pure lead, from which the spark should be brought. —"Comptes Rendus," May 12th.

A New Electric Insulator.—Mr. H. Highton writes to the editor of the "Chemical News" (May 2nd) that some time ago he discovered, in the course of experiments, that vegetable tar, by the addition of the oxides of lead (or in a less degree by some other substances), is almost instantly solidified, and that the solid substance thus obtained has remarkable insulating powers. In some experiments at Silvertown he found that No. 18 copper wire, covered with a coating of gutta-percha weighing only 21 lbs. to the mile, had its insulation increased nearly 200,000 per cent., and that the insulation resistance was no less than 2,800,000,000 units, an insulation sufficient for any lengths possible on the surface of the earth. Insulation of so great cheapness makes all further experiments on telegraphy without insulation needless, though in fresh water or by land this can be effected to very great distances.

Preventing Ship's Compasses being affected by Iron Cargoes.—A new method for this purpose has been devised by M. Gloessner, and is described in a paper which he has published in the "Bulletin de l'Académie Royale des Sciences, etc. etc. de Belgique," No. 4, 1873.

Experiment in Electro-Dynamics with a Gramme Magneto-Electric Machine.—The following experiment with this machine is described in "Comptes Rendus" by MM. Planté and Niaudot-Breguet. It is of special interest to the reader, because this machine is now described in our pages:—If a secondary couple (of lead plates) be charged with a Gramme magneto-electric machine, and then be left undischarged in connexion with the machine which has been stopped, the latter presently begins to turn under influence of the current from the secondary couple in the same direction as it was turned in charging; and continues turning (more slowly, indeed, yet at a considerable rate) for two or three minutes till the couple is discharged. In this restitution there is, probably, only slight loss. That the machine in its motion should turn in the same direction as before seems paradoxical, but may be explained by the laws of currents. Further, the secondary couple once charged gives a current more powerful than that produced by the machine which it puts in motion, the difference of intensities continuing the motion.

ZOOLOGY AND COMPARATIVE ANATOMY.

On Hæmoglobin in the Animal Kingdom.—To the "Proceedings of the Royal Society" (No. 140), Mr. E. Ray Lankester, B.A., has contributed a splendid paper on this subject in which he gathers together all that has been done on the Continent, and adds to this his own researches on the point, which are much vaster. In this way he has produced the best and most exhaustive memoir that has been written on this important subject. The following is an historical account of what has been done on the question: "After Hoppe Seyler and Stokes had shown that the red colouring-matter of the blood of Vertebrata could be recognized by its peculiar absorption-spectrum, Kuhne discovered that the same colouring-matter, the oxygen-carrying properties of which were known from other researches, was diffused in the voluntary muscular tissue of mammals, and imparted to them their red tint. Rollett then obtained from the red vascular fluid of the earthworm crystals which were identical with those of Hæmoglobin, and Nawrocki at the same time as myself confirmed the supposition that Hæmoglobin is the cause of the red coloration of the blood of *Lumbricus*, by careful spectroscopic observation of the fluid and the derivatives yielded by it (Hæmatin). I also established by spectroscopic analysis the existence of Hæmoglobin in the blood of the mollusk *Planorbis*, in that of the larva of the insect *Cheironomus*, in that of the Crustaceans *Cheirocephalus* and *Daphnia*, and in the vascular fluids of the marine Annelids *Eunice*, *Nereis*, *Terebella*, and others. I found also that in the Annelids of the family "Chlorémiens" of Audouin and Edwards, as well as in some species of *Sabella*, the Hæmoglobin was replaced by a body having similar properties, giving a dark red colour to the vascular fluid when seen in sufficient thickness, and a bright green in thinner layers. This body gave a very sharply marked and characteristic pair of absorption-bands in the oxidized condition, which were changed to a single one in the reduced condition, as in the case of Hæmoglobin, the bands, however, having a relative intensity and a position altogether differing from those of Hæmoglobin. By the action of cyanide of potassium, followed by that of a reducing agent (sulphide of ammonium), this body, to which the name Chlorocruorin was given, furnished two absorption-bands identical with those exhibited by Hæmoglobin when similarly treated. Last year I found that the red colour of the pharyngeal muscles of the Gasteropods *Lymnæus* and *Paludina* was due to the presence of Hæmoglobin diffused in the muscular tissue; and at the Meeting of the British Association at Edinburgh I demonstrated its occurrence in the pharyngeal muscular mass of *Littorina*, where it is in sufficient quantity to give a very intense blood-red colour. The interest of this fact consists in this, that in no other part, not even in the blood of these mollusks, does Hæmoglobin occur; hence the doubts which Brozeit had attempted to throw upon Kühne's conclusions with regard to the red colour of mammalian muscular tissue were rendered of less significance than before." Then follows a long series of researches by Mr. Lankester himself, which are llustrated by an excellent plate.—[Over from the last Number of P. S. R.]

The Honey-making Ant of North Mexico.—A paper on this subject has been read before the Academy of Sciences, Philadelphia, on April 21, by Mr. Edwards. The community is divided into three classes—the workers, arriers, and the honey-makers. The workers are much larger than the others, and of a black colour; they guard the nest and convey to it the materials from which the honey is made; these they deposit in a leaf over the centre of the nest, and from this leaf it is transported by the carriers to he honey-makers in the interior of the nest. The carriers are much smaller than the workers, and of a light brown colour. The honey-makers resemble the carriers in size and colour, with the exception of the enlarged abdomen. They are found in the centre of the nest, generally at a depth of two or three feet from the surface. They are supported on a sort of web made of closely woven fibres. Each ant occupies a superficial indentation in the web in which it remains. In fact, all locomotion in the honey-makers is impossible, as the distended abdomen, which constitutes the honey-bag, is at least twenty times as large as the rest of the body. The honey is of a fine flavour, and much sought after by the natives.

What are Instinctive Actions?—This is really, to the thoughtful man, who is learned on the subject, the most intensely difficult question. A paper on this question appears, from the pen of Mr. George Henry Lewis, in "Nature," April 10, and is well worthy of perusal. He (Mr. Lewis) states, among other things, that the fact that we require some character to distinguish the instinctive from the impulsive actions, may be readily shown. No one calls breathing, secretion, excretion, &c., instincts. Yet these are the actions of congenital tendencies in the organism. "A hungry chick," says Mr. Spalding, "that never tasted food, is able, on seeing a fly or spider for the first time, to bring into action muscles that never were so exercised before, and to perform a series of delicately adjusted movements that end in the capture of the insect." Every one would pronounce this a typical case of instinct. Now compare with it the following, which no one would class among the instincts: A new-born animal that has never breathed before is able, on first feeling the stimulus of the atmosphere, to bring into action a very complicated group of muscles which never were so exercised before, and to perform a series of delicately adjusted movements which end in the aëration and circulation of the blood. This contrast may lead us to the character sought. Understanding that every line of demarcation in psychical phenomena must be more or less arbitrary, and only justified by its convenience, we may draw such a line between impulse and instinct. Impulses are the actions which from the first were fatal, inevitable, being simply the direct reflex of the stimulated organs. Given the respiratory organs and the atmosphere, respiration is the inevitable result. Given the secretory organ and the plasma, secretion is the inevitable result. There is no choice, the action either takes place or it does not.

The Lemurs not related to the Apes.—Professor Milne Edwards has made an important discovery. It seems that he has prosecuted an extensive series of observations on "The Embryology of the Lemurians and the zoological affinities of those animals;" and he finds that the placental system differs so widely from that of the simiæ, with which they have been supposed to present very close relationships, that he is of opinion the lemurs should take an intermediate, but wholly distinct, place between monkeys and carnivores.

A Change of Habits in an Animal.—At the Academy of Sciences, Philadelphia, February 18, Mr. T. C. Gentry called attention to what he considered to be an interesting case of a change of habits which had recently occurred in the life of an ordinary chickaree, the *Scinus hudsonius,* of Pallas. During the early part of last autumn, his attention was called to the fact that the birds in a certain designated locality of Mount Airy, during the hours of the night, were undergoing a system of wholesale destruction, the work of small animals which were supposed to belong to some species of carnivora. Labouring under this impression, and being desirous of securing a specimen or two, he started for the scene of slaughter, bent upon discovering the name and character of the animal; when within a few rods of the place, the almost deafening noise that greeted his ears from the tall trees led him to suspect that all was not right. After reaching the spot, a few moments of anxious waiting sufficed to reveal to him the cause of the noise and the origin of the sacrifice above alluded to; for, sitting upon a twig just above his head, he observed a *chickaree,* holding in its paw a bird which it had captured, and from which it was very contentedly sucking the life current. It is a well-established fact, he further remarked, as far as he had been able to verify it, that the numerous species of rodents, with but two exceptions at the most, subsist principally or entirely upon vegetable matter, especially the hard parts of plants, such as nuts, bark, and roots. This habit of imitating the propensities of the *Mustelidæ,* he thought might have arisen from the habit which some squirrels possess, possibly the one under consideration, of sucking the eggs of birds; the blood-sucking habit he assumed to be an outgrowth from the other. This adoption of another's mode of life by *S. hudsonius,* he thought a discovery of some note, as usurpation of habits, leading to functional and structural changes in an animal's economy, is accounted an element of no mean weight in the *development hypothesis,* according to the testimony of able writers upon evolution.

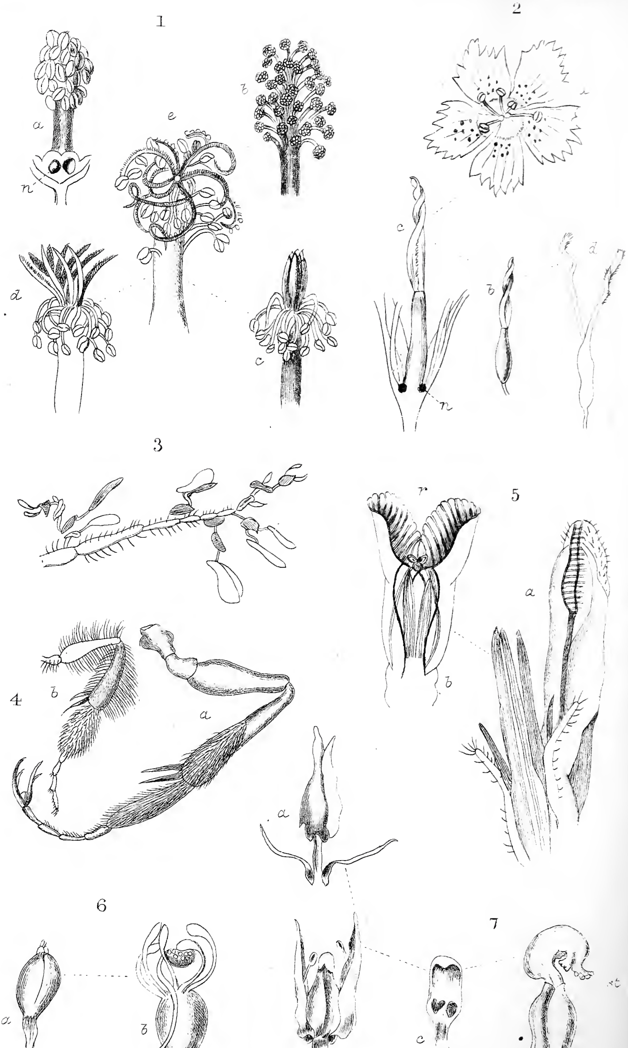
The Sexes of Sphæroma.—In a recent memoir on Crustacea on the Coast of France, published in the "Annales des Sciences Naturelles," 5e série, tome xvii. 1872–3, M. Hesse has, with considerable hesitation, advanced the opinion that *Sphæroma* is only the female of *Cymodocea,* and that *Dynamene* is the female of *Næsea.* The hesitation of this author rests upon th fact that the evidence in his possession was unsatisfactory and negative in character, significantly remarks his ill success in raising the young of these animals, raised as far as the third mouing of the offspring of *Sphæroma,* which he degré de transformation, ils or, "Lorsque ces Crustacés sont parvenus à ce *Sphéromiens.*" In the case at la forme de leur mère, c'est-à-dire celle des expressed, and the absen of *Dynamene* and *Næsea* less hesitation is ex- American coast, car so far as known, of the former genus from the Neither has *Cymo*not be considered as conclusive against the proposition. *docea* yet been obtained so far as Professor Verril knows on our coast, but *Sphæroma quadridentata* [Say] is not uncommon on the coast of New England south of Cape Cod; and, in any considerable collection of these animals, both sexes may be easily found.—Prof. Verril in "Silliman's Journal," April.

The Classification of Mammals.—Mr. Theodore Gill has published a work on this subject in America, which has been issued by the Smithsonian Institution. It is yet, however, incomplete. The part published contains, (1) a list of the families and higher groups of mammals, with some of their synonyms; (2) Bibliography of the works referred to; (3) Synoptical Tables of Characters of the subdivisions of Mammals, with a catalogue of the Genera. The Synoptical Tables are completed only to the end of the Cete. This part of the work gives a very convenient epitome of the principal characters of the groups, and it is to be hoped that it will soon be completed.

A Peculiar Degraded Race of Man has been explored, so to speak, by M. Lagardelle, who communicates through M. Hamy, one of the secretaries of the Anthropological Society of Paris, some curious information in regard to the habitations of the degraded people known under the names of *Colliberts, huttiers,* &c., who for many ages occupied the marshy lands of Poitou, near the mouths of the Sèvre, and whose descendants were known till recently as *nioleurs*. This district was occupied by Gauls before the Norman Conquest, and after that event it became, from its inaccessible character, a place of refuge for fugitives. In the eleventh and twelfth centuries the Colliberts, whose special occupation was fishing, were dependent, as *homines conditionales,* on several religious houses, but were nevertheless left in a state of heathen, almost savage, ignorance. Their huts were made of interlaced willow twigs, and their only means of locomotion before the formation of the network of canals, which have proved the chief agents in rescuing them from their isolation, were their long ash-stilts and the so-called *nioles,* or light boats, from which they took their name.

The Animals dredged in Lake Ontario in 1872.—Mr. Alleyne Nicholson, who lately gave a brief account in the "Annals" of his labours, now prints a fuller description of these in the "Canadian Journal." This is fully analysed in "Silliman's Journal" for May, by Prof. A. E. Verril, who says that "the dredgings were all in shallow water as compared with those made by Mr. S. I. Smith in Lake Superior in 1871. The greater part of the species were obtained in Toronto Bay, where the depth was from 1 to 3 fathoms. Some dredgings were also made in the open lake, where the water was from 8 to 40 or 50 fathoms deep. But in most of the deeper dredgings very few animals were found. The list of animals obtained includes 43 species, of which 21 are shells, and 6 fishes and reptiles. The minute species are omitted. The shells are all inhabitants of shallow water, and most of them are species that are widely distributed in the fresh waters of the northern United States and Canada. *Valvata tricarinata* was the only species found living at depths as great as 8 fathoms; all the others were from less than 4 or 5 fathoms. Three species of leeches are described and figured as new. One of these, *Clepsine patelliformis,* appears to be perfectly identical with *C. elegans,* described by me in this Journal, vol. iii. p. 132, Feb. 1872. The colour differs slightly from the variety originally described; but the colour-variety that he describes is not uncommon at New Haven. Prof. Nicholson states that this species carries the young attached to the ventral surface by means of their posterior sucker, and thinks that this is a remarkable habit. He says, 'This extraordinary habit of carrying the young has been noticed by Prof. Verril in another species of *Clepsine*; but I am not aware that attention has otherwise been drawn to it.' In the paper by me, to which he refers (this Journal, Feb., 1872), I gave this habit as a *generic* character (as many other writers had done before me), saying (p. 127), 'The young adhere in a group to the posterior part of the lower surface of the body of the parent, by means of the posterior sucker, and before quitting the parent, usually present the essential characters, and often nearly the pattern of colour of the adult, though paler.' And in describing the species, the attached young of four species were mentioned, and more or less fully described."

Habits of Ants Displaying Considerable Intelligence.—Mr. Darwin has received a letter from J. D. Hague, which, as it contains facts of interest, he has sent to "Nature," April 10, for publication. Among other points of interest in the communication is the following account:—"One day I observed a number of ants, perhaps thirty or forty, on the shelf at the foot of the vase. Thinking to kill them I struck them lightly with the end of my finger, killing some and disabling the rest. The effect of this was immediate and unexpected. As soon as those ants that were approaching arrived near to where their fellows lay dead and suffering, they turned and fled with all possible haste. In half an hour the wall above the mantelshelf was cleared of ants. During the space of an hour or two the colony from below continued to ascend, until reaching the lower bevelled edge of the shelf, at which point the more timid individuals, although unable to see the vase, somehow became aware of trouble and turned about without further investigation; while the more daring advanced hesitatingly just to the upper edge of the shelf, where, extending their antennæ and stretching their necks, they seemed to peep cautiously over the edge until beholding their suffering companions, when they too turned and followed the others, expressing by their behaviour great excitement and terror. An hour or two later the path or trail leading from the lower colony to the vase was almost entirely free from ants. I killed one or two ants on their path, striking them with my finger, but leaving no visible trace. The effect of this was that as soon as an ant ascending towards the shelf reached the spot where one had been killed, it gave signs immediately of great disturbance, and returned directly at the highest speed possible. A curious and invariable feature of their behaviour was, that when such an ant, returning in fright, met another approaching, the two would always communicate, but each would pursue its own way; the second ant continuing its journey to the spot where the first had turned about, and then following that example."



Kath^e. Bennett.

W. West & Co. imp.

Modes of fertilization in plants.

RECENT OBSERVATIONS ON THE FERTILISATION OF PLANTS.

By ALFRED W. BENNETT, M.A., B.Sc., F.L.S.

Lecturer on Botany, St. Thomas's Hospital.

[PLATE CII.]

IT is proposed in the following article to give an account of some of the most recent observations on the subject of the contrivances by which the Fertilisation of Flowers is effected; a subject the details of which are so numerous and varied that the field of observation open, not only to the scientific botanist, but even to the ordinary observer, seems almost boundless. So much has now been written on this subject that everyone who has followed it to any extent is aware that the greater number of flowers are cross-fertilised—though to this rule there are exceptions to which we shall allude presently—and that the mode in which this cross-fertilisation is usually effected is by the agency of insects. There are, however, a considerable number of flowers which are fertilised without the assistance of insects by means of the wind; and as these present, as a class, peculiar features of their own, we may spend a little time in the first place in considering them.

A very good and familiar example of flowers fertilised by the agency of the wind is furnished by the common hazel, which flowers from January till the early part of March, even when the weather is very cold, and when there are scarcely any insects on the wing. The flowers of the hazel are of two kinds, male and female. The male flowers constitute the familiar catkins, which drop off and disappear before the leaves make their appearance. The catkins are generally in bunches of from two to four, every catkin containing on an average perhaps from 100 to 120 flowers. Each of these male flowers consists of a simple scale-like bract enclosing from eight to twelve anthers, each of which discharges, when ripe, a cloud of innumerable pollen-grains; so that the number of these grains in any single catkin must be prodigious. The female flowers are found on the same branches as the catkins, and are also in clusters of from two to six or eight (the future nuts), and are of equally simple structure with the male flowers, being formed of a single pistil enclosed in bracts, the ovary surmounted by from three to five stigmas, the bright crimson threads by which these female flowers are recognised. If one of these crimson threads is placed under an ordinary pocket lens, it will generally be found to have on its surface several apparently minute particles of dust, which, on further examination, are found to be pollen-grains which have been blown from the male flowers. Each individual pollen-grain has the power of emitting a "pollen-tube," which penetrates the stigma, reaches the ovary, and by the fertilisation of the ovule induces the formation of the embryo, and thus the development of the ovule into the fertile nut. Since the only means by which the pollen can be conveyed from the male to the female flower is the agency of the wind, and it is only quite by chance that any of the grains can reach their destination, the reason is obvious of the enormous amount of pollen with which the catkins of the hazel are furnished. In some plants, the fertilisation of which is effected in the same manner, the quantity of pollen is still greater, and this is especially the case in the Coniferæ or fir-tribe. If a yew-tree is struck with a stick or agitated by the wind at the time when the pollen is being discharged, it will rise in the form of a dense smoke, giving the impression of a burning bush; and American travellers have described how the water of some of their lakes near the shore is covered at certain seasons by a thick stratum of a sulphur-like substance, the pollen blown from the neighbouring pine-woods. Whether the female flowers of the hazel are fertilised from the catkins on the same or on a different bush is a point still in dispute.

Another instance in which there is little doubt that fertilisation is accomplished by the agency of the wind, though botanists are not quite unanimous on this point, is that of our common cereal crops, and especially of wheat. Important in the highest degree from a mere mercantile point of view as is any question connected with the production of our corn crops, it is only very recently that any reliable observations have been made on the mode in which the flowers of wheat are fertilised; but these have led to some very curious results.* When a field of wheat is in flower, that is, in ordinary seasons, in the early part of June, each ear will be found to be furnished with a great number of purplish anthers hanging at the ends of filaments of extraordinary delicacy, or rather of empty anther-sacs from which every grain of pollen has been discharged. These anthers

* See "Gardener's Chronicle," March 15 and 22, and May 24, 1873.

appear, when they have arrived at maturity, to break suddenly out of the opening bud, the filament elongating in a moment to several times its original length, the anther bursting at the same time, when the slightness of its attachment to the filament causes the least breath of wind to sweep the whole of the light dusty pollen out of its case, some of which must necessarily reach the neighbouring stigmas in the same ear, provided there is not enough wind to blow it completely away. In rye and oats this extraordinarily rapid lengthening of the filaments is even more conspicuous than in wheat. Hence the importance attached by farmers to comparatively calm sunny weather at the critical period when the corn is in flower.

These two examples furnish good illustrations of the structure which prevails in those flowers that are fertilised by the wind. They are generally of very simple structure, and rarely brightly coloured, since bright colours would be of no advantage to them. The quantity of pollen is usually very large, and the structure of the male flowers such that it is dispersed by the wind with the greatest facility, this being brought about by the slender "versatile" filaments of the wheat and by the lightly hanging catkins of the hazel, the willow, and other early-flowering shrubs, which appear before the leaves, and hence at a period when there is no obstruction to the free dissemination of the pollen.

In the majority of flowers, however, the structure of the pollen, or the arrangement relatively to one another of the pistil and stamens, is such that fertilisation could not be effected by the wind alone. Sometimes the pollen-grains themselves are too large and heavy to be thus conveyed, or they are united together by fine threads or even into dense masses; or the position of the stigmatic portion of the pistil is evidently not adapted for the pollen to reach it in this way; and Nature then employs as the agent in fertilisation the services of insects or of other small animals. This opportunity is afforded by the visits of insects to the flowers in search of the honey or nectar which forms an important portion of the food of many classes. The mode of attraction to the flowers which serve them for food is mainly two-fold, scent and colour; in other words, those properties which chiefly render flowers attractive to our own senses. The honey or other sweet juice is generally stored in small glands or receptacles, which together form the "nectary," the position of which is extremely variable; the deep pits at the base of the corolla in the crown imperial, the small scroll-like petals of the hellebore, the bottom of the spur in orchises and the larkspur, the prolongations of two of the stamens which project into the spur of the violet and pansy, very frequently minute glands at the base of the stamens or pistil, &c. Nature is always economical of her resources; and accordingly we do not generally find that strong scent and brilliant variegation of colour are bestowed on the same flower. Those which are most prized for the power or delicacy of their scent have, as a rule, flowers either inconspicuous, or, if large and conspicuous, of uniform unvariegated colour; as, for instance, the mignonette, Daphne, primrose, sweet violet, lily of the valley, rose, evening primrose, pink (in its primitive white state), honey-suckle, lime-tree, and many others; while the most brilliantly-variegated flowers are comparatively or quite scentless, as the fritillary, Pelargonium, larger and smaller Convolvulus, Tropæolum, Mimulus, Ranunculus, pansy, &c. In scented flowers the scent proceeds from the nectar itself, and is therefore a sufficient guide for the insects in search of it. One of the largest of scented flowers, the evening primrose, blossoming only in the night, is fecundated by night-flying moths, which probably require the large sulphur-yellow flowers, as well as the scent, to guide them from a distance in the dim light. A distinction may also be drawn in general terms between the mode of fertilisation of large conspicuous and of smaller variegated flowers; the agents in the former case being generally large insects, butterflies, moths, beetles, or bees; in the latter very much smaller ones. If a watch is kept on very large flowers, such as the single hollyhock, single peony, " Convolvulus major " of the gardens, the large white wild Convolvulus, Fuchsia, &c., it will be seen that their visitors mostly consist of large beetles, hive or bumble-bees, or butterflies, while the small flowers are overrun with small flies or other minute insects to whom the variegation serves as a guide, the streaks or rows of colouring invariably pointing to the nectary or receptacle of honey. American naturalists state that many of the largest and most gorgeous flowers of the western continent, such as the Bignonias or trumpet-flowers, are fecundated by humming-birds. A very good illustration of the different contrivances exhibited by two closely-allied plants—one scented and fertilised by bees, the other scentless and variegated and fertilised by very minute insects—is afforded by the sweet violet and the pansy.*

If attention is paid to the arrangement and position of the stigmas and stamens at the time when insects are seeking the flowers for the sake of the honey, it will be seen that the anthers are almost always at this time discharging their pollen, and that it is impossible for the insect to find its way to the nectary, or to insert its proboscis into it, without brushing against one or more of the anthers, and carrying away with it a portion of the pollen. Either in its retreat from the flower or in entering the

* See "Nature," vol. viii. p. 49, May 15, 1873.

next flower (of the same species) which it visits, it will also almost inevitably strike against the stigma and leave some of the pollen-grains behind on it, which will then put out their tubes and fertilise the ovules. But inasmuch as in by far the majority of cases the stigma is not "receptive," or in that papillose and viscid condition in which alone it incites the emission of the pollen-tubes at the same time that the pollen is being discharged from the anthers in the same individual flower, provision is thus made for that "cross-fertilisation" which we have already spoken of as the general rule; and indeed in many cases no other mode of fertilisation is possible.

Readers of botanical literature are now so familiar, both from articles in this journal (POPULAR SCIENCE REVIEW, July 1869, p. 261, and Jan. 1870, p. 45) and elsewhere, with illustrations of the infinite variety and beauty of the contrivances for the cross-fertilisation of flowers by insect agency, that we do not propose to give many more here. The simple arrangement by which the pistil and stamens in the same flower arrive at maturity at different times may be noticed without difficulty by the most careless observer. It is only necessary to gather the common rib-grass (*Plantago lanceolata*) to observe that the feathery stigmas are produced from the still half-closed bud before the stamens are nearly mature; and the same is the case with the water-side figworts (*Scrophularia nodosa* and *aquatica*). The reverse, however, is far more common, and may be well seen in almost any plant belonging to the natural order Caryophyllaceæ, as, for example, any of the common species of stitch-wort (*Stellaria Holostea* or *graminea*), where the anthers have actually dropped off the filament before the stigmas have acquired their receptive condition. The hare-bell, or any other species of Campanula, wild or cultivated, will illustrate the same phenomenon. A singular circumstance connected with these arrangements is that closely allied species of the same genus exhibit sometimes exactly opposite peculiarities in this respect; and it is even uncertain whether the same species does not vary under different conditions. A very interesting account of the phenomena presented by a number of plants of the pea-tribe belonging to the natural order Leguminosæ, by Mr. T. H. Farrer, will be found in "Nature," vol. vi. We may give a single very good example of this in the two common mallows, illustrated by fig. 1 in our plate, which are taken from a book, to which we shall have occasion to refer again, by Dr. H. Müller, of Lippstadt,* on the Fertilisation of Flowers by Insect Agency. In the large mallow (*Malva sylvestris*) the stamens are collected together into

* "Die Befruchtung der Blumen durch Insekten und die gegenseitigen Anpassungen beider. Von Dr. Hermann Müller." Leipzig, 1873.

a bundle completely surrounding and overtopping the pistil, as represented in *a* and *b*, the anthers being in the act of discharging their pollen in *b*. At a later stage, *c*, the empty anthers are bent down out of the way of the stigmas, which are even yet not in a receptive condition; this latter state being represented at *d*. Spontaneous self-fertilisation is in this case scarcely possible. In the smaller species (*Malva rotundifolia*) the structure is the same up to a certain point, but the stigmas mature earlier, and when in this condition coil themselves among the anthers, as represented in *e*, there being still sufficient pollen left in the anthers to ensure the self-fertilisation of the flower. The two species often grow intermixed; both are scentless; insects are, however, abundantly attracted by the large showy flowers of *M. sylvestris*, which are also beautifully streaked, the streaks all pointing towards the nectar-glands (*n* in *a*), at the base of the tube formed by the filaments. The flowers of *M. rotundifolia* are much smaller and of paler colour and are not streaked, and hence not so attractive to insects. Dr. Müller records thirty-one species of insects, chiefly Hymenoptera, which he detected visiting the former, whilst only four were observed to frequent the latter species.

Our fig. 2 is a very good illustration of a necessarily cross-fertilised flower. *Dianthus deltoides*, the "maiden-pink," is scentless; but each of the five petals is provided with a number of purple spots, which seem to indicate to the butterflies, by which they are chiefly visited, the exact place wherein to insert their proboscis in order to reach the honey-glands, indicated at *n* in *c*. The anther, at this time discharging pollen, is placed immediately over each petal, and the butterfly cannot fail to carry off some of the dust on its head. A second inner row of five stamens, at this period completely concealed within the tube of the corolla, do not mature till later; and it is only after all the anthers have dropped off that the two stigmas, previously coiled round one another, separate and develop the hairs which serve for the detention of the pollen, as shown in *d*.

While the various contrivances connected with the arrangements of the male and female organs have been more or less known to botanists for three-quarters of a century, very little attention has been paid, until the publication in the present year of Prof. Müller's book already mentioned, to the corresponding adaptations of the structure of insects for the same purpose. This naturalist—an accomplished entomologist as well as botanist—has made this branch of the subject his special study, and has collected together a large number of interesting and curious facts. There are two ways in which chiefly insects perform their part in the fertilisation of flowers—in their search for honey and for pollen. We have already seen several instances of the mode in which insects, and especially those furnished with a long proboscis and belonging to the orders Lepidoptera and Hymenoptera, involuntarily detach some of the pollen while obtaining their food, and carry it away with them to fructify other flowers which they then visit. One of the most interesting examples of this was first described in detail by Darwin in his work on the Fertilisation of Orchids; and it is extremely easy to observe the manner in which the pollen-masses or "pollinia" of orchids are carried away on the proboscis of butterflies and moths. The natural order Asclepiadaceæ, to which belong the beautiful waxen-flowered Hoya and the singular fœtid Stapelia, has the pollen arranged, in the same manner as in orchids, in pollen-masses which are similarly fixed in pairs to a viscid base, the whole apparatus being easily detached on to any insect which visits the flower. Fig. 3 represents the foot of a butterfly with eight of these pollen-masses and eleven of the viscid bases attached to it, belonging to the Brazilian *Asclepias curassavica.*

The second mode in which insects assist in the fertilisation of flowers is by the voluntary deportation of pollen; and this is chiefly effected by Hymenoptera belonging to the class Apidæ, which includes the hive and bumble-bees that build nests in which they store up large quantities of food for their young while in the larva state. This "bee-bread," as it is termed, with which the thighs of homeward-bound bees are seen to be heavily laden, consists almost entirely of innumerable pollen-grains robbed from the flowers, which the little depredators may be seen to despoil in a very scientific manner. Though the greater quantity of this pollen is carried home, small quantities of it are unintentionally left behind here and there on the stigmas of the flowers, quite sufficient to ensure the fertilisation of the ovules. Prof. Müller arranges the different genera of Apidæ into a series according to their adaptation for this deportation of pollen, from the extent to which their thighs, shins, and feet are clothed with hairs. Fig. 4, *a*, is the right hind-leg of the little *Prosopis variegata*, in which the upper part of the leg is perfectly naked, the lower portion only being slightly covered with hairs (and this is even somewhat exaggerated in the drawing); so that its power of collecting pollen is very small. Fig. 4, *b*, is the same limb of a neuter or working individual of a species of Bombus or bumble-bee, in which every part of the leg is densely clothed with hairs, and the quantity of pollen it can carry off is therefore immense.

Besides these, there is a third purpose for which insects remove the pollen of flowers, which is less known, and the object of which in the vegetable economy is not so evident: viz. by actually eating it. This has chiefly been observed in the case of flies or Diptera belonging to the class Syrphidæ, the movements of which in summer and autumn, in hovering over flowers and then suddenly darting upon them, are so remarkable. Many entomologists doubt whether it is possible for flies, which have no mandibles, and whose only food-obtaining organ is a proboscis adapted for suction, to masticate so comparatively hard a substance as pollen-grains. This need not, however, present a difficulty to anyone who has smarted under the irritating attacks of flies and midges during rainy weather in mountainous countries. We have ourselves dissected the bodies of flies belonging to this family, and found their stomachs in many cases perfectly loaded with pollen-grains. Prof. Müller takes this view very decidedly, and gives some admirable drawings, from which we have taken our fig. 5, to show the manner in which the extreme tip of the proboscis is furnished with a number of cross-bars, *r*, by means of which, as he has himself observed, these insects are able even to tear asunder the fine threads by which the grains of pollen are frequently attached to one another, as in the evening primrose. Fig. 5, *a*, represents the extremity of the proboscis of one of the largest and commonest of these "hoverers," *Eristalis tenax*, closed; *b* the same open, showing the cross-bars.

It is often a matter of surprise to the cultivators of flowers that many species which flower luxuriantly in our gardens never produce fruit or seed, though all the separate organs of the flower appear to be perfectly developed. This is the case, for instance, with the large white Convolvulus grown frequently against the walls of houses, and with the yellow jessamine which flowers in the winter, and to a less extent with the Calycanthus or allspice-tree. The reason of this is no doubt generally the absence of those insects which serve as their fertilisers in their native country, our native species either not being attracted by their foreign nectar, or not possessing the mechanical appliances necessary to obtain it, and hence not visiting the flowers.

We mentioned at the outset that though the large majority of flowers are cross-fertilised, yet there are exceptions to the rule. Darwin has described the peculiar contrivance by which self-fertilisation is effected in the singular Bee-orchis (*Ophrys apifera*) of our chalk hills, alone among our native orchids. There are not a few flowers which never or scarcely ever completely open their petals so as to allow either the entrance of an insect or the escape of the pollen. An instance of this is furnished by the pretty little bog plant the sundew (*Drosera* *rotundifolia*), a flower of which is represented by fig. 6, *a* representing its ordinary utmost state of expansion, while at *b* are the organs of reproduction enclosed in it. The pistil ends in five club-shaped stigmas covered with receptive papillæ; while the 8-12 stamens, one only of which is represented in our drawing, curve in and out among them by their flexible filaments, so as to bring the pollen into actual contact with the stigmas.

The most singular, however, of these special contrivances for self-fertilisation are the peculiarly-shaped "cleistogamous" flowers, as they have been termed—which occur in many plants belonging to widely-separated natural orders, either intermixed with the ordinary conspicuous flowers or appearing at a different time of the year—with respect to which very little has been written in English botanical works. Among the natural orders in which these flowers have been found are Violaceæ, Cistaceæ, Oxalideæ, Balsamineæ, Polygalaceæ, Caryophyllaceæ, Malpighiaceæ, Leguminosæ, Campanulaceæ, Convolvulaceæ, Acanthaceæ, Labiatæ, and one order of Endogens, Commelynaceæ.* The two species of Impatiens or Touch-me-not, which grow wild in this country—*I. Noli-me-tangere*, native in Westmoreland and some other rocky and woody parts, and *I. fulva*, a North American plant fully naturalised by the banks of the Wey and other parts of Surrey, as well as the smaller *I. parviflora*, now also rapidly becoming completely naturalised in the neighbourhood of London—have closed, imperfect, self-fertilised flowers intermixed with the showy yellow ones. They are far more numerous than the conspicuous flowers, much smaller, and easily recognised even in the bud.† The calyx is quite regular, not presenting the "spur" of the open flowers, always remains perfectly closed, and is pushed off at the extremity of the seed-vessel in the form of a little brown cap. The petals are entirely absent. The stamens are of an altogether different shape to those of the larger flowers, and contain but a very small quantity of pollen, which, however, is amply sufficient for the fertilisation of the ovules, the full number of seeds appearing to be always produced.

The most easily observed instances are, however, in the case of our common wild violets, the sweet violet (*Viola odorata*), or the various forms of the dog violet (*V. canina*). The existence of these flowers in Viola was known as long ago as the time of Linnæus, who, in his "Prælectiones Botanicæ," says that the flowers of *Viola mirabilis* produced in the spring

* See Von Mohl in "Botanische Zeitung," 1863, pp. 311 et seq.

† See a full description and plate in the "Journal of the Linnean Society," vol. xiii. p. 147, May 29, 1872.

are often barren, while the later ones, which have no corolla, are fertile. Von Mohl has seen the pollen escape from the anthers on to the stigmas and give out abundance of pollen-tubes. Monnier says that the ordinary spring flowers of *Viola hirta* and *odorata* never produce seed; but this statement is disputed by others. The "cleistogamous" flowers of the violet appear long after those that are so familiar in the spring, and may be found in abundance about July and August, very small, but still not difficult to make out. Fig. 7, *a*, shows the appearance of one of these unopened flowers, the only visible part being the five sepals, of nearly the same form, though much smaller, than the ordinary ones. On opening the appearance is presented shown in *b*; no trace of petals; there are five stamens, two of them represented in the figure, with long filaments and very small anthers, offering scarcely any resemblance to those of the open flowers, which have very large anthers and no filaments. The pollen, again very small in quantity, is contained in two almost transparent bags at the base of the anther, shown at *n* in *c*, and is discharged directly on to the stigma. The pistil, *d*, consists of a conical ovary, and a very large stigma curved completely over in a semi-circle so as to bring the papillose receptive surface (*st*) into a horizontal position in which it will most readily receive the pollen. A most instructive contrast is afforded between the arrangements of the reproductive organs in these two kinds of flowers on the same plant. In the showy spring flowers the stigma projects horizontally in the form of a beak above and quite clear of the stamens, the arrangement of which is such that it is scarcely possible for any of the pollen to reach the stigma without the intervention of insect agency. In these closed summer flowers it will be seen that the arrangements have evidently an exactly opposite purpose. They produce abundance of seed. Another section of the genus Viola, of which the wild pansy (*Viola tricolor*) may be taken as the type, produce no cleistogamous flowers; and the contrivances for fertilisation are, as has already been mentioned, quite different from those in the true violets.

In two Indian species of Campanula, the closed flowers are described by Professor Oliver as being altogether different in shape to the conspicuous ones. They are covered by a completely closed membrane, the rudiment of the corolla; the stamens are extended horizontally, and the anthers are quite connate, and together adnate to the stigma. As the flowers have only at present been observed in dried herbarium specimens, the mode in which the pollen-grains reach the stigma is still uncertain. In *Juncus bufonius* it is said that the pollen-tubes are emitted while still within the anther, the wall of which they pierce. In the wood-sorrel, *Oxalis acetosella*, the closed flowers, which appear towards the end of the summer, resemble much more closely the well-known spring flowers, which are in this case certainly fertile.

In accordance with the ordinary practice of economy by nature, the amount of pollen in the "cleistogamous" is generally very much less than in the open flowers, since it has very little chance of being wasted. In the small flowers of Malpighiaceæ, Jussieu states that there are only a very few grains of pollen; in those of the wood-sorrel, where twenty to thirty ovules have to be fertilised, Von Mohl gives the quantity as from one to two dozen grains in each anther-cell; in Impatiens it is considerably larger, while in Viola the number of grains is very small.

More detailed examination of these closed flowers in different plants will doubtless yield interesting and important results.

EXPLANATION OF PLATE CII.

Fig. 1. (*a–d*) Different stages in the development of the pistil and stamens of *Malva sylvestris*, (*n*) nectar-glands; (*e*) mature pistil and stamens of *Malva rotundifolia*.

„ 2. *Dianthus deltoides*: (*a*) open flower, the first row of five stamens developed; (*b, c*) pistil, with the two stigmas closely rolled together, (*n*) nectar glands; (*d*) pistil at a later stage, with the stigmas unrolled and receptive.

„ 3. Foot of a butterfly with pollen-masses of *Asclepias curassavica* attached to it.

„ 4. (*a*) Right hind-leg of *Prosopis variegata*; (*b*) right hind-leg of *Bombus Scrimshiranus*.

„ 5. End of the proboscis of *Eristalis tenax*; (*a*) closed, (*b*) open, to show the cross-bars (*r*) with which it is furnished.

„ 6. *Drosera rotundifolia*; (*a*) unopened flower, (*b*) pistil and one stamen from the same.

„ 7. Cleistogamous flower of *Viola canina*; (*a*) external view of flower; (*b*) the same opened, showing pistil and two stamens; (*c*) anther, with the pollen-bags (*n*); (*d*) pistil; (*st*) the receptive stigmatic surface.

(Figs. 1–5 after H. Müller.)

NEWS FROM JUPITER.

By RICHARD A. PROCTOR, B.A. (Cambridge),

Honorary Secretary of the Royal Astronomical Society,
Author of "Other Worlds than Ours," "The Sun,"
"The Moon," "Saturn," &c. &c.

THE planet Jupiter has passed during the last year through a singular process of change. The planet has not, indeed, assumed a new appearance, but has gradually resumed its normal aspect after three or four years, during which the mid zone of Jupiter has been aglow with a peculiar ruddy light. The zone is now of a creamy-white colour, its ordinary hue. We have, in fact, reached the close of a period of disturbance, and have received a definite answer to questions which had arisen as to the reality of the change described by observers. Many astronomers of repute were disposed to believe that the peculiarities recently observed were merely due to the instruments with which the planet has been observed—not, indeed, to any fault in those instruments, but, in fact, to their good qualities in showing colour. A considerable number of the earlier accounts of Jupiter's change of aspect came from observers who used the comparatively modern form of telescope known as the silvered-glass reflectors, and it is well known that these instruments are particularly well suited for the study of colour-changes. Nevertheless, observations made with the ordinary refracting telescope were not wanting; and it had begun to be recognised that Jupiter really had altered remarkably in appearance, even before that gradual process of change which, by restoring his usual aspect, enabled every telescopist to assure himself that there had been no illusion in the earlier observations.

I propose now to discuss certain considerations which appear to me to indicate the nature and probable meaning of the phenomena which have recently been observed in Jupiter. It seems to me that these phenomena are full of interest, whether considered in themselves or in connection with those circumstances on which I had been led to base the theory that Jupiter is a planet altogether unlike our earth in condition, and certainly unfit to be the abode of living creatures.

I would first direct special attention to the facts which have been ascertained respecting the atmosphere of Jupiter.

It does not appear to have been noticed, as a remarkable circumstance, that Jupiter should have an atmosphere recognisable from our distant station. Yet, in reality, this circumstance is not only most remarkable, but is positively inexplicable on any theory by which Jupiter is regarded as a world resembling our own. It is certain that, except by the effects produced when clouds form and dissipate, our terrestrial atmosphere could not be recognised at Jupiter's distance with any telescopic power yet applied. But no one who has studied Jupiter with adequate means can for a moment fail to recognise the fact that the signs of an atmosphere indicate much more than the mere formation and dissipation of clouds. I speak here after a careful study of the planet during the late opposition, with a very fine reflecting telescope by Browning, very generously placed at my disposal by Lord Lindsay; and I feel satisfied that no one can study Jupiter for many hours (on a single night) without becoming convinced that the cloud-masses seen on his disc have a *depth* comparable with their length and breadth. Now the depth of terrestrial cloud-masses would at Jupiter's distance be an absolutely evanescent quantity. The span of his disc represents about 84,000 miles, and his satellites, which look little more than points in ordinary telescopes, are all more than 2,000 miles in diameter. I am satisfied that anyone who has carefully studied the behaviour of Jupiter's cloud-belts will find it difficult to believe that their depth is less than the twentieth part of the diameter of the least satellite. Conceive, however, what the depth of an atmosphere would be in which cloud-masses a hundred miles deep were floating!

It may be asked, however, in what sense such an atmosphere would be inexplicable, or, at least, irreconcilable with the theory that Jupiter is a world like our earth. Such an atmosphere would be in strict proportion, it might be urged, to the giant bulk of the planet, and such relative agreement seems more natural than would be a perfect correspondence between the depth of the atmosphere on Jupiter and the depth of our earth's atmosphere.

But it must not be forgotten that the atmosphere of Jupiter is attracted by the mass of the planet; and some rather remarkable consequences follow when we pay attention to this consideration. Of course a great deal must be assumed in an inquiry of the sort. Since, however, we are discussing the question whether there can be any resemblance between Jupiter and our earth, we may safely (so far as our inquiry is concerned) proceed on the assumption that the atmosphere of Jupiter does not differ greatly in constitution from that of our earth. We may further assume that at the upper part of the cloud-layers we see, the atmospheric pressure is not inferior to that of our atmosphere at a height of seven miles above the sea-level, or one-fourth of the pressure at our sea-level. Combining these assumptions with the conclusion just mentioned, that the cloud-layers are at least 100 miles in depth, we are led to the following singular result as to the pressure of the Jovian atmosphere at the bottom of the cloud-layer:—The atmosphere of any planet doubles in pressure with descent through equal distances, these distances depending on the power of gravity at the planet's surface. In the case of our earth, the pressure is doubled with descent through about $3\frac{1}{2}$ miles; but gravity on Jupiter is more than $2\frac{1}{2}$ times as great as gravity on our earth, and descent through $1\frac{2}{5}$ mile would double the pressure in the case of a Jovian atmosphere. Now 100 miles contain this distance ($1\frac{2}{5}$ mile) more than seventy-one times; and we must therefore double the pressure at the upper part of the cloud-layer seventy-one successive times to obtain the pressure at the lower part. Two doublings raise the pressure to that at our sea-level; and the remaining sixty-nine doublings would result in a pressure exceeding that at our sea-level so many times that the number representing the proportion contains twenty-one figures.* I say *would* result in such a pressure, because in reality there are limits beyond which atmospheric pressure cannot be increased without changing the compressed air into the liquid form. What those limits are we do not know, for no pressure yet applied has changed common air, or either of its chief constituent gases, into the liquid form, or even produced any trace of a tendency to assume that form. But it is easily shown that there must be a limit to the increase of pressure which air will sustain without liquefying. For the density of

* The problem is like the well-known one relating to the price of a horse, where one farthing was to be paid for the first nail of 24 in the shoes, a halfpenny for the next, a penny for the third, two pence for the fourth, and so on. It may be interesting to some of my readers to learn, that if we want to know roughly the proportion in which the first number is increased by any given number of doublings, we have only to multiply the number of doublings by $\frac{3}{10}$ths, and add 1 to the integral part of the result, to give the number of digits in the number representing the required proportions. Thus multiplying 24 by $\frac{3}{10}$ths gives 7 (neglecting fractions); and therefore the number of farthings in the horse problem is represented by an array of 8 digits.

any gas changes proportionately to the increase of pressure, until the gas is approaching the state when it is about to turn liquid. Now air at the sea-level has a density equal to less than the 900th part of the density of water; so that if the pressure at the sea-level were increased 900 times, either the density would not increase proportionally, which would show that the gas was approaching the density of liquefaction, *or else* the gas would be denser than water, which must be regarded as utterly impossible. Or if any one is disposed, for the sake of argument, to assume that a gas (*at ordinary temperatures*) may be as dense as water, then we need proceed but a few steps farther, increasing the pressure about 18,000 times instead of 900 times, to have the density of *platinum* instead of that of water, and no one is likely to maintain that our air could exist in the gaseous form with a density equalling that of the densest of the elements. We are still an enormous way behind the number of twenty-one figures mentioned above; and in fact, if we supposed the pressure and density to increase continually to the extent implied by the number of twenty-one figures, we should have a density exceeding that of platinum more than ten thousand millions of millions of times!

Of course this supposition is utterly monstrous, and I have merely indicated it to show how difficulties crowd around us in any attempt to show that a resemblance exists between the condition of Jupiter and that of our earth. The assumptions I made were sufficiently moderate, be it noticed, since I simply regarded (i.) the air of Jupiter as composed like our own; (ii.) the pressure at the upper part of his cloud-layer as not less than the pressure far above the highest of our terrestrial cumulus clouds (with which alone the clouds of Jupiter are comparable); and (iii.) the depth of his cloud-layer as about 100 miles. The first two assumptions cannot fairly be departed from to any considerable extent, without adopting the conclusion that the atmosphere of Jupiter is quite unlike that of our earth, which is precisely what I desire to maintain. The third is, of course, open to attack, though I apprehend that no one who has observed Jupiter with a good telescope will question its justice. But it is not at all essential to the argument that the assumed depth of the Jovian atmosphere should be even nearly so great. We do not need a third of our array of twenty-one figures, or even a seventh part, since no one who has studied the experimental researches made into the condition of gases and vapours can for a moment suppose that an atmosphere like ours could remain gaseous, *except at an enormously high temperature*, at a pressure of two or three hundred atmospheres. Such a pressure would be obtained, retaining our first two assumptions, at a depth of about fourteen miles below the upper part of the cloud-layer. This is about the 6,000th part of the diameter of Jupiter; and if any student of astronomy can believe that that wonderfully complex and changeful cloud envelope which surrounds Jupiter has a thickness of less than the 6,000th part of the planet's diameter, I would recommend as a corrective the careful study of the planet for an hour or two with a powerful telescope, combined with the consideration that the thickness of a spider's web across the telescopic field of view would suffice to hide a breadth of twenty miles on Jupiter's disc.

But we are not by any means limited to the reasoning here indicated, convincing as that reasoning should be to all who have studied the aspect of Jupiter with adequate telescopic power. We have in Jupiter's mean density an argument of irresistible force against the only view which enables us even hypothetically to escape from the conclusions just indicated. Let it be granted, for the sake of argument, that Jupiter's cloud layer is *less* than fourteen miles in depth, so that we are freed for the moment from the inference that at the lower part of the atmosphere there is either an intense heat or else a density and pressure incompatible with the gaseous condition. We cannot, in this case, strike off more than twenty-eight miles from the planet's apparent diameter to obtain the real diameter of his solid globe—solid, at least, if we are to maintain the theory of his resemblance to our earth. This leaves his real diameter appreciably the same as his apparent diameter, and as a result we have the mean density of his solid globe equal to a fourth of the earth's mean density, precisely as when we leave his atmosphere out of the question. Now I apprehend that the time has long since passed when we can seriously proceed at this stage to say, as it was the fashion to say in text-books of astronomy, "therefore the substance of which Jupiter is composed must be of less specific gravity than oak and other heavy woods." We know that Brewster gravely reasoned that the solid materials of Jupiter might be of the nature of pumice-stone, so that with oceans resembling ours a certain latitude was allowed for increase of density in Jupiter's interior. But in the presence of the teachings of spectroscopic analysis, few would now care to maintain, as probable, so preposterous a theory as this. Everything that has hitherto been learned respecting the constitution of the heavenly bodies, renders it quite unlikely that the elementary constitution of Jupiter differs from that of our earth. Again, it was formerly customary to speak of the possibility that Jupiter and Saturn might be hollow globes, mere shells, composed of materials as heavy as terrestrial elements. But whatever opinion we may form as to the possibility that a great intensity of heat may vaporise a portion of Jupiter's interior, we know quite certainly that there must be enormous pressure throughout the whole of the planet's globe, and that even a vaporous nucleus would be of great density. For it is to be remembered that all that I have said above respecting the possibility of gases existing at great pressures applies only to ordinary temperatures—such temperatures, for example, as living creatures can endure. At exceedingly high temperatures much greater pressure, and therefore much greater density, can be attained without liquefaction or solidification. And in considering the effect of pressure on the materials of a solid globe, we must not fall into the mistake of supposing that the strength of such solid materials can protect the material from compression and its effects. We must extend our conceptions beyond what is familiar to us. We know that any ordinary mass of some strong, heavy solid—as iron, copper, or gold—is not affected by its own weight so as to change in structure to an appreciable extent. The substance of a mass of iron forty or fifty feet high, would be the same in structure at the bottom as at the top of the mass; for the strength of the metal would resist any change which the weight of the mass would (otherwise) tend to produce. But if there were a cubical mountain of iron twenty miles high, the lower part would be absolutely plastic under the pressure to which it would be subjected. It would behave in all respects as a fluid, insomuch that if (for convenience of illustration) we suppose it enclosed within walls made of some imaginary (and impossible) substance which would yield to no pressure, then, if a portion of the wall were removed near the base of the iron mountain, the iron would flow out like water * from a hole near the bottom of a cask. The iron would continue to run out in this way, until the mass was reduced several miles in height. In Jupiter's case a mountain of iron of much less height would be similarly plastic in its lower parts, simply because of the much greater attractive power of Jupiter's mass. Thus we see that the conception of a hollow interior, or of any hollow spaces throughout the planet's globe, is altogether inconsistent with what is known of the constitution of even the strongest materials.

How, then, are we to explain the relatively small mean density of Jupiter's globe? On the supposition that his atmosphere is less than fourteen miles deep, we cannot do so; for there is nothing hypothetical in the above considerations respecting a solid globe as large as Jupiter's, excepting always the assump-

* The effect of pressure in rendering iron and other metals plastic has been experimentally determined. Cast steel has been made to flow almost like water, under pressure.

tion that the globe is not formed of substances unlike any with which we are familiar. Even this assumption, though it is one which few would care to maintain in the present position of our knowledge, amounts after all to an admission of the chief point which I am endeavouring to maintain: it is one way—but a very fanciful way—of inferring that Jupiter is utterly dissimilar to the earth. Rejecting it, as we safely may, we find the small density of Jupiter not merely unexplained, but manifestly inexplicable.

All our reasoning has been based on the assumption that the atmosphere of Jupiter exists at a temperature not greatly differing from that of our own atmosphere. If we assume instead an exceedingly high temperature, abandoning of course the supposition that Jupiter is an inhabited world, we no longer find any circumstances which are self-contradictory or incredible.

To begin with, we may on such an assumption find at once a parallel to Jupiter's case in that of the Sun. For the Sun is an orb attracting his atmospheric envelope and the material of his own solid or liquid surface (if he has any) far more mightily that Jupiter has been known to do. All the difficulties considered in the case of Jupiter would be enormously enhanced in the case of the Sun, if we forgot the fact that the Sun's globe is at an intense heat from surface to centre. Now we know that the Sun is intensely hot because we feel the heat that he emits, and recognise the intense lustre of his photosphere; so that we are not in danger of overlooking this important circumstance in his condition. Jupiter gives out no heat that we can feel, and assuredly Jupiter does not emit an intense light of his own. But, when we find that difficulties precisely corresponding in kind, though not in degree, to those which we should encounter if we discussed the Sun's condition in forgetfulness of his intense heat, exist also in the case of Jupiter, it appears manifest that we may safely adopt the conclusion that Jupiter is intensely heated, though not nearly to the same degree as the Sun.

We have thus been led by a perfectly distinct and independent line of reasoning to the very conclusion which I have advocated elsewhere on other grounds, viz. that Jupiter is in fact a miniature sun as respects heat, though emitting but a relatively small proportion of light. I would invite special attention to the circumstance that the evidence on which this conclusion had been based was already cumulative. And now a fresh line of evidence, in itself demonstrative I conceive, has been adduced. Moreover I have not availed myself of the argument, very weighty in my opinion, on which Mr. Mattieu Williams has based similar conclusions respecting the temperature of Jupiter, in his interesting and valuable work called "The Fuel of the Sun." I fully agree with him in regarding it as a reasonable assumption, though I cannot go so far as to regard it as certain, that every planet has an atmosphere whose mass corresponds with, or is even perhaps actually proportional to, the mass of the planet it surrounds. If we make such an assumption in the case of Jupiter, we arrive at conclusions closely resembling those to which I have been led by the above process of reasoning.

Thus many lines of evidence, and some of them absolutely demonstrative, in my opinion, point to the conclusion that Jupiter is an orb instinct with fiery energy, aglow it may well be with an intense light which is only prevented from manifesting itself by the cloudy envelope which enshrouds the planet.

But so soon as we regard the actual phenomena presented by Jupiter in the light of this hypothesis, we find the means of readily interpreting what otherwise would appear most perplexing. Chief among the phenomena thus accounted for, I would place the recent colour-changes in the equatorial zone of Jupiter.

What, at a first view, could appear more surprising than a change affecting the colour of a zone-shaped region whose surface is many times greater than the whole surface of our earth. It is true that a brief change might be readily explained as due to such changes as occur in our own air. Large regions of the earth are at one time cloud-covered and at another free from clouds. Such regions, seen from Venus or Mercury, would at one time appear white, and at the other would show whatever colour the actual surface of the ground might possess when viewed as a whole. But it seems altogether impossible to explain in this way a change or series of changes occupying many years, as in the case of the recent colour-changes of Jupiter's belt. Let me not be misunderstood. I am not urging that the changes in Jupiter are *not* due to the formation and dissipation of clouds in his atmosphere. On the contrary, I believe that they are. What seems to me incredible, is the supposition that we have here to deal with such changes as occur in our own air in consequence of solar action.

I do not lose sight of the fact that the Jovian year is of long duration, and that whatever changes take place in the atmosphere of Jupiter through solar action might be expected to be exceedingly slow. Nay, it is one of the strongest arguments against the theory that solar action is chiefly in question, that any solar changes would be so slight as to be in effect scarcely perceptible. It is not commonly insisted upon in our text-books of astronomy—in fact, I have never seen the point properly noticed anywhere—that the seasonal changes in Jupiter correspond to no greater *relative* change than occurs in our daily supply of solar heat from about eight days before to about eight days after the spring or autumn equinox. It is incredible that so slight an effect as this should produce those amazing changes in the condition of the Jovian atmosphere which have unquestionably been indicated by the varying aspect of the equatorial zone. It is manifest that, on the one hand, the seasonal changes should be slow and slight so far as they depend on the sun, and, on the other, that the sun cannot rule so absolutely over the Jovian atmosphere as to cause any particular atmospheric condition to prevail unchanged for years.

If, however, Jupiter's whole mass is in a state of intense heat—if the heat is in fact sufficient, as it must be, to maintain an effective resistance against the tremendous force of Jovian gravitation—we can understand any changes, however amazing. We can see how enormous quantities of vapour must continually be generated in the lower regions to be condensed in the upper regions, either directly above the zone in which they were generated, or north or south of it, according to the prevailing motions in the Jovian atmosphere. And although we may not be able to indicate the precise reason why at one time the mid zone or any other belt of Jupiter's surface should exhibit that whiteness which indicates the presence of clouds, and at another should show a colouring which appears to indicate that the glowing mass below is partly disclosed, we remember that the difficulty corresponds in character to that which is presented by the phenomena of solar spots. We cannot tell why sun-spots should wax and wane in frequency during a period of about eleven years; but this does not prevent us from adopting such opinions as to the condition of the sun's glowing photosphere as are suggested by the behaviour of the spots.

It may be asked whether I regard the ruddy glow of Jupiter's equatorial zone, during the period of disturbance lately passed through, as due to the inherent light of glowing matter underneath his deep and cloud-laden atmosphere. This appears to me on the whole the most probable hypothesis, though it is by no means certain that the ruddy colour may not be due to the actual constitution of the planet's vaporous atmosphere. In either case, be it noted, we should perceive in this ruddy light the inherent lustre of Jupiter's glowing mass, only in one case we assume that that lustre is itself ruddy, in the other we suppose that light, originally white, shines through ruddy vapour-masses. It is to be remembered, however, that whichever view we adopt, we must assume that a considerable portion of the light received, even from these portions of the planet's disc, must have been reflected sunlight. In fact, from what we know about the actual quantity of light received from Jupiter, we may be quite certain that no very large portion of that light is inherent. Jupiter shines about as brightly as if he were a giant cumulus-cloud, and therefore almost as white as driven snow. Thus he sends us much more light than a globe of equal size of sandstone, or granite, or any known kind of earth. We get from him about three times as much light as a globe like our moon in substance, but as large as Jupiter, and placed where Jupiter is, would reflect towards the earth; but not quite so much as we should receive from a globe of pure snow of the same size and similarly placed. It is only because large parts of the surface of Jupiter are manifestly *not* white, that we seem compelled to assume that some portion of his light is inherent.

But the theory that Jupiter is intensely hot by no means requires, as some mistakenly imagine, that he should give out a large proportion of light. His real solid or liquid globe (if he have any) might, for instance, be at a white heat, and yet so completely cloud-enwrapped that none of its light could reach us. Or, again, his real surface might be like red-hot iron, giving out much heat but very little light.

I shall close the present statement of evidence in favour of what I begin to regard as in effect a demonstrated theory, with the account of certain appearances which have been presented by Jupiter's fourth satellite during recent transits across the face of the planet. The appearances referred to have been observed by several telescopists, but I will select an account given in the monthly notices of the "Astronomical Society," by Mr. Roberts, F.R.A.S., who observed the planet with a fine telescope by Wray, 8 inches in aperture. "On March 26, 1873," he says, "I observed Jupiter about 8 p.m., and found the fourth satellite on the disc. I thought at first it must be a shadow; but, on referring to the 'Nautical Almanac,' found that it was the fourth satellite itself. A friend was observing with me, and we both agreed that it was a very intense black, and also was not quite round. We each made independent drawings which agreed perfectly, and consider that the observation was a perfectly reliable one. We could not imagine that such an intensely black object would be visible when off the disc, and waited with some impatience to see the emersion, but were disappointed by fog, which came on just at the critical time." Another observer, using a telescope only two inches in aperture, saw the satellite when off the disc, so that manifestly the blackness was merely an effect of contrast.

In considering this remarkable phenomenon, we must not forget that the other satellites do not look black (though some of them look dark) when crossing Jupiter's disc, so that we have to deal with a circumstance peculiar to the fourth or outermost satellite. Nevertheless, we seem precluded from supposing that any other difference exists between this satellite and the others than a certain inferiority of light-reflecting power. I might indeed find an argument for the view which I have suggested as not improbable, that Jupiter is a heat-sun to his satellites, since the three innermost would be in that case much better warmed than the outermost, and therefore would be much more likely to be cloud-encompassed, and so would reflect more light. But I place no great reliance on reasoning so ingenious, which stands much as a pyramid would stand (theoretically) on its apex. The broad fact that a body like the fourth satellite, probably comparable to our moon in light-reflecting power, looks perfectly black when on the middle of Jupiter's disc, is that on which I place reliance. This manifestly indicates a remarkable difference between the brightness of Jupiter and the satellite; and it is clear that the excess of Jupiter's brightness is in accordance with the theory that he shines in part with native light, or, in other words, is intensely heated.

This completes the statement of the evidence obtained during the recent opposition of Jupiter in favour of a theory which already had the great advantage of according with all known facts, and accounting for some which had hitherto seemed inexplicable. If this theory removes Jupiter from the position assigned to him by Brewster as the noblest of inhabited worlds, it indicates for him a higher position as a subordinate sun, nourishing with his heat, as he sways by his attractive energy, the scheme of worlds which circles round him. The theory removes also the difficulty suggested by the apparent uselessness of the Jovian satellites in the scheme of creation. When, instead of considering their small power of supplying Jupiter with light, we consider the power which, owing to his great size and proximity, he must possess of illuminating them with reflected light, and warming them with his native heat, we find a harmony and beauty in the Jovian system which before had been wanting; nor, when we consider the office which the Sun subserves towards the members of his family, need we reject this view on account of the supposition—

> That bodies bright and greater should not serve
> The less not bright.

THE OUTLINE OF CLOUD FORMS: THE ELECTRIC CUMULUS, ANVIL CLOUD, AND RAIN-BALL.

By SAMUEL BARBER, F.M.S.

BY the outline of a cloud we most readily distinguish its class, and the peculiar characteristics it may happen to possess as a species. To take the case of Cumulus. Although the term "Cumulus" (a mass) does not indicate, so well as the names of the other two types adopted by Howard, the form which it presents to the eye, yet, in fact, the varieties of this cloud, which is of the utmost value in weather prediction, are, by outline alone, more distinctly defined and easier to be discriminated than those of any other. It would, perhaps, be possible to form a classification of the various species of the cloud entirely by their outlines.

I distinguish four main varieties of cumulus, from which I select two forms, the most striking and the most valuable as weather prognostics, to illustrate the use of observing outlines. The first is the Electric Cumulus,* and the second the Anvil Cloud of Sir J. Herschell. The outline of the Electric Cumulus is very sharp and hard, not broken by large indentations, and loose feathery processes like that of the commoner kinds of cumulus, formed rapidly by exhalations from the earth, and drifting near its surface: but we have almost a continuous line, terminating perhaps in stratus or cumulo-nimbus below, yet rising to a vertex, conical or rounded, and consisting of a series of small curves and minute projections, representing the rounded protuberances on the surface of the cloud.

There is no cloud that possesses a more distinct outline than this, and none which exhibits more brilliant or dazzling effects of light. As a weather prognosticator it is best observed at a distance, and near the horizon, when the form of the summit may be more exactly discerned.

We now take the Anvil Cloud.

* Previously described by me in the "Quarterly Journal Brit. Meteor. Soc.," Jan. 1872.

This species, alluded to by Sir John Herschell in his "Familiar Lectures on Science," cannot be regarded as so strictly a cumulus as the form we have just remarked upon, inasmuch as it exhibits at times a great tendency to the form of stratus, and at other times to that of cirrus; or, perhaps we should rather say to the form of cumulo-cirrus.* As an indicator of wind, this cloud may probably be regarded as unrivalled. It frequently appears two or three days before heavy gales, especially when they are of long duration, as about the Equinoxes. Without being hyper-critical, or, I should say, hyper-analytical, we may distinguish three varieties of the cloud, the distinction between the outlines of which is quite characteristic. The first variety possesses greater affinity for ordinary cumulus than the other two, and it often shows great resemblance in many points to the electric cumulus. It occurs for the most part in large masses, or banks, the summits of which, as it drifts along with the wind, stand out in sharp relief against the upper sky, and exhibit the most striking and fantastic resemblances to terrestrial objects, beetling crags, towers, and heads of animals—the last being of frequent occurrence. When of this variety, the Anvil Cloud appears to be highly condensed, and is of a dark blueish or slatey tint. It is generally, I believe, the precursor of heavy rain as well as wind.

The second variety of the cloud, which approaches to stratus, exhibits a more irregularly formed "anvil," the "waist" being usually much more conspicuous on one side than on the other. This is also a dense cloud, without much marking on its surface, the outline being not nearly so irregular as that of the variety just described. It is of a lighter tint, grey or muddy blueish, and does not, I think, occur in an isolated form, but rises from a bank of lower stratus or cumulo-stratus. It is also a wet-weather cloud.

The third variety is apparently much thinner in texture than the two preceding, being, however, of a double character: cirrus in the upper part, condensed cumulus, or cumulo-stratus in the lower. This is the least common of all three varieties, but is an excellent indicator of wind.

There is another form of cloud which has a close affinity for this last-mentioned species; a kind of aggregated cirrus, generally of a dark tint and seen at high altitudes, in windy weather. This lacks the consistency and volume of cumulus, and mostly spreads itself out in a sheet, with rounded edges, and without surface marking; whereas the third form of anvil cumulus ex-

* This cloud, also an excellent indicator of wind, does not appear to have received the attention it deserves from meteorologists. The reader must not confound it with cirro-cumulus.

hibits much of the character of electric cumulus in its lower parts, having also a considerable volume and rotundity of outline.

The year 1872 will be long remembered both for its excessive rainfall and the number and destructive violence of its thunderstorms. It was equally remarkable for the variety and striking character of its cloud forms. The electric cumulus was scarcely absent for a day during the whole period over which the thunderstorms extended. On one occasion, when leaving Liverpool for Blackburn, I observed three or four conical piles of the cloud upon the horizon in the direction of the latter town: the weather was beautiful at Liverpool, but a storm, as I learnt on arriving at my destination, had raged there at the time I observed the cloud so many miles away.

There can be little doubt that this phenomenon may often be seen at a distance of 50 to 150 miles from the point where the storm breaks.

Another remarkable form that appeared during the summer of 1872 was the "Festooned," or Pocky cloud, as some have termed it. Professor Poey a year or two ago, alluded to it as a "new" variety. Since then, however, it has been shown to be of ancient date, and a somewhat elaborate and interesting account of earlier observations was contributed by Mr. Scott to the "Quarterly Journal of the Meteorological Society," April 1872. I have myself observed the cloud on several occasions, though only once or twice in perfect form. The illustration given by Mr. Scott in his paper was furnished by Dr. Clouston. The droplets or festoons which form the lower outline of the cloud have a semi-elliptical or egg-shaped form, were very dark, and extended over a considerable portion of the heavens. In the most perfect example noted by me (about twelve years ago) the pendulous processes or droplets had an almost perfectly circular outline, even, and well defined. The festoons were about 4° or 5° in apparent diameter, their altitude being about a mile. The whole mass from which the droplets depended was not large, and moved with the wind; the curves meanwhile retaining their form intact. What made the case most singular was, that the regularity of the outline could be maintained, even a few moments, under the variable atmospheric conditions of the time. Though the outlines were so regular, the surface of the cloud had a very nimbus-like appearance, and was of a lurid yellow tint. The sky was not overcast at the time.

The more usual concomitants of this form are, however, a dark turbid sky and a "pallium" of cirro-cumulus subsiding into nimbus or nimbo-stratus. Under these conditions I observed it twice during the stormy summer of last year, one of the cases being immediately after a thunderstorm. The fact of its being emphatically a foul-weather cloud adds interest to the investigation, for heavy rain and wind usually follow its appearance. My own observations indicate, however, that rain is more certain to follow than wind. In Lancashire it is sometimes termed "Rain-ball."

The origin of these symmetrical cloud forms is very difficult to determine. Mr. Scott, in his paper above referred to, attaches considerable importance to the experiments of Sir J. Herschell and Mr. Jevons, by whom it has been shown that a similar appearance may be produced by gradually mixing two fluids of slightly different specific gravities.

The nature, however, of the forces which determine the peculiar symmetry of the forms in question seems almost equally obscure in the case of the experiments as in that of the atmospheric phenomenon they are used to illustrate. In the spherical forms observed by myself it is hard to imagine such an appearance being caused by a mere undulatory movement of the vapour arising from gravitation. We are rather reminded of the formation of bubbles ; but if that be an analogous case, the tension of the vapour must be something unusual. Let the reader, however, compare this phenomenon with the peculiar rounded prominences that occasionally appear on the sides of a large mass of the electric cumulus, and range themselves in regular lines proceeding from a common origin or vertex. Must we attribute these protuberances to an electrical decomposition of vapour ?

Plate CIII.

W. West & Co. sc.

SEXUALITY IN PLANTS.

By MAXWELL T. MASTERS, M.D., F.R.S.

[PLATE CIII.]

IT has long since become unnecessary to offer any argument or illustration in support of the doctrine of sexuality in plants. Among the so-called flowerless plants even, the evidence of the existence of distinct sexes is now so overwhelming that there are few who hesitate to believe in its occurrence, even in those cases where only one of the two sexes has up to this time been demonstrated. Linnæus, to whom, most of all, we owe the promulgation of the doctrine, though he was by no means the first to propound it, proceeded to establish it by inductive, circumstantial evidence. He brought forward comparatively little in the way of direct proof or absolute demonstration, even among flowering plants, while the actual existence of sexes in the so-called flowerless plants has been questioned up to within quite recent times. It is a singular fact, however, that the whole process of fertilisation has been, generally speaking, more thoroughly and completely demonstrated among the so-called Cryptograms, long considered as a sexual, than among the more highly developed flowering plants. It is curious also to remark the different views now taken as to the process from those which were held originally. As soon as it was clearly perceived that the stamens and the pistils, or their contents, were the essential agents in the process of fertilisation, it was naturally surmised that the pistil of every given flower was fertilised by the pollen of the same flower. Under this supposition many curious contrivances which were observed were at once set down as so many aids and promoters of self-fertilisation.

Sprengel was one of the first to show the fallacies of these observations, and to demonstrate the frequent existence of cross-fertilisation, whether effected by the agency of winds or by pollen-carrying insects.

Vaucher added other illustrations, but it was not till the publication and experimental researches of Darwin that the subject received the attention it merited. Darwin's classical paper on *Primula*, in the "Journal of the Linnean Society," followed up by similar memoirs on *Lythrum*, *Linum*, &c., stirred up a host of observers. Large numbers of new facts were recorded, all confirming the idea that while self-fertilisation is not impossible, and is indeed in some few cases inevitable, yet in the majority of instances some provision for cross-fertilisation is afforded, if not constantly, at least occasionally. Hildebrand, Delpino, Alfred Bennett, and others, have correlated these facts, and, making allowance for exceptional instances, they one and all confirm the views expressed by Darwin. The observations and experiments of these gentlemen are so well known, and the records of them are so accessible, that we do not propose now to occupy space by making further allusions to them. Suffice it merely to say, that these observations have reference to the facilities offered by various structural modifications for favouring cross-fertilisation and preventing self impregnation or *vice versâ*, and they all tend to show the advantage that accrues from an occasional cross.

Our object in the present communication has reference to another department of the subject; and it is one we think it desirable to call attention to, as it appears not to receive so much attention as its importance demands. We allude particularly to the circumstances promoting the development of pollen-forming or ovule-bearing flowers respectively.

Before proceeding further we ought to explain that in using the expressions male, female, or hermaphrodite flowers, we do so, unless otherwise stated, with reference to structural conditions rather than to physiological office. The term "bisexual" is preferable to that of hermaphrodite, as not implying any physiological distinction.

For our present purpose, then, a flower with stamens and pistils perfectly formed is bisexual or hermaphrodite, even though its pistil be not fertilised by its own pollen, but by that derived from some other source.

For convenience sake, we take a bisexual flower as our starting-point; and we propose to allude to various not infrequent changes observed in flowers of that description, in consequence of which their sexual organisation becomes more or less materially modified.

A plant usually producing flowers, bisexual or hermaphrodite as to structure, may bear flowers of one sex only by the simple arrest of growth. Thus, if the stamens of any given flower be arrested in their development, the blossom becomes female, as happens not unfrequently in some buttercups, lesser celandine (*Ranunculus*), and others.

Conversely, if the pistil be not developed the adult flower will be male, as happens in many Umbellifers and Caroyphylleæ.

The exact opposite of this change occurs when flowers usually of one sex become bisexual by the development of stamens or of pistils, as the case may be. Instances of this kind are common in almost all normally unisexual flowers. If the unisexual condition of an ordinary bisexual plant be considered from a structural point of view as an arrest of development, the present instance must be attributed to an exaltation of that process.

There is another way in which an ordinarily one-sexed flower may become two-sexed, and that is by the more or less perfect change of stamens into pistils, or of pistils into stamens. This is sometimes the result of a substitution of one part for another, but in other cases of an actual permutation. A stamen becomes converted at a certain stage of its growth into a pistil, or *vice versâ*. Such changes are by no means uncommon in plants. We may thus have a stamen assuming the guise of a pistil, a pistil endowed with all the attributes of a stamen; we may even have pollen formed within the tissues of the ovule itself, as has been seen in a passion-flower and in a rose. A more complete hermaphroditism can hardly be conceived.

So far we have been dealing with individual flowers, but analogous changes occur throughout the whole organism. Thus many plants, under ordinary circumstances, produce unisexual flowers, male and female, on the same individual. Such are the plants called *monœcious*. Now it sometimes happens that plants of this character become entirely unisexual by the development of male or of female flowers, only to the exclusion of the other. Such occurrences are not uncommon in mulberries and walnuts.

The converse of this is, when a plant ordinarily producing flowers of different sexes on different individuals (*diœcious*) forms flowers of both sexes on the same plant, becomes, in other words, monœcious. This occurs occasionally in the hop.

These changes in the structural condition of the flower, variously modified and combined in different cases, constitute all the changes in the sexual organisation of the flower which concern us at present. May we not say of these puzzling transformations what Horace said of a girlish-looking youth—

Mire sagaces falleret hospites
Discrimen obscurum, solutis
Crinibus ambiguoque vultu.

It is obvious that the accurate determination of the causes of the changes above alluded to is a point not only of high physiological interest, but also of much practical value. A working gardener is often puzzled, and his employer disgusted, at finding his strawberries barren, his vines refusing to set, his melons 'shy-bearers.' Where seed is wanted, and little, and that perhaps of bad germinating power, is produced, the disappointment is naturally great. We are far from saying that the reasons for these untoward events can, in the present state of our knowledge, be at all times determined; but we do say that the cause is often obvious, and that few more striking instances of the benefit which science may confer on practice can be adduced than those which vegetable physiology has conferred on the cultivator.

We have seen that the structural changes affecting the reproductive organs of the flower may be reduced to—1, an arrest; and 2, to exaltation; or 3, to perversion of growth or of development. In seeking the causes of these changes it would seem, at first sight, natural to refer an arrested growth to a relatively deficient supply of nutriment, or to some other debilitating or obstructing cause. The opposite condition might as readily be accounted for by an increased food supply, or by the presence of other favourable conditions. No doubt this is true so far as it goes, but the problem is more complex than it appears to be on the surface. An arrest of growth, for instance, may arise from a superabundance of food, or from an inability to assimilate it. One may starve in the midst of plenty. Again, it is notorious that exaltation of development, in one organ or set of organs, may be a sequela of impaired nutrition; in others, the principle of compensation comes into play in such cases—if one part is debilitated, another takes on proportionately more vigorous development. If the balance be once disturbed, the opportunity for change is at once, and of necessity, afforded. To further illustrate this matter, we may now advert to the theory of Dr. R. Spruce; and which, if not proved, at least affords a valuable focus for the concentration and correlation of evidence, and a good stand-point from which to discuss it. According to this theory the progenitor of existing plants had structurally and functionally hermaphrodite flowers. In course of time the economy of force accruing from division of labour led, and still leads, to a separation of the sexes. The health and vigour of the individual plant would be promoted by the separation, the number and vigour of its offspring increased. Once the equilibrium disturbed, natural selection would tend to perpetuate the change as one generally advantageous to the plant. The changes in question do not amount to the actual annihilation or obliteration of either sex. In a unisexual flower one sex, though not actually, may be at least potentially present—nay, must be, if Darwin's theory of pangenesis be true—and so it happens that, when any change of conditions occurs, the heretofore latent gemmules start into life, and the unisexual is once more replaced by the bisexual state. In other words, a reversion occurs to the assumed primitive condition.

There are numerous instances among one-sexed plants to prove that the missing organs are latent, rather than altogether deficient. It has already been stated that many one-sexed flowers are so by arrest of development; the male or the female element, as the case may be, is present, but in a latent or rudimentary state. So many flowers which in the adult state are one-sexed, are in the young state structurally hermaphrodite. Indian corn or maize, the two sexes of which are very distinct in the fully developed condition, is said to have primordially bisexual flowers. A plant which in one year, or it may be for a succession of years, produces flowers of one sex only, may in another season form either bisexual blossoms, or flowers of both sexes on the same plant. We have seen cases of the first kind in the ash and in some of the maples; of the second in walnuts, mulberries, and hops; while in certain kinds of vines, and in some strawberries, the fact alluded to is notorious. Dr. Spruce ("Journ. Linn. Soc." xi. 1871, p. 95) records cases of the same kind in palms growing about the Amazon, and in which the trees produce chiefly female flowers one year, and take a comparative rest in the following one by forming male flowers, whose formation does not so greatly tax the energies of the tree. Evidences of the same tendency are afforded by the circumstances that the seeds of unisexual plants produce seedlings, now of one, now of another, sometimes of both sexes, in very unequal proportions. The seeds of a Papaw, *Carica Papaya*, which were collected from a female plant in South America, produced, when sown at Mentone, seedlings which developed male flowers, and afterwards bisexual flowers mixed with the males—a condition never observed by the person who furnished the seed, though his attention was specially called to it. It seems probable that the changed conditions of growth may have induced the alteration; but, as we shall see presently, such an assumption must not be accepted without question, as other causes may produce like results. Cuttings, also, and buds taken from a plant of one sex, though they will in general perpetuate the characters of that sex, have been occasionally known to develop flowers of the opposite sex.

Dr. Spruce has not, so far as we know, done more than make very brief reference to his theory, and has not yet sought to establish it in detail.* We therefore run some risk of misinterpreting his views, but we would suggest that if it be asserted that the progenitors of our existing flowers were hermaphrodite, and that they have since become unisexual, then the numerical proportion of fossil plants with hermaphrodite flowers ought to be very much larger than it is. Again, we ought to find in the older strata, as compared with more recent deposits, a much larger proportion of hermaphrodite than of one-sexed flowers, whereas the exact reverse holds good. We are quite aware that too much stress must not be laid on any conclusion derived from what remain to us of fossil plants.

There is now-a-days, and probably always was, a much larger proportion of woody plants with one-sexed flowers, and the latter would stand a better chance of being preserved than would the softer-tissued more ephemeral-lived plants. Lecoq estimates the proportion of unisexual species in central France among woody plants or perennials at one in eight, while in annuals the proportion is one in thirty-five. With hermaphrodite flowers, again, the frequent aggregation of one-sexed flowers into dense masses or catkins would necessarily impart a degree of permanence to them not possessed by plants producing their flowers in smaller numbers, or in less compact masses. Still, even if the necessary allowances be made, we do not think Dr. Spruce's views receive support from geology. To us it appears that the bulk of evidence goes to show that annual plants, or those which flower once only in the course of their lives, are of more recent origin than woody plants which flower repeatedly, while the proportion of one-sexed flowers among annuals is much less than in the case of longer-lived plants.

There is another point of view from which this question may be approached, and that may perhaps be more consonant with Dr. Spruce's real view than that which we have attributed to him, and that is the primordial oneness of sex. We are so much in the habit of dwelling on the differences of sex, that we are apt to overlook the fact that those differences do not exist in the first instance, and that even in the adult state they are characteristic of the individual, not of the species. In the life of all creatures there is a period when there is no perceptible difference of sex, and it seems to depend on circumstances which sex shall ultimately be developed. Now, if there were any intrinsic difference such as by our everyday language we imply that there is, it would surely be manifest from the beginning, and not be a subsequent evolution.

* Dr. Spruce's papers on this subject may be found in the "Gardener's Chronicle," 1870, p. 826, and in the "Journal of the Linnean Society," 1871, vol ix. p. 96.

We take it, then, that there is a primordial oneness of sex, as Plato long since argued, and in that sense we agree with Dr. Spruce. We are constantly meeting in plants with traces of this essential unity of sex. We can see it in the development of all flowers; we meet with it frequently in the structural changes from one sex to the other, and to which we have already drawn attention. If we find the same organ bearing, at the same time, on one side pollen and on the other side ovules—a by no means unusual occurrence—it is difficult to conceive that there can be so great an intrinsic difference between the sexes as is usually admitted. If we find the pistil producing pollen, and the stamens forming ovules—as happens not unfrequently in the common stonecrop and in the wallflower—our belief in the absolute diversity of the two sexes becomes less implicit. If we meet with ovules bearing pollen in their interior, as has now been seen in species of passion-flower by Mr. J. A. Salter, and by the writer in a rose, our faith in the duality of sex becomes well nigh uprooted. In face of such evidence is it not reasonable to suppose that as sexual characteristics of any kind are themselves secondary in point of development, and individual, not specific, so the dual nature of the sexual principle, so conspicuous in the adult organism, is a later development or evolution from an originally homogeneous unity? The old tradition of the development of Eve from the rib of our forefather Adam may not after all be so purely mythical an assertion. What Milton said of the spirits may, if we exclude the notion of volition, be properly applied to plants:—

> "Spirits, when they please,
> Can either sex assume, or both."

It remains now to enquire what are the causes which disturb the equilibrium in the first instance, and to ascertain what are the special circumstances which favour the development of one sex at the expense of the other.

With reference to the first point, it would appear that although very slight causes are sometimes sufficient to deflect the balance, yet at others, and those more frequent, much more violent changes are powerless to bring about such a result.

Allusion has been already made to a seedling Papaw, the produce of American seed developing hermaphrodite flowers when grown on the shores of the Mediterranean, and the changed conditions have been assumed to be sufficient to account for the phenomenon. On the other hand we have seen a male plant of the Papaw, cultivated for years in the Oxford Botanic Garden, suddenly produce bisexual flowers without obvious change of condition; and numerous parallel changes are familiar to all observers. Sometimes in these cases it is not made sufficiently clear whether ripe fruit only, or ripe fruit containing ripe seeds capable of germinating, are developed—a very important element to be considered, as the fruit may often ripen and develop only imperfect seed or none at all.

The structural changes hitherto effected as a consequence of man's interference, either intentionally or of necessity, are relatively slight. Consider, for instance, the artificial conditions under which plants are transplanted, pruned, grown, fed in gardens, and then contrast the rare instances in which any absolute or essential changes in structure (not merely of degree of development, more or less) occur. Important structural changes of a relatively permanent character appear, as a rule, to be brought about very slowly and gradually.

As regards functional activity, however, the case is very different. Very slight alterations will often immediately and profoundly modify the fertility of a given flower and the vigour of its seedlings. Cases are recorded wherein a flower ordinarily sterile, when fertilised by its own pollen, has developed perfect fruit and seeds when grafted on to some other species. Cultivation, climatic changes, diseases, injuries, all have a tendency to influence for good or ill the reproductive functions of plants, even though the change in circumstances be apparently slight, and the structural alteration consequent on them absolutely inappreciable.

We have already cited instances where altered climatal conditions, as the transfer of a plant from Europe to America, have, on the other hand, induced changes in the sexual organisation of the plant. There are several cases cited where a species growing within certain latitudes is of one sex chiefly, while the same species growing in other latitudes developes mainly flowers of the opposite sex. Instances of a similar character are related in reference to moisture. A willow growing in a very wet locality has been known to produce female flowers only, while in a dry place male catkins only were produced. In the case of some Begonias, which, under ordinary circumstances, produce separate male and female flowers on the same plant, Mr. Anderson Henry has succeeded in inducing the formation of female flowers only by removing two out of the three stigmatic lobes, and fertilising the remaining one. All the plants, four or five in number, which have resulted from this cross, have produced female flowers only. Mr. Henry has repeated the experiment with the same result. Such observations as these need confirmation and extension; and from the ease with which they may be made, and their importance, may be commended to the special notice of amateurs. It is obvious also that in the case of ordinarily hermaphrodite flowers the time at which an alteration of the "environment" occurs must be taken into consideration. As a rule, the stamens are developed before the pistil; hence if some check to growth accrue, it may occur before the formation of the pistil, when a staminiferous flower would result. Or, again, the circumstances inducing an arrest of growth at the period when the stamens are forming may subsequently change, and the pistil be regularly formed, though the stamens remain undeveloped or abortive.

That the precise period at which growth and development take place is an element of great importance in such matters, is one which no physiologist is likely to dispute. Not to mention cases in the animal kingdom, it is sufficient to say that the conformation of flowers produced out of their accustomed season is very often more or less deranged; their position is often different, their form changed, the number and arrangement of their parts altered. Of course the reproductive organs undergo corresponding changes. The flowers of apples or pears which are occasionally produced on the so-called "midsummer shoots" have perfect stamens, but rarely perfect pistils. Under ordinary circumstances, the flowers we have mentioned are developed in autumn, on short stunted branches or spurs, and remain quiescent till the following spring; but in the cases under consideration an imperfect flower is formed within a few weeks, at the end of a long, weakly shoot, also of rapid growth. There is nothing surprising in this; it is just what might be expected, and it furnishes an illustration of our argument that the period at which certain changes occur is an element of cardinal importance in the determination of the nature of those changes. Baillon records having met with an hermaphrodite flower in June on the common hazel. It would be sufficiently extraordinary to meet with such a flower at any time, but it seems more consistent to meet with such a flower in summer rather than in winter, the normal period of flowering.

The bearing that this part of our subject has on practical gardening is obvious, and particularly in the case of forcing. Practical gardeners know well that in forcing vines, pines, strawberries, cherries, cucumbers, or indeed any plant which is required to produce its flowers and fruit out of due season, they cannot be too careful in the timely regulation and adjustment of the heat and moisture at their disposal. Want of care, or deficient judgment, will defeat the object aimed at, and a crop of leaves only, or sterile "blind" flowers, or flowers which refuse to "set," will be the consequence. The anatomist knows the structural reasons for this; the physiologist speculates on the causes which put the structures into action; the practical man, taught by experience, knows how to avail himself both of the one and the other—if not to make the machine, at least to set it going, and regulate its action according to his wishes.

In this place we may appropriately call attention to the opinions of Mr. Meehan on the sexuality of plants, and which demand attention as the opinions of a practised cultivator, a good observer, and a shrewd reasoner.* As the result of his observations, he comes to the conclusion that in plants a high degree of vigour produces the female sex, while a less robust constitution is sufficient for the development of the pollen. In this manner the alternation sometimes observed in unisexual plants may be accounted for. A plant producing fruit, and more particularly ripe seed, for a succession of years, becomes more or less exhausted, and during the period when it is recruiting its energies it forms male flowers only. Mr. Meehan bases his theory on the relative position of the flowers of the two sexes, showing that the female flowers are, as a rule, placed on the strongest axial parts, the male ones on the weakest. As a consequence of this, the female flowers are so placed as to receive the direct flow of the nutrient fluid, while the male flowers often derive their supplies from collateral, or less direct sources, and in smaller quantities. He further goes on to show that the invigorating effects of climate, of manuring, &c., tend more particularly to the development of the female rather than to that of the male flower.

Apart from ascertained facts, it seems reasonable to suppose that a less degree of vital energy would be required for the staminate flowers, whose functions are much sooner fulfilled, than for the pistillate flowers, whose office of forming, protecting, ripening the pistil, and more especially its contents (the ripe seed), naturally occupies so much longer a period, and involves so much larger a demand on the resources of the plant. There are several facts which lend colour to this theory. In America, strawberry-blossoms are frequently unisexual. In this country, also, some varieties are apt to produce "blind," i.e. sterile flowers. The same thing happens in vines, and indeed in many other plants. Spruce and Meehan, as we have seen, would consider this tendency to produce unisexual flowers as an evidence of progress; and so indeed it may be, on the principle of division of labour. The gardener, however, looks upon the occurrence in quite a different light, and does his best to rid himself of such undesirable plants. But if the advantage accruing from division of labour, and specially from the operation of cross fertilisation, were fully recognised by him, he should rather promote than discourage such a tendency, and counteract the sterility by the artificial employment of pollen from some

* Cited in "Gardener's Chronicle," 1870, p. 243.

other plant or variety. In this manner, too, he would counteract that weakness of constitution, the result of continual in-and-in breeding, and which is so apparent in many of the higher bred flowers and vegetables of the present day, and which leaves them an easy prey to disease and parasitic fungi. At any rate, we owe to the observation of practical gardeners the establishment of the fact that a relatively high temperature is most conducive to the formation of stamens in the case of strawberries, a low temperature to that of pistils. So again, in the case of vines, it has been observed that a high temperature conduces specially to the formation of tendrils, a low one to that of fertile flowers. It is probable, however, that varying conditions of moisture may have as much effect in this way as the mere variation of temperature.

That parasitic fungi should determine the formation of stamens seems at first sight sufficiently remarkable. Nevertheless such is the opinion held by M. Cornu, in France, and it was independently brought before the notice of the British Association at Exeter, by Miss Becker. Moreover, the notion receives the assent of the veteran mycologist, the Rev. M. J. Berkeley, than whom none more competent to express an opinion on such a subject. The facts are as follows:—The common *Lychnis* of our hedges, *Lychnis diurna*, has unisexual and diœcious flowers; but when affected by a parasitic fungus, the flowers, which should be pistillate only, develop stamens also. This is attributed by Miss Becker to the fact that the fungus (*Ustilago antherarum*), although able to penetrate the plant, can only fructify in the anthers, and consequently it becomes the determining cause of the production of the stamens in the normally female flower. We have not all the evidence before us, on which account we find it difficult to understand how the presence of the fungus in the anthers should be taken as a proof that they (the anthers) were called into development by the fungus. That other flowers on the same plant unaffected with fungus should have pistils only and no stamens, is surely not to be taken as a proof that parasitic fungi can cause the development of stamens. The origin of sexual differences, and the power of inducing in animals the appearance of one or other at will, have from the oldest times exercised the thoughts of philosophers. As we have seen, the solution of the problem is not only of the highest interest as a matter of science, but also as regards the direct material welfare of mankind. Without intending any disparagement to the devotees of the sister science of zoology, we may yet affirm confidently that the botanists and gardeners between them have so far advanced considerably beyond their *confrères* in the unravelling of this, by no means the least, of the mysteries of life.

EXPLANATION OF PLATE CIII.

FIG. 1. Flower of willow, bearing one stamen, and one pistil. (Mag.)
„ 2. Normal male flower of the same species. (Mag.)
„ 3. Capsule of poppy, surrounded by secondary capsules, resulting from the substitution of pistils for stamens. (Nat. Size.)
„ 4. Stamens of gourd, bearing ovules (after Berkeley). (Nat. Size.)
„ 5. Pistil of Bæckea, bearing stamens in the interior in place of ovules. (Mag.)
„ 6. Scale from double hyacinth, bearing an anther above, and two ovules beneath. (Mag.)
„ 7. Filament of a rose, bearing below two imperfect polliniferous ovules, and two-celled anther, and terminating in a dilated stigma. (Mag.)
„ 7A. Ovule from the above, compressed, and showing the partial conversion of its tissues to those of an anther. (Mag.)
„ 7B. Pollen-cells from ovule. (Mag.)
„ 7C. Spiral anther-cells from ovule. (Mag.)
„ 7D. Normal ovule of rose.
„ 8. Hop, bearing male and female flowers on the same inflorescence.

THE PROGRESS OF SCIENCE IN CHINA.

By ROBERT K. DOUGLAS,
Of the British Museum.

IN no instance has the truth of the French proverb "Le mieux est l'ennemi du bien" been more clearly shown than in the case of modern Japan and China. The progress made of late years by the people of the former country has been so rapid and astounding that the more modest advances made by their neighbours have appeared too insignificant for notice. With their national power of acquisitiveness the Japanese have without hesitation imported wholesale all the knowledge and science of the West with as much ease as though they were ordering a consignment of shirtings. They have founded universities and established schools, where foreign professors of every branch of European learning deliver lectures to young gentlemen in black cloth coats and patent leather boots. They have constructed railways and introduced telegraphs, and have gone to a vast expense to obtain an accurate geological survey of their country. For these and all their other efforts to Europeanise Japan they are looked upon as the pioneers of civilisation in the East. They are held up as models of what intelligent Easterns should be, and any doubt thrown on the stability of the movement is laughed to scorn. And certainly, if other Oriental States are to be judged by the standard of rapid progress thus set up, the Chinese, when put into the balance, cannot but be found wanting. Perhaps one reason why they have not rushed with such headlong speed into the scientific market of the West is that they have less need of foreign instruction than the Japanese, their scientific knowledge, such as it is, being more advanced than that possessed by their neighbours. Some allowance must doubtless be made for their deeply-rooted old-fashioned prejudice in favour of walking in the paths which their forefathers have trod. It is, moreover, always more difficult to set a large body in motion than a small one; and even if the Chinese were as impressionable as the people of the "land of the rising sun," the effect of a movement among them would, for a long time, be less observable than would be the case in the latter country.

But though when we turn to China we cannot point to any such surprising results as those which have transformed Yedo and Yokohama into the similitude of European cities, it would be a mistake to suppose that Western science has not of late years been making its way slowly—and perhaps all the more surely because slowly—among the 400,000,000 inhabitants of the "middle kingdom." It is true that they have neither adopted railways nor established telegraphs. They have not founded colleges, except one in the capital, neither have European professors met with any demand for their services outside the walls of Peking. But many of the most thoughtful men of the Empire have been carefully comparing the state of scientific knowledge in China with that existing in Western lands; and intellectually proud though they be, they have eagerly set themselves to work to make up for the time which they have lost during the many centuries of stagnation which, until the foundation of the present dynasty, overshadowed the land. It is no exaggeration to say that at the close of the Ming Dynasty (1644) Chinese science was at a lower ebb than it was 2,000 years before that date. From whence the ancient Chinese acquired their learning it is difficult to say, but there can be no doubt but that certain sciences were more studied and better understood by Chinese scholars in the time of King David than at any subsequent period prior to the accession of the Tatar Emperors.

On these and kindred subjects the histories of China reveal origins so ancient as to dwarf into insignificance the greatest antiquity of which western Europe can boast. If we trace, for instance, the history of the science of numbers, as known to the Chinese, we are carried back nearly 4,000 years, to the time of the Emperor Hwang-ti, who, we are told, instructed his minister to form "nine arithmetical sections" under the following headings: 1. Plane mensuration; 2. Proportion; 3. Fellowship; 4. Evolution; 5. Solid mensuration; 6. Alligation; 7. Surplus and Deficiency; 8. Equation; and 9. Trigonometry. To the same emperor is attributed the formation of the sexagenary cycle, and this belief derives some confirmation from the fact that the present chronological era of cycles dates its commencement from the sixty-first year of his reign. In the "Book of History" mention is made of the existence, in the time of the Emperor Yao (B.C. 2300), of an astronomical board, the members of which were employed in watching the motions of the heavenly bodies, in marking the solstices and equinoxes, and in forming the Imperial Calendar. Later, again, in the *Chow-pi*, a work on trigonometry (B.C. 1100), we trace a great advance in the knowledge of mathematical principles, as may be seen from the following translation of the first section, which may be said to contain an epitome of the whole work, taken from "The Chinese and Japanese Repository" of April 1864:—"I, formerly Chow-kung, addressing Shang-kaon, said, 'I have heard it said, my lord, that you are famous at numbers; may I venture to ask how the ancient Fo-hi established the degrees of the celestial sphere? There are no steps by which one may ascend the heavens, and it is impracticable to take a rule and measure the extent of the earth; I wish to ask, then, how he ascertained these numbers?' Shang-kaon replied, 'The art of numbering originates in the circle and quadrangle. The circle is derived from the quadrangle. The quadrangle originates in the right angle. The right angle originates in the multiplication of the nine digits. Hence separating a right angle into its component parts, if the base be equal to 3, and the altitude to 4, a line connecting the farther extremities will be 5. Square the external dimension, and half the amount will give the area of the triangle. Add together all the sides, and the result will equal the sum of 3, 4, and 5. The square of the hypothenuse being 25, is equal to the squares of the two short sides of the triangle. Thus, the means by which Yu restored order throughout the empire, was by following out the principles of these numbers.' Chow-kung exclaimed, 'How truly great is the theory of numbers! May I ask what is the principle of the use of the rectangle?' Shang-kaon replied, 'The plane rectangle is formed by uninclined straight lines. The direct rectangle is used for observing heights. The reversed rectangle is used for fathoming depths. The flat rectangle is used for ascertaining distance. By the revolution of the rectangle, the circle is formed. By the junction of rectangles, the square is formed. . . . The numbers of the square being the standard, the dimensions of the circle are deduced from the square. . . . This knowledge begins with the straight line, the straight line is a component part of the rectangle, and the numbers of the rectangle are applicable to the construction of all things.' Chow-kung exclaimed, 'Excellent indeed!'"

And we may well echo the exclamation. But unfortunately this promise of great scientific results was doomed, during many succeeding ages, to be obscured. Evil days overtook the lovers of literature and science. Their books were burnt, many of their number were put to death, and the remainder,

"Neglected and oppress'd,
Wished to be with them and at rest."

In succeeding ages there were partial revivals in scientific research, and during the Yuen Dynasty (A.D. 1280–1368), an algebraic system, possibly derived from the Arab traders who at that time began to visit China, was introduced by a native writer in a work entitled, "The Mirror of the Mensuration of Circles." But with the accession of the Ming Emperors (A.D. 1368) darkness again covered the land, and so completely during the following two hundred years were the works of the earlier native scholars forgotten, that when the Jesuit missionaries laid bare their stores of European science at the court of their patron Kang-hi, the message sounded in the ears of their hearers not only as an improvement on the native methods of computation and system of astronomy, but as something quite new and startling. The road to honour and advancement thus thrown open to the missionaries was eagerly trodden by them. The Astronomical Board was placed under their direction, and the young Emperor, himself a youth of learning and scientific attainments, treated them with marked consideration and favour. The stimulus, however, thus given to the study of the science of numbers led to the reproduction of the native works of which we have been speaking, and others of a similar kind; and though it was universally acknowledged that the missionaries had supplied much that was wanting in the native scientific systems, they from that time ceased to hold the pre-eminently high position they had formerly occupied. Latterly, the spirit of scientific enquiry has become very general throughout the empire, and the Jesuits have found worthy successors in the native authors, who have enriched the literature of their country with many learned and valuable works on astronomy and mathematics. Quite recently, also, translations of several European works on these subjects, notably Mr. Wylie's edition of De Morgan's "Treatise on Algebra," Loomis' "Elements of Analytical Geometry, and of the Differential and Integral Calculus," Herschel's "Outlines of Astronomy," as well as several original works on mathematics, have been published in China, the joint work of foreigners and natives, and have met with much favour and support from the literary classes. New editions of several of these works have been brought out by wealthy natives, among whom Euclid is now almost as much studied as among ourselves.

As was the case with the Egyptians of old, the scientific knowledge, properly so called, of the Chinese is confined almost entirely to arithmetic and geometry. Of geology, mineralogy, pneumatics, electricity and chemistry, they know nothing. In antiquity the medical art vies with the knowledge of numbers; but it has been from the beginning, and is now, an art and not a science. The voluminous native works on medicine which are to be found in almost every bookseller's shop throughout the Empire dwell entirely on the virtues of simples. The properties belonging to herbs, and to the leaves and fruits of plants, have been carefully studied by medical practitioners in all ages, but beyond this point these learned men have never got. They know nothing of anatomy, and of the composition of the simplest compounds they are entirely ignorant. Hence the status of medical men is a very low one. They are looked upon only as quacks and impostors, and occupy much the same position that certain herbalists hold among ourselves. The doors of the profession are thrown open to them without any qualifying examination to bar the way. Any one may set up as a doctor who chooses to do so, and so long as he is tolerably successful with his patients he is allowed to pursue his course unmolested; it is only when a patient dies under his care that the officials trouble themselves about him. This state of the law acts in two ways: for while it succeeds in deterring utterly incapable men from entering the profession, it makes practitioners extremely unwilling to undertake dangerous cases.

Of physiology the Chinese know next to nothing, and their ideas as to the functions of the various organs are as vague as they are absurd. *Post-mortem* examinations are unknown among them, and hence they derive what they profess to know solely from the traditions of the past, aided by their own imaginations. According to the highest authorities the body is a microcosm, and is composed of the five elements—fire, water, metal, wood, and earth. When these act together in harmony, the subject is in perfect health, but when the balance is lost disease and sickness supervene. The great object, therefore, of the physician is to discover which of these, having gained the preeminence, requires to be repressed; and this is done by carefully feeling and comparing the various pulses of the body—for, according to the theory of these wise men of the East, each organ has a separate pulse, which communicates with an ascertained part of the surface of the body, and as each organ is intimately connected with one of the five elements, it is easy to discover, by an examination of all the pulses, which one is at fault. A receipt book is then referred to, and from it is chosen a medicine either "to strengthen the breath, to put down the phlegm, to equalise and warm the blood, to repress the humours, to purge the liver, to remove noxious matters, to improve the appetite, to stimulate the gate of life, or to restore harmony," as the case may be.

Of the functions of the brain they are a good deal in the dark, although from a well-known experiment they have derived the conclusion that it is to some extent the seat of the intellect. The unfortunate man who served to convince them of this fact was a member of the Han-lin College, whose great learning and wonderful memory had earned for him the *soubriquet* of "the walking library." It chanced, however, that while riding in Mongolia he was thrown from his horse to the ground with such violence, that the blow fractured his skull. A native physician who was called in, alarmed at the extent of the injury, attempted the strange experiment of substituting the brains of a cow for those of his patient. "But," adds the narrator, "the accident occasioned the utter prostration of his eminent powers of mind, and he became from that time forward a wholly different man from what he had been before." Another belief, not based upon experience, is that the brain, by means of the spinal cord, is intimately connected with the kidneys. The functions of some of the organs are thus described in a well-known work, entitled, "The Mirror of Medicine:"—

"The spleen rubs against the stomach, and grinds the food; it also keeps up the proper degree of heat in the five tsang. It moves the muscles and lips, and thus regulates the opening of the mouth; moreover, it directs our secret ideas, so that they become known to us.

"The liver regulates the tendons, and ornaments the nails of the hands and feet.

"The heart regulates the blood-vessels, beautifies the complexion, and by its means we are enabled to open the ears and move the tongue.

"The kidneys govern the bones, beautify the hair of the head, and open the orifices of the two yin.

"The diaphragm being spread out like a membrane beneath the heart, and being intimately joined all round to the ribs and spine, thus covers over the thick vapour, so that the foul air cannot arise."

The gall-bladder is believed to be the seat of courage; and, like the New Zealanders, Chinamen imagine that by devouring the gall of wild beasts and fearless men they gain courage and daring—a theory which is not unfrequently submitted to the test of practice on the death of celebrated bandits and rebels, when would-be graduates in bravery become eager competitors for the secret source of the deceased's former greatness. But of all matters relating to physiology, that of which they profess to know most, the circulation of the blood, is that of which they are pre-eminently ignorant. They appear to make little or no distinction between arteries and veins, and they hold the wildest ideas as to the course pursued by the blood through the body, and the purposes it serves. Fortunately Chinamen have a profound distrust of the pretended knowledge of the native doctors. They are far too practical a people to remain blind to the powerlessness of those practitioners in cases of real illness, or to ignore the superior skill and science of European physicians. The importance of health is sufficient to dissipate all prejudices, and men who would as soon cut their children's throats as allow them to attend a mission school, do not hesitate to apply to the foreign *i-sangs* for advice for themselves, their wives, and their families. Of this disposition on the part of the natives advantage has been taken by the various missionary societies, and hospitals have been established at Peking and at many places along the coast, where the good effected has been incalculable. Not only have they been the means of disseminating throughout the empire a general knowledge of the superiority of foreign medical practice, but they have acted as schools of medicine for a number of intelligent natives who, while assisting the medical men in the treatment of the patients, have graduated in the science. The printing press, also, has done good work in opening the eyes of Chinamen to a knowledge of the anatomy of the human frame, the causes of disease, and its cure. Four works by Dr. Hobson deserve special notice, from their intrinsic value and from the favour with which they have been received by native scholars. His first production, in 1851, a "Treatise on Physiology," was extremely popular, and was republished at Canton by a local magnate, accompanied by a laudatory preface. Six years later he brought out the "First Lines of the Practice of Surgery in the West," which he illustrated with upwards of 400 woodcuts carefully copied from the works of Liston, Ferguson, Druitt, Erichsen and others. A "Treatise on Midwifery and Diseases of Children" followed in 1858, and in the same year he published his "Practice of Medicine and Materia Medica." All these works met with the most unqualified success, not only in China but in Japan also, where they were reprinted with copious notes. Other works by Roberts, Kerr, Lobscheid and others, have aided in the same good cause, and are already bearing fruit by giving an impetus to scientific enquiry, and by breaking down the prejudices which stand in the way of the introduction of other branches of Western knowledge into China.

The study of the geography of the Empire, and of the structure of its language, has occupied the attention of some modern scholars, and the works of many of them are marked by deep research and great critical acumen. But their indisposition to enquire into the languages, history and geography, of foreign countries, narrows the field of their observation, and diminishes the interest that is felt in the results of their labours.

From the nature of things, however, the sciences, and especially the non-applied sciences, must for many years to come make but very slow progress in China. Within a narrow circle of scholars they will doubtless be more and more cultivated, and gradually a knowledge of them will leaven the whole land. But at present they do not find favour with the governing classes, who in all they do look for some immediate advantage, and are unwilling to trouble themselves about any branch of knowledge which is not, in some way, subservient to the practical interests of their class. For science, as science, they have no love. They are willing to use it to serve the ends they wish to gain at the moment, but they are equally willing to discard it as soon as those ends are accomplished. As an instance in point we may quote the equipment and disbandment of the Lay-Osborn expedition in 1863. Being sorely pressed by the Tae-ping rebels, the Chinese Government determined to establish a steam navy, which was to be commanded by Englishmen and manned by natives. In prosecution of their scheme, they purchased a fleet of despatch and gun-boats, but before they arrived the danger was passed. Colonel Gordon had captured Nanking and crushed the rebellion, and as a natural sequence the Government threw over their agent Lay, and sent the vessels back to England. Since that time other motives have been at work, which have induced them again to seek the aid of foreign mechanical science. At Tientsin, Shanghai, Nanking and Foochow, they have established arsenals; and, at the three latter places, dockyards also, where vessels of war are built, and every kind of munition of war is manufactured, under the direction of foreign engineers. At Foochow the arsenal is situated on the banks of the river Min, where, in combination with the yards for the construction of vessels and their armaments, have been established schools, in which natives are passed through such a course of instruction as to fit them for taking the command and management of vessels and dockyards. About 300 young Chinamen are here engaged in studying navigation and mechanics under the superintendence of between sixty and seventy teachers, artisans, &c., most of whom are French. A half-pay English naval officer presides over the school of navigation, and has so far succeeded with his pupils as to be able to provide good and efficient native crews and engineers for the steamers employed on Government duty along the coast. Already several transports carrying guns, and gunboats, have been successfully launched from the dockyard, and others are rapidly approaching completion. The former vessels have been employed in carrying the imperial grain to the north, and although they are entirely manned and officered by natives, it is noteworthy that no accident has as yet befallen any of them.

The arsenals at Nanking and Tientsin are more entirely devoted to the manufacture of rifled guns, torpedoes, and all kinds of munitions of war. That at Shanghai resembles more nearly in its constitution the establishment on the banks of the Min, but differs from all three in that a staff of translators are there constantly employed in rendering into Chinese European scientific works and important newspaper articles on similar subjects. This, then, is the measure of support which the rulers of China are at present disposed to give to science. They are willing and anxious to spend thousands of pounds annually in building men-of-war, but not one penny will they expend in furtherance of scientific truth. They lay out vast sums in the purchase of Armstrong guns and Minié rifles, but they lend no helping hand to the spread of such useful branches of knowledge as, for instance, chemistry, mineralogy and electricity, among the people. It is plain that we must not expect them to take any initiative in advancing science; and if we had only them to look to, the scientific future of China would be dark indeed. But, as we have already said, there is growing up among scholars of the present day a keen taste for scientific enquiry. Wealthy gentlemen are devoting their time and their money to the reproduction of the works of ancient native authors and of modern foreign writers on scientific subjects; and while the Government is patronising only those arts which conduce to war, the merchants are rapidly adopting steam and the telegraph for the more peaceful purposes of trade.

BARNACLES; THEIR FACTS AND THEIR FICTIONS.

By JOHN C. GALTON, M.A. (Oxon.), M.R.C.S., F.L.S.

Late Lecturer on Comparative Anatomy at Charing-cross Hospital.

[PLATE CIV.]

"They spawne, as it were, in March and Aprill; the Geese are found in Maie and June, and come to fulnesse of feathers in the moneth after. And thus hauing through God's assistance, dicoursed somewhat at large of Grasses, Herbes, Shrubs, Trees, Mosses, and certaine excrescences of the earth, with other things moe incident to the Historie thereof, we conclude and ende our present volume, with this woonder of England. For which God's name be euer honored and praised."—Gerarde, *Herball*, 1633.

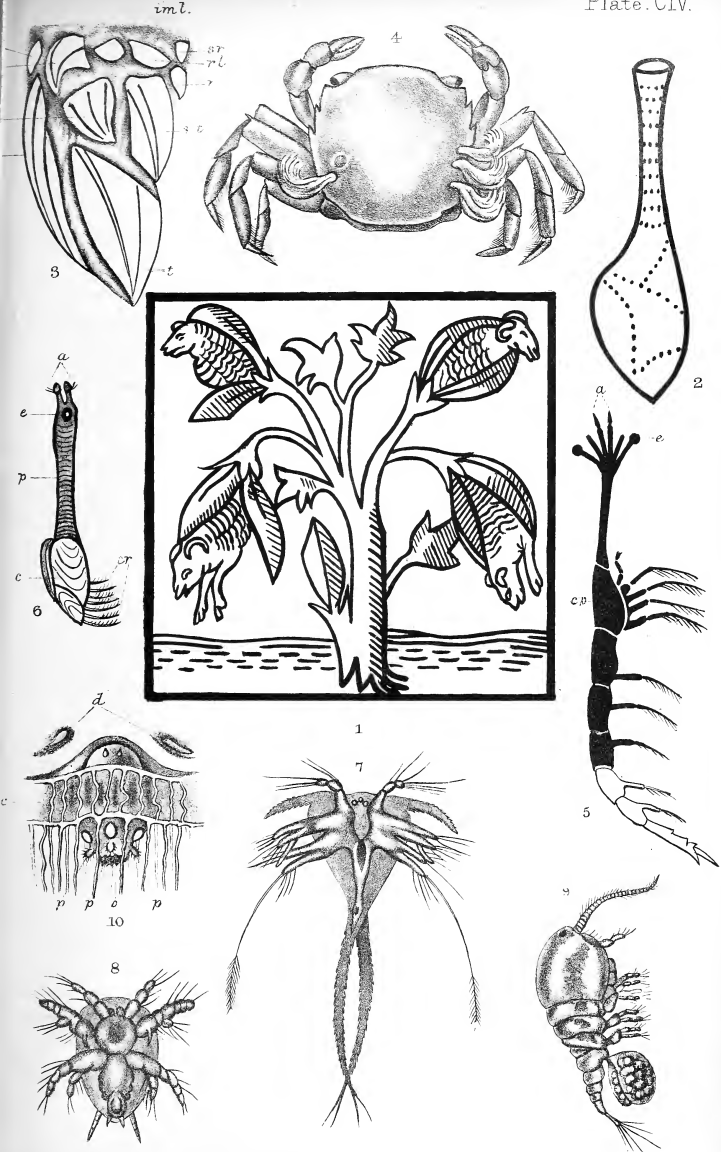
"Da ich nach meiner Art zu forschen, zu wissen, und zu geniesen mich nur an Symbole halten darf, so gehören diese Geschöpfe zu den Heiligthümern, welche fetischartig immer vor mir stehen und durch ihr seltsame Gebilde, die nach dem Regellosen strebende, sich selbst immer regelnde und so im Kleinsten wie im Grössten durchaus gott-und menschenähnliche Natur sinnlich vergegenwärtigen."—Goethe, *Die Lepaden*, 1823.

THE words with which the great poet-philosopher of Germany concludes a fragmentary note on the Barnacles, and which are placed at the head of this article, stand in somewhat striking contrast with the pious sentiments preceding them, expressed just two centuries before, by "old Gerarde," as many still lovingly term him, as a fitting conclusion to the description of the Bernicle-tree, which forms the last of the Appendices to his ponderous "Herball."

The above difference in the way of regarding the same subject, may, however, be no less due to the difference in the range of vision of the renowned courtier of Weimar and of the comparatively obscure English "master in Chirurgerie," than to a probable "change of type" in the mind of men brought about during the lapse of two centuries.

Although, from the scope of the periodical in which it appears, this article should properly be zoological rather than

Plate. CIV.



J.C. Galton del.

W. West & Co imp.

Barnacles.

historical in its bearings, it will not, I think, be out of place, before we enter upon the region of crude—and, may be, uninteresting—fact, to take a preliminary glance at a myth which has been for so long a period associated with the creatures which are the subject of the following pages, and traces of which even now exist in the nomenclature of the naturalist.*

Professor Max Müller, in his charming work on the Science of Language, devotes several pages to the tracing out of this myth through its several phases, which extend over a period of no less than five centuries.

It was language, believes this, one of our best philologists, which first suggested this myth; for, as he well observes, "Words without definite meanings are at the bottom of nearly all our philosophical and religious controversies, and even the so-called exact sciences have frequently been led astray by the same Siren voice."

"Barnacle," in the sense of the marine animals which are the subject of this article, though nearly identical in sound with "Barnacles" in the sense of spectacles,† had, originally, no connection whatever with that term, being evidently the diminution of the Latin *perna*, a ham; *pernacula* being changed into *bernacula*.‡

Now whence did the "Bernicle goose," the reputed progeny, adult form, or *imago*, of this supposed mollusc, derive its deceitful and misleading title? Bernicle geese were caught in Ireland (*Hibernia*), and were hence probably called originally *Hibernicæ* or *Hiberniculæ*. By a dropping of the first syllable —which frequently occurs in Latin words which have found their way into the modern Romance dialects—the word became transformed into *Berniculæ*, a term almost synonymous with the name of the shells, *Bernaculæ*. As the names, then, were identical, or nearly so, "argal," the creatures were one and the

* "No man would suspect Linnæus of having shared the vulgar error, nevertheless he retained the name of *Anatifera*, or duck-bearing, as given to the shell, and that of *Bernicula*, as given to the goose."—Max Müller.

† In this sense the word may soon be disposed of. It seems to be connected with the German *Brille*, which is a corruption of *beryllus*—"gemma speculum presbiterorum aut veterum *d i* brill" (Diefenbach, *Glossarium Latino-Germanicum*). In Old French the word *béricle* is used in the same sense, and in the dialect of Berri the form *berniques* is found. The word *bernicula* appears to be traceable to *beryllus*, through the intermediate modification *berynicula* or *beryllicula* (dimin.).

‡ "Appellantur et pernæ concharum generis, circa Pontias insulas frequentissimæ. Stant velut suillo crure longo in arena defixæ, hiantesque, qua limpitudo est, pedali non minus spatio, cibum venantur."—Pliny, *Hist. Nat.* 32, 55.

same. Such reasoning is irresistible, and must, of course, be conclusive! *

The vitality and antiquity of this myth was great; for though it had to run the gauntlet of contradiction—*e.g.* by Albertus Magnus and by Roger Bacon, in the thirteenth century,† the belief in the miraculous transformation of the Barnacle-shell into the Barnacle-goose was as firmly established in the twelfth as it was in the seventeenth century. No better instance of the reality of this belief can be given than the fact that Bernicle-geese were allowed to be eaten during Lent, as they were not fowl but fish—an iniquitous custom against which Giraldus Cambrensis with much zeal and unction inveighs.

A brief relation may not be without interest of the myth which had not only managed to struggle against contradictions no less than five centuries, but was of such seemingly sufficient stability that it could be turned to account by the faithful—both pastor and flock—in the no little important matter of varying—so elastic is the zoology of ecclesiastical dietetics ‡—the somewhat meagre monotony of Lenten dishes.

Bellenden, archdeacon of Murray, thus quaintly renders the description of the origin of the "geis genesit of the see, namit clakis," § given by one Hector Boece, in a Latin history of Scotland (1527):—"All treis that ar cassin in the seis be proces of tyme apperis first wormeetin, and in the small boris

* One Joannes Caius, however, suggests to Gesner, that the bird called *Bernaclus* ought to be called *Bernclacus,* for the Old Britons and the modern Scots called, and still call, the wild goose *Clake.* "Hence they still retain the name which is corrupted with us, *Lake* or *Fenlake, i.e.* lake goose, instead of Fencklake, for our people frequently change letters, and say *bern* for *bren.*" One fatal objection to this theory is that among the numerous varieties of the name *bernicula* not one comes at all near to *bernclacus.*

† The former declares that he saw the birds lay eggs and hatch them, which fact was corroborated later (in 1599) by some Dutch sailors who had visited Greenland. Æneas Sylvius (afterwards Pope Pius II.), when on a visit to King James (1393–1437) who, by the way, he terms "hominem quadratum [the 'ἀνὴρ τετράγωνος' of Aristotle?] et multa pinguetudine gravem," inquired after the bernacle-tree, and complains, somewhat petulantly, that miracles will always flee farther and farther, for that when he came to Scotland to see the tree, he was told that it grew further north in the Orcades.

‡ Professor Max Müller states that in Bombay, where with some classes of people fish is a prohibited article of food, the priests call the barnacle a sea-vegetable, under which name it is allowed to be eaten.

§ Gesner, in the Third Book ("Qui est de Avium natura") of his *Historia Animalium,* gives two rough woodcuts of the "clakis," and states, *inter alia,* that the *bernicla* were called *Barliatæ,* but that he prefers *brâtæ,* or *berniclæ.*

and hollis thairof growis small wormis. First they schaw their heid and feit, and last of all they schaw their plumis and wyngis." Boece had evidently some idea of a normal process of generation, for, after scoffing at the prevalent belief of the "rude and ignorant pepyl" that the geese were produced by the trees fringing the shore, and fell, like over-ripe fruit, into the water, and then straightway swam away, he proceeds to state "that als sone as their appillis or frutis fallis of the tre in the see flude, they grow first wormeetin, and be schort process of tyme ar alterat in geis."

"Old Gerarde" substantially repeats the same tale in his Appendix to his "Herball," affirming that, "There are found in the north part of Scotland, and the islands adjacent, called Orchades,* certaine trees, whereon doe growe certain shell-fishes, of a white colour, tending to russet; wherein are conteined little living creatures; which shels in time of maturitie doe open, and out of them grow those little living foules, whom we call Barnakles, in the north of England Brant Geese, and in Lancashire tree Geese; but the other that do fall upon the land perish and come to nothing." All this is hearsay; but he goes on to describe "what our eis have seene, and hands have touched," in a "small island in Lancashire, called the Pile of Foulders," which seems to have been a receptacle and lumber-room for all the "flotsam and jetsam" of the waves of the Irish Channel.†

Besides giving a rough woodcut, showing all the phases in the produce of the Bernicle-tree, from the stage of branch-bud to the launch of its fledgling fruit on the surrounding waters, he solemnly remarks:—

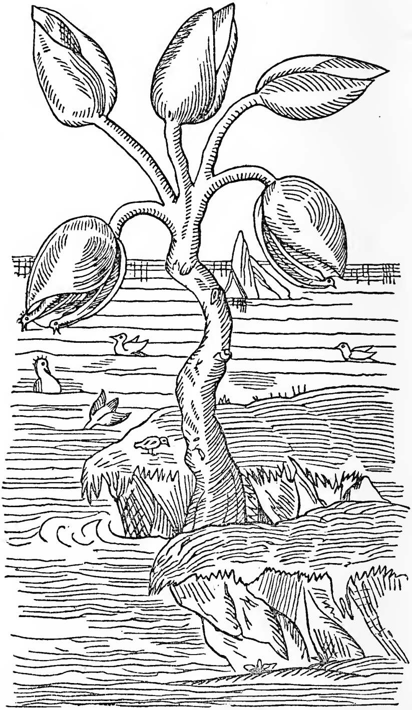
> "The Historie whereof to set foorth according to the woorthiness and raritie thereof, woulde not onely require a large and peculiar volume, but also a deeper search into the bowels of nature then my intended purpose wil suffer me to wade into, my insufficiencie also considered, leaving the historie thereof rough hewen unto some excellent men, learned in the secrets of nature, to be both fined and refined; in the mean space take it as it falleth out, the naked and bare truth, though unpolished."

About a century later we come across "a fined and refined" version of this "rough hewen historie," in "A Relation concerning Barnacles, by Sir Robert Moray, lately one of His

* The Orkneys; not far from that "Ultima Thule" which would have been a limit to all flying legends.

† Probably Peel Island, the Pile of Fouldrey ("la peele de Foddray," or the Pylle of Folder). See Baines' "History of the County Palatine and Duchy of Lancaster," vol. ii. p. 651. London: 1870.

Majesties Council for the kingdom of Scotland," which was read before the Royal Society, and published in its "Philosophical Transactions." The shells are described as hanging from a fragment of a fir-tree, cast up on the island of East [Uist], by a pedicle "not unlike the windpipe of a chicken," which is not unnaturally regarded as a kind of suction apparatus for the withdrawal of nutriment from the tree. The shells are



further stated each to be divided into five sections (see fig. 2), by "cross seams or sutures," and to have within them "little Birds, perfectly shaped, supposed to be Barnacles."

Having traced this interesting story to the publications of a learned society, "nullius addictus jurare in verba magistri," as its motto sets forth, I have, I hope, gently bridged over the gulf between myth and fact, marvel and the comparatively commonplace. But before quitting the region of romance for strictly prosaic and matter-of-fact territory, I would direct attention to a curiously parallel story which Professor Max Müller omits to mention in his otherwise most exhaustive account of the Barnacle-tree myth. This will be found in chapter xxvi. of "The Voiage and Travaile of Sir John Maundevile, Knt.," which treats "Of the Contries and Yles that ben bezonde the Lond of Cathay; and of the Frutes there," &c. This "Knyght of Ingelond, that was y bore in the toun of Seynt Albans, and travelide aboute in the worlde in manye diverse contreis, to se mervailes and customes of countreis, and diversiteis of folkys, and diverse shap of men, and of beistis," and who has, it seems, been wrongfully accused of purloining his descriptions from the great Venetian Ulysses, Marco Polo, makes mention of the following among the curiosities of Cathay:—

"And there growethe a manner of Fruyt, as thoughe it were Gowrdes: and whan thei ben rype, men kutten hem a to, and men fynden with inne a lytylle Best, in Flessche in Bon and Blode as though it were a lytylle Lomb, with outen Wolle. And men eten both the Frut and the Best; and that is a gret Marveylle. Of that Frute I have eten; alle thoughe it were wondirfulle: but that I knowe wel that God is marveyllous in his Werkes. And natheles I told hem of als gret a Marveylle to hem that is amonges us: and that was of the Bernakes. For I tolde hem that in oure Countree weren Trees that beren a Fruyt, that becomen Briddes fleeynge: and tho that fellen in the Water lyven: and thei that fallen on the Erthe dyen anon: and thei ben right gode to Mannes mete. And here of had thei als gret Marvayle that sum̃e of hem trowed it were an impossible thing to be."

I have given in the plate accompanying this article a facsimile (fig. 1) of the woodcut which illustrates this tale, as it possesses some interest when compared with the figure (see opposite page) reproduced from Gerarde's "Herball."

Let us now turn our attention for a while to the not less wonderful, though possibly less romantic, history told to us by hard facts.

The Barnacles proper and their allies, the Acorn-shells, which have been classed together by zoologists under the term "Cirripedia," from the *cirri*, or curls of hair, in which their feet terminate, may be divided provisionally, and conveniently for purposes of description, into the *Pedunculated* and *Sessile* groups. Though the former are also in a sense sessile, in that they are fastened, when adult, to other bodies which may be either fixed or movable, they are nevertheless to be distinguished from the latter group by having their main body hanging from a stalk, pedicle, or peduncle, of varying length, which permits of some degree of motion, while the body of the sessile kinds is directly fixed to its support by a firm and often broad base.* Both kinds must be fairly familiar even to the most ordinary sea-side visitor; the pedunculated, in the shape of the pink clusters, like locks of a Medusa's hair, which, clinging to a worm-eaten fragment of wreck, or to the cork float of a fisherman's seine, he sees thrown upon the shore after a storm; while the sessile varieties, as little, short, coarsely truncated, clustered cones—not limpets—try the tenderness of his feet when he takes his bathe from the rocks.

As regards geographical distribution, these animals extend all over the world; those, of course, attached to floating objects having the widest range. These excepted, the majority inhabit the warmer temperate and tropical seas. Of those attached to fixed objects, or to littoral animals, rarely more than three or four species are found in the same locality. Of the pedunculated kinds, the fixed *Lepadidæ*—to which family the common ship-barnacle belongs—are attached mostly to organic bodies, some being deeply embedded in the skin of the shark (*Anelasma squalicola*) or of whales (*Coronula balœnaris*), while others fasten upon turtles, sponges, various molluscs, or inhabit the gill-cavities of Crustaceans (as *Dichelaspis* in a *Palinurus*).

I have before me, as I write, some specimens of *Spirula* shells, and of the lovely lilac *Ianthina*, which floats in mid-ocean, buoyed up by its egg-raft, to which certain *Lepadidæ* are adhering; also of a crab from China waters (fig. 4), on either side of whose carapace *Conchoderma Hunteri* has effected a lodgment.† With regard to the geographical range of sessile Cirripedes, they are found in every sea, from lat. 74° 18′ North to Cape Horn; but their distribution is much affected by locality, as they do not live upon coral reefs, or where shores and sea bottoms are muddy, sandy, or are formed of shifting shingle.

With regard to fossil *Cirripedia*, geologists have had much difficulty in identifying specimens, because the shell-valves of the same species are rarely co-embedded, since the membrane

* A parallel nomenclature will at once occur to the botanist as applied to the two varieties of oak which inhabit this country.

† These specimens, presented to the University Museum, Oxford, by Robert Garner, Esq., F.L.S., were kindly lent to me by my former teacher, Professor Rolleston, F.R.S.

holding the various divisions of the valve together decays very easily. The oldest known (pedunculated) Cirripede is a *Pollicipes*, found in the Stonesfield slate—Lower Oolite—but the *Lepadidæ* were not at their culminant point until during the deposition of the great Cretaceous system, at which time there were three genera, and at least thirty-two species of this group.* No true sessile Cirripede has been found in any secondary formation.† This group first makes its appearance in Eocene deposits, and is found subsequently, often abundantly, in the later Tertiary formations. The present, however, is the epoch of the *Balanidæ*, for "these Cirripedes," as Darwin remarks, "now abound so under every zone, all over the world, that the present period will hereafter apparently have as good a claim to be called the age of Cirripedes, as the Palœozoic period has to be called the age of Trilobites."

As mythology has almost crowded out commonplace natural history, there remains but scanty space at our disposal for the barest *resumé* of the anatomy of the *Cirripedia.*

Let us take a common ship-barnacle (*Lepas*) as a type. Here we notice a flesh-coloured, translucent, wrinkled stem, possibly more than a foot long, attached maybe to wood or cork, and from this stem there dangles a triangular pearly shell-fish, the valves of which, bordered with the most lovely orange, from time to time open and disclose several pairs of curling feelers. The animal, in fact, bears no distant resemblance to a siphonate mollusc (see *The Anatomy of the River Mussel*, POPULAR SCIENCE REVIEW, July 1870), which has altered its mode of life, and, careless of the stoppage of its ventilating flues, has settled down at the wrong end. Such superficial resemblance did not fail to mislead even men such as Linnæus, Cuvier, and the classical malacologist, Poli, all of whom classed this animal among the *Mollusca.* Each valve of the shell will be seen superficially to be made up of two unequal, irregularly triangular parts, the larger of which, lying nearest to the stem, or peduncle, is termed *scutum*, while the other, occupying the free apex of the valve, is known by the name of *tergum.* There remains a single unpaired sill, to which these twin

* *Aptychus* (or *Trigonellites*) of D'Orbigny, apart from structural differences, is not a Cirripede. It existed at the Carboniferous period—"a period vastly anterior to the oldest known *Pollicipes*."

† The form *Verruca* (Cretaceous), which must be ranked as a distinct family of equal value with *Balanidæ* and *Lepadidæ*, is not a real exception. "On the contrary, it harmonises with the law that there is some relation between serial affinities of animals and their first appearance on this earth."

doors are hinged, which is called the *carina*, or keel. These several parts are held together by a strong membrane, composed of *chitine*, a substance which enters largely into the composition of the wing-cases (*elytra*) of beetles, and whose main chemical reaction is that it is insoluble in boiling caustic potash.

This is a description of a *Carapace*—as the whole shelly box is called in Crustacean terminology—reduced almost to its simplest expression; but in some pedunculated forms, *e.g.* *Pollicipes*, there are many more shell elements, all of which, however, may be reduced to system by comparison with the scheme (see fig. 3) laid down by Darwin. Now the shell of a sessile Cirripede—*e.g.* *Balanus*, the "Acorn-shell," which bears a distant resemblance to a miniature jelly-mould—though very complex in composition, and having at first sight not even the remotest resemblance to that of a *Lepas*, will be best understood by taking as a key that of *Pollicipes*, the oldest known genus, "from which, in one sense, all ordinary Cirripedes, both sessile and pedunculate, seem to radiate." If, then, this form be taken as a standard of comparison, the homology of the several parts in sessile and pedunculate Cirripides, according to Darwin, "admits of no doubt." These relations of homology may, I think, be roughly indicated by imagining a pedunculate Cirripede in the position of a stranded boat, *i.e.* keel downwards, *cirri* consequently uppermost, and the *carina* and the several accessory factors (such as we have in *Pollicipes*) excluding of course the *scuta* and *terga*—to grow up and around the animal, encircling it as the outer whorls of the perianth do the petaloid stamens of the flower of the water-lily, while the two pairs of excluded—in a different sense *in*cluded—elements are left to form small trap-doors, as it were, for the protection of the upper open end of the truncated cone thus formed.

Let us now investigate the internal anatomy of a Cirripede. Having taken a *Lepas* and secured it with pins, keel downwards, to a loaded cork, submerged beneath a stratum of spirit or water, we shall find our boat covered over at the *stern*al half by a thick membrane passing from gunwale to gunwale ("occludent margins") of either *scutum*, while at the other end it is open for the free play of twelve rowers—the *cirri*—who like galley-slaves sit two on a bench, but far too crowded, up in the bows. "Qu'est-ce donc que l'on fait dans cette galère?" Having carefully divided the membrane which, like a half-deck, covers the stern, we come across a strong transverse thwart, the *adductor scutorum* muscle. After severing this from one of the points of its attachment, we are enabled to turn over one of the sides of our galley, and thus expose its crew and their freight.

The bulk of the somewhat globular body, which nearly fills its boat-shaped receptacle—called technically the *capitulum*, and is invested by a loose membranous "sack"—is composed of a *thorax*, which supports the cirri, and of a special enlargement, the *prosoma*, which contains the stomach. The mouth, which will be found in front of the first pair of cirri, is armed with a paired series of organs of mastication—mandibles, maxillæ, and their palps—collectively termed *trophi*, and leads into a short œsophagus, which, in turn, communicates with a capacious globular stomach. The food, consisting of minute crustaceans, is wafted towards the mouth by the cirri, and is there seized, but not triturated by the trophi. After the juices have been absorbed, the rejectamenta are let out at the anus, wrapped up in an epithelial case of the stomach. Darwin believes that *Lepas* can throw up food *viâ* the æsophagus. The stomach, which sometimes has a pair of blind sacs (*cœca*) appended, is covered with a dark glandular mass, possibly exercising the function of a liver, which communicates by large openings with its interior. The interior, which is somewhat wide at its commencement, makes a sharp turn upon the stomach, and after running along the dorsal aspect (*i.e.* beneath the *carina*) of the animal, and decreasing gradually in calibre, ends by an oval opening in the very rudimentary abdomen. The cirri, of which, as just stated, there are six pairs, consist each of two long elegantly curling arms, *rami*, fringed with hairs, and supported on a common *pedicle*. At the bases of the first pair may be seen certain filamentary appendages, which have been supposed to act as gills; but this is doubtful, as in many Cirripedes they are quite absent. Moreover, the mere surface of the body and of the "sack" seems to suffice for respiration. Coiled up between the last pair of cirri, but much longer than the longest of any of these appendages, lies a whip-like organ, the penis, at whose base the anus opens.

All *Cirripedia*, with some exceptions—*viz.* certain species of *Ibla* and *Scalpellum*—are hermaphrodite; some species, however, of the genera just cited have their masculine energies reinforced by parasitic males, which—from their not pairing with the opposite sex, but, *mirabile dictu*, with hermaphrodites—Darwin has termed "complemental males." * At fig. 10 one of these "cavalieri serventi" is shown *in situ*. The peduncle is

* "We look in vain," says Darwin, "for any, as yet known, analogous facts in the animal kingdom." None of the *Balanidæ* have these "complemental males."

"gorged with an inextricable mass" of branching ovarian tubes, filled with immature ova and a granular matter. These are gathered together into two main ducts, which run on either side in the peduncle to join two glandular masses of an orange colour, and of the thinness of a wafer, described by Darwin as "gut-formed bodies," which embrace the stomach. These, which were believed by Cuvier to be salivary glands—organs which have no existence in the *Cirripedia* — are ovaries. Since these important glands have, oddly enough, no oviducts, how do the ova get into the "sack' of the animal? Just before the Cirripede changes its coat ("Exuviation"), which it does frequently, being a "very growing" animal, the ova burst from the tubes in the peduncle, and, after being carried along the main "lacuna," which serves for the circulation of the blood, are collected—how? it is not known—in the cellular "corium" underlying the body-"sack." Eventually the ova, aggregated by a modification of the corium into two "lamellæ," become adherent to certain "ovigerous frœna," which are a pair of folds of skin depending inside the sack on each side of the attachment of the body. Now these folds, though thus specialised, serve, together with the whole surface of the body in these gill-less Cirripedes, for respiration; but in the sessile forms their homologues, in the shape of a much-folded membrane communicating with the circulating channels and having no "ovigerous" function, were held to be gills by Professor Owen. Here is a remarkable instance of the "Transition of organs," for Darwin has no doubt "that the two little folds of skin, which originally served as ovigerous frœna—but which likewise very slightly aided the act of respiration—have been gradually converted by natural selection into branchiæ, simply through an increase in their size and the obliteration of their adhesive glands. If all pedunculated Cirripedes had become extinct—and they have already suffered far more extinction than have sessile Cirripedes—who would ever have imagined that the branchiæ in this latter family had originally existed as organs for preventing the ova from being washed out of the sack?"

No heart has been discovered in any of the Cirripedes. The blood circulates in *lacunæ*, or channels not defined by distinct walls, the principal one of which has a kind of valve to prevent regurgitation of the blood into the body during the contraction of the peduncle.

The nervous system ordinarily consists of a chain of six ganglia, or nerve centres, from which nerves radiate. Two of these become fused together in *Pollicipes*, and in some of the sessile Cirripedes the concentration proceeds as far as in any Decapod Crustaceans—for instance, a spider-crab (*Maia*). Cirripedes—though this was once doubted—have eyes in their adult stage provided with special optic nerves, but the function of this organ is probably limited to the cognizance of shadows intervening between them and a source of light. Saccular organs, opening externally by orifices, supposed to be olfactory and acoustic in function, have been found at the bases of the outer maxillæ and first pair of cirri respectively.

A brief outline of the earlier phases of the life of a Cirripede must suffice. In the yelk of its ovum segmentation is complete, but there is no primitive band—a point in which it differs from that of a crab or lobster, which are accordingly placed in a separate sub-class by Fritz Müller. The larva (*Nauplius*), on emergence from the egg, passes through three stages, each of which is further modified by a series of moults before that it arrives at the adult condition and has "settled down" permanently. This *Nauplius* form—"the extreme outpost of the class," as Fritz Müller terms it—varies so little in all the divisions of the *Crustacea*, be their representatives ever so unlike when adult, that in the six orders selected and figured for comparison by Haeckel, "no greater difference"—as he well observes—"can be detected than in six different 'good species' of a genus." I have figured in the plate two instances (figs. 7, 8) of this "common family form of all Crustaceans" (gemeinschaftliche Stammform aller Krebse), and of their far more differing forms (figs. 6, 9) when adult. The organs which undergo the most curious transformations while the *Nauplius* is passing through its three stages are its eyes. In the first stage there is only a single simple eye, possibly formed by the confluence of two, in the normal position in the front of the head; but in the succeeding stage the organ is doubled, but the two eyes, as yet simple, have shifted their position backwards. In the third, or pupal stage, the eyes remain in the same place, but have now become large and compound; while in the last, or mature stage, they have not only moved some way posteriorly again, but have actually become again simple and minute, being either confluent, as in *Lepas*, or fairly far apart, as in *Balanus*. The larva in its last or pupal stage (see fig. 6) bears a great resemblance to the mature form, except in the size of its eyes and in the presence of a pair of antennæ in front of them, by which, through the medium of a large sucker in their middle joints, it is enabled to anchor itself to some object. Though this is a voluntary act, the animal cannot for long change its mind and "slip moorings," but eventually remains fixed, "willynilly," owing to the secretion from a pair of cement-glands in the neighbourhood of the stomach—the future ovaries, in fact—which runs along ducts to the antennal sucking-discs. In course of time the antennæ atrophy and the animal becomes permanently fixed by the "setting" of the "marine cement." In the sessile Cirripedes the system of cement-glands is very complex, for at each period of growth new organs are formed, while the old glands are preserved, though now functionless, adherent to the basis of the shell.

The homologies of the Cirripedes with the typical form of the Crustacean class, of which it is a member, will be indicated by comparison of figs. 6 and 5. Out of the twenty-one "secondary aggregates, called segments or somites"—to use the language of Herbert Spencer—which, distributed in sevens equally among the head, thorax, and abdomen, go to make up the perfect Crustacean, the adult *Lepas* possesses no less than seventeen, which are disposed thus:

Peduncle (bearing a pair of eyes, a pair of antennæ, and, in early *Nauplius* stage, an additional pair) = 3 somites.

Trophi of mouth (consisting of mandibles, maxillæ, and outer maxillæ, in pairs) = 3 somites.

Thorax (bearing six pairs of cirri) = 6 somites.

Rudimentary abdomen = 3 somites.

But this only makes 15 as a total, and if the thoracic somites present are the six posterior segments, there must be two lacking between the outer maxillæ and the first pair of thoracic legs. Now, luckily, these missing members will be found in *Proteolepas*, in which every segment in the body is "as distinct as in an Annelid." *

There is a curious and aberrant group of Crustaceans, termed *Rhizocephala*, which live not only on, as harmless "commensals"—to use the language of Van Beneden—but by, and in their "host," generally some hermit- (*Pagurus*) or other genus of crab (*Porcellanus*), from whose abdomen they project like sausage-shaped excrescences filled with ova. Into such shapeless creatures the comparatively shapely Cirripede was converted, suggests Fritz Müller, by "natural selection." Now certain Cirripedes are in the habit, as has been previously stated, of fixing upon living animals. Suppose, then, at some primeval epoch, such an one had adhered to the soft abdomen of a hermit-crab, and that the cement-ducts in the peduncle, instead of keeping to the surface, had penetrated the body of

* See further an article on "The Lobster," by Mr. St. George Mivart, F.R.S., in the Popular Science Review, Oct. 1868.

the luckless host. This would be beneficial to the future parasite, as securing a better hold; and variations in this direction would consequently be preserved as advantageous. As soon as the ducts had penetrated, an osmotic interchange of fluids would take place, the balance of benefit being against the "host;" and since this source of nourishment would be more constant than the somewhat precarious livelihood casually gotten by the waving cirri, the latter organs, together with their neighbours, the *trophi*, finding their "occupation gone," would in time atrophy, while the *quondam* cement-ducts would become nutriferous rhizomes. Those Cirripedes having a constant means of subsistence would be better off than their less fortunate relations who still kept on "living from hand to mouth," and would outstrip them in the "struggle for existence." Protected by the abdomen of its *Porcellanus* host, or by the lodging "annexed" by the hermit *Pagurus*, it would gradually leave off its calcareous coat and become at last "only a soft sack filled with eggs, without limbs, without mouth or alimentary canal, and nourished, like a plant, by means of roots, which it pushed into the body of its host. The Cirripede had become a Rhizocephalon."* The *Anelasma squalicola*, which lives upon sharks in northern seas, represents the halfway stage of this transformation. Here the shell-less test is supported on a peduncle which is beset with hollow filaments which "penetrate the shark's flesh like roots." On the other hand, the cement-glands are absent, the parts about the mouth minute, and the cirri destitute of bristles.

Having begun the article, now concluded, with myths, we bring it to a close with "matters of fact;" but we think that it will be conceded, that sometimes "hard facts" and even scientific speculations, are no less strange than fiction and the wildest flights of fancy.

LIST OF PRINCIPAL WORKS REFERRED TO.

Burmeister, Hermann. "Beiträge zur Naturgeschichte der Rankenfüssler" (Cirripedia). 4to. Berlin, 1834.

Carus, Victor. "Icones Zootomicæ." Tab. x. figs. 33–44. Leipzig, 1857.

Clark. "A List of Dissections in the University Museum, Cambridge."

---

* It is significant that the *Cirripedia* and *Rhizocephala*, when in the *Nauplius* stage, have more points in common than they have with the *Nauplii* of other Crustaceans.

Coldstream. Article "Cirrhopoda," in vol. i. of Todd's "Cyclopædia of Anatomy and Physiology."

Darwin. "A Monograph on the Sub-class Cirripedia." 2 vols. Ray Society: London, 1851–54.—"A Monograph on the Fossil Lepadidæ," and "A Monograph on the Fossil Balanidæ." Palæontographical Society, 1851–54.—"On the Origin of Species," p. 211, 3rd edit. London, 1851.

Gegenbaur. "Grundzüge der Vergleichenden Anatomie." 2te Aufl. Leipzig, 1870.

Gerarde. "Herball, enlarged and amended by Thomas Johnson, Citizen and Apothecarye of London." p. 1589. London, 1633.

Gerstaecker in Bronn's "Klassen und Ordnungen des Thierreichs." 5ter Bd. "Arthropoda" (Rankenfüssler), pp. 406–589. Taf. i.–vi.

Gesner. "Conradi Gesneri, Tigurini, medicinæ et philosophiæ professoris in Scholâ Tigurinâ Historia Animalium." Liber iii. p. 109. Francofurti.

Giraldus Cambrensis. "Topographia Hibernica." Cap. xv. "De bernacis ex abiete nascentibus, earumque natura."

Goethe. "Die Lepaden." 1823. "Sämmtliche Werke." 27ter Bd. s. 280. Stuttgart, 1858.

Haeckel. "Natürliche Schöpfungsgeschichte." 2te Aufl. s. 487. Taf. viii.–ix. Berlin, 1870.

Hoeven, Van der. "Handbook of Zoology," translated by Clark. Vol. i. pp. 598–621, pp. 633–640, pl. xii. fig. 5. London, 1856.—"Philosophia Zoologica," pp. 235–347. Lugdun. Batav. 1864.

Huxley. "An Introduction to the Classification of Animals," p. 125. London, 1869.

Martin, Saint-Ange. "Mémoire sur l'Organisation des Cirripèdes." "Mémoires présentés à l'Acad. des Sciences de Paris." Tome vi. p. 513. 1835.

Maundevile. "The Voiage and Travaile of Sir John Maundevile, Knt." Reprint from the Edit. of 1725, edited by T. O. Halliwell, p. 264, cap. xxvi. London, 1866.

Moray. "A Relation concerning Barnacles, by Sir Robert Moray, lately one of his Majesties Council for the kingdom of Scotland." Phil. Trans. No. 137. 1677–78.

Müller, Fritz. "Facts and Arguments for Darwin." Translated by Dallas. London, 1869.

Müller, Max. "Lectures on the Science of Language." 2nd Series. Lect. xii. "Modern Mythology." London, 1864.

Robinson. "Some Observations on the French 'Macreuse' and the Scotch 'Bernacle.'" Phil. Trans. vol. xv. 1685.

Rolleston. "Forms of Animal Life," p. cxviii. Oxford, 1870.

Spencer, Herbert. "The Principles of Biology."

Thompson. "Discovery of the Metamorphosis in the second type of the 'Cirripeda,' viz. the Lepades, completing the Natural History of these singular Animals, and confirming their affinity with the Crustacea." Phil. Trans. 1835, p. 355, and pl. vi.

Troschel. "Handbuch der Zoologie." 7te Aufl. Berlin, 1871.

EXPLANATION OF PLATE CIV.

FIG. 1. From a drawing taken * from the woodcut in Chapter xxvi. of Sir John Maundevile's "Voiage." This should be compared with the woodcut † at p. 388, borrowed by Prof. Max Müller from Gerarde's "Herball."

„ 2. Taken from fig. 3 of a plate in the "Phil. Trans.," accompanying Sir Robert Moray's "Relation concerning Barnacles.' This seems to supply a link between the mythical epoch, as represented by Gerarde's figure, and that of fact, as represented by the following diagram.

„ 3. Diagram of the *capitulum* of a *Lepas*, showing the relations of the various factors of the shell, reduced and modified—*e.g.* by turning it upside down, for better comparison with fig. 2—from Darwin's figure (fig. 1) at p. 3 of his Monograph on the *Lepadidæ*. (*c*) Carina.‡ (*t*) Tergum. (*s c t*) Scutum. (*u l*) Upper Latus. (*s c r*) Subcarina. (*c l*) Carinal Latus. (*i m l*) Infra-median Latus. (*r l*) Rostral Latus. (*s r*) Subrostrum. (*r*) Rostrum.

„ 4. Drawn by the author from a specimen belonging to the University Museum, Oxford. The bottle containing it is thus labelled:—"*Conchoderma Hunteri*, on carapace of a crab from Amoy. The eye is situated in this species on the oral side of the adductor, the reverse of its position in *Lepas*." On the right side, three of the Cirripedes are *in situ*, while, on the left, only one out of two originally adherent remains, the position of its former neighbour being indicated by a scar-like pit in the carapace of the crab.

„ 5, 6. Modified from woodcuts in Darwin's "Monograph of the Cirripedia," illustrating the homologies between this group as represented by a *Lepas* (fig. 6), and the *Crustacea*, as represented by one of the *Stomapoda* (fig. 5). Those "somites" of the Crustacean body, which are present in the Cirripede, are coloured dark, those being merely left in outline which have no representative in the latter group. (*p*) Peduncle. (*c*) Capitulum. (*c r*) Cirri. (*e*) Eye. (*a*) Antennæ. (*c p*) Carapace.

„ 7, 8, 9. Reduced and modified from figures in Tafs. viii. ix. of Prof. Häckel's "Natürliche Schöpfungsgeschichte." Fig. 7 is the larval form (*Nauplius*) of a *Lepas*, such as may be conveniently represented by the preceding figure, while figs. 8, 9 respectively illustrate the *Nauplius* and adult stage of a

---

* By kind permission of Messrs. Ellis and White, the publishers.

† Kindly lent by Messrs. Longmans.

‡ Made up of three factors in fossil species of *Scalpellum*.

Crustacean proper (*Cyclops*). The main object of these figures is to demonstrate the fact that, however dissimilar in their adult forms may be the representatives of the various divisions of the Crustacean stock ("Stammform"), they have a striking similarity, making allowance for differences in minor particulars, in their larval stage.

FIG. 10. "Complementary male" of *Scalpellum Vulgare* attached over fold in "occludent margin" of the *scutum* of the hermaphrodite. Reduced and modified from fig. 37, tab. x. of Carus' "Icones Zootomicæ," taken from fig. 9, pl. v. of Darwin's monograph. (*o*) Orifice of sack of male. (*p*) Spinous projections above the rudimentary valves. (*c*) A transparent border of chitine—supporting long spines—which forms a border to the "occludent margin" of the *scutum* of the hermaphrodite. (*d*) Depression for the *adductor scutorum* muscle of the hermaphrodite.

At the top of the figure are represented, as seen through the whole thickness of the animal, the prehensile larval antennæ.

For comparison with the above, see the figure of the male of *Scalpellum regium*, given in one of Prof. Wyville Thomson's "Notes from the *Challenger*," in "Nature," August 28. 1873.

REVIEWS.

AMERICAN RECORD OF SCIENCE.*

THE Americans are attempting in their own country what has been attempted with the most signal failure in this. They are trying to publish, with successful results, an annual work recording the progress made, not only at home, but throughout the entire world, in the whole field of scientific research. The only book of the kind which our own literature possesses is that production which is known as the "Year-Book of Facts," a volume which we need hardly add is absolutely worthless as a scientific record. The present American work is got up on a larger scale; and is, so far as selection of paragraphs is concerned, edited with a certain selective skill, which renders it much more valuable as a scientific volume. But in saying this we are giving it all the praise within our power. For most assuredly it is unrepresentative, as of course every such volume must be. It is, as a matter of course, interesting to the mere "dabbler" in science; and we doubt not there are sufficient of this class alone in America to render its publication successful; but as a purely scientific book it has no real value whatever. Let us take an example in order to prove the force of what we say. Chemistry alone is not one of the most widely diffused branches of knowledge, yet the monthly journal which is published by the "Chemical Society," and which consists almost exclusively of condensed paragraphs showing the work that is being done, would in two of its numbers fully equal in bulk the present volume. That is to say, the progress of chemical science alone, in a single year, would, if recorded, occupy six times the space that is covered by the present work. When, then, we take the numerous other branches of science into consideration—such, for instance, as Anatomy, Physiology, Botany, Zoology, Geology, Palæontology, Mineralogy, Physics, Mechanics theoretical and practical, Astronomy, Ethnology, Meteorology and Microscopy—we see how utterly impossible is such a book as the present one if it really be intended as a record of science for the scientific worker. If, on the other hand, it is addressed, as is our own brief summary, to the man of general scientific tastes, then we must regard it as a very excellent volume; and most probably it is in this light that the editor, Mr. Spencer F. Baird, views the work. Examined under this aspect

* "Annual Record of Science and Industry," for 1872. Edited by Spencer F. Baird, with the Assistance of Eminent Men of Science. New York: Harper Brothers, 1873.

the book proves a most interesting one; the records are, in most instances, up to date—though in a few this is not so—and in general are well selected. Moreover, the work is well got up, and printed, considering its American origin, in very good clear type. We fancy the editor does not receive the "Monthly Microscopical Journal," as he records Dr. Hudson's discovery of *Pedalion mira* as being a novelty taken from another journal; whereas, as histological readers are aware, this very singular and interesting rotifer was described nearly a year earlier by Dr. Hudson in a communication to the "Monthly Microscopical Journal." We observe also that in the Report of the Royal Commission on Scientific Education, the critic confounds the secretary with the members. Withal, the book is interesting and instructive, and we wish it every success.

TYNDALL'S AMERICAN LECTURES.*

PROFESSOR TYNDALL is certainly the Helmholtz of England, if not something better still. We have often had to give him what might appear, to those ignorant of the man, unseemly praise, but which we felt we were thoroughly honest in awarding. And often all our encomiums were modest indeed when contrasted with those ebullitions of *kudos* which our American brethren have very recently indulged in. Dr. Tyndall has seemed to electrify them, and we do not wonder at their tendering him the highest praise, for now in the work before us we can see the reason of it all. Here is a book which gives the words in which the English lecturer indulged, and we cannot wonder that the various audiences which he addressed were well-nigh enraptured with their speaker. For assuredly it would be impossible to find within our language a work in which more eloquent words are employed to detail more striking facts, and withal are addressed to an audience essentially unscientific it its character, and which can yet appreciate, to a very intense degree, the wonders and the beauty of the principles set forth.

We know of no work in the whole range of natural philosophy which deals with its subject in such clear and incisive words as the present one; and furthermore we find in it the difficulties of optics explained in a fashion which for clearness and intelligbility stands unrivalled. We may point to one or two portions of the work, in which the style is singularly lucid. And in the first place we may take that portion in which its author seeks to explain, to a popular audience, the exact nature of diffraction. This is an exceedingly difficult matter to make people comprehend, but we think Dr. Tyndall has happily succeeded in making it understood. We cannot follow him in his explanation, for it would take us too far and would occupy too much space; and therefore we leave it for the reader himself. But what, for instance, could be simpler than the passage in which Dr. Tyndall explains the error of the mighty Newton. "Newton," he says,

---

* "Six Lectures on Light," delivered in America in 1872–1873. By John Tyndall, LL.D., F.R.S., Professor of Natural Philosophy in the Royal Institution. London: Longmans, 1873.

"who was familiar with the idea of an ether, and who introduced it in some of his speculations, objected, as already stated, that if light consisted of waves, shadows could not exist; for that the waves would bend round the edges of opaque bodies and agitate the ether behind them. He was right in affirming that this bending ought to occur, but wrong in supposing that it does not occur. The bending is real, though in all ordinary cases it is masked by the action of interference. This inflection of the light receives the name of diffraction."

On all other branches of the important subject on which he has lectured the matter and manner of delivering it is the same, and we might chose many quotations if space permitted. But we must conclude with one more excerpt. It is upon the subject so often of late years illustrated by Dr. Tyndall, in his Institution lectures—the identity of heat and light in their mode of passage. "Perhaps," says he, "no experiment more conclusively proves the substantial identity of light and radiant heat than the formation of invisible heat-images. Employing the mirror already used to raise the beam to its highest state of concentration, we obtain, as is well known, an inverted image of the carbon points formed by the light rays at the focus. Cutting off the light by the ray-filter, and placing at the focus a thin sheet of platinized platinum, the invisible rays declare their presence and distribution by stamping upon the platinum a white-hot image of the carbons." A series of illustrations show at a glance the mode in which this interesting experiment is conducted.

The author's remarks on Fraunhofer's lines are also full of interest and instruction, but we cannot go into the subject. His concluding lecture is an eloquent peroration, and must have mightily charmed his audience. To the *savant* it seems to us that not the least valuable part of the work will be the quotations from Lord Brougham's attack on Young, and Young's able and masterly-written defence—of which we learn with sorrow, from his biographer's sketch, that only a single copy was sold. Altogether we have been fascinated by this work of Dr. Tyndall's, and we doubt not that its readers will be vast in numbers on this side of the Atlantic and the other.

NICOL'S MINERALOGY.*

HAVING passed through a first edition, this book has now a second time come before the public, and in our opinion it is much improved in its new guise. Doubtless there are not a few who will object to the system of classification adopted by the author, some fancying the crystallographical the only method, while others as strongly uphold the plan which is based on the chemical composition. But it seems to us that the author has adopted a wise course in his effort to steer between the two. And we fancy his mode of arranging minerals, while it is by no means complete, is

* "Elements of Mineralogy," containing a General Introduction to the Science, with Descriptions of the Species. By James Nicol, F.R.S.E., F.G.S., Professor of Natural History in the University of Aberdeen. 2nd Edition. Edinburgh: Black, 1873.

nevertheless the only system which can be followed in the present state of our knowledge. We note also that the present edition has been improved in various instances by additions from the recently edited works of Naumann, and in the more chemical department by emendations from the writings of Rammelsberg, in the formulæ of various species. In regard to the chemical constitution of several of the minerals we could have wished to see many changes introduced; but, in the present condition of chemical science, we do not think that the author is so much to blame for adherence to the older views, especially as in most cases he has given the new formulæ in addition to the older ones. The book is exceedingly well illustrated, a point, in our opinion, of considerable importance; for difficult as it may be for a tyro to recognise a species by reference to a drawing, it would be absolutely impossible for him to do so were he to attempt it without the aid of illustrations. The introductory chapters appear, too, to give the beginner ample information with which he can, if he has any industry, study the subject satisfactorily. The descriptions of the different minerals appear well done, in but a few instances at all approaching error; in one case, however, we think it does so—that of *Andalusite*, whose colour does not appear to be accurately given.

HALF-HOURS IN THE GREEN LANES.*

A BOOK which cannot fail to please the young, and from which many an older reader may glean here and there facts of interest in the field of nature. Mr. Taylor has endeavoured to collect those facts which are to be recorded daily by an observant country gentleman with a taste for natural history; and he has attempted to put them together in a clear and simple style, so that the young may not only acquire a love for the investigation of nature, but may also put up, by reading this little book, an important store of knowledge. We think the author has succeeded in his object. He has made a very interesting little volume, not written above the heads of its readers as many of these books are, and he has taken care to have most of his natural history observations very accurately illustrated. If there is anything in the work which we might be inclined to object to, it is that tendency so common in all these works to convert a capital lesson into a little sermon. This exhibits itself very seldom indeed, and our only reason for noticing it is the decided love we have for the writer's works. The book has so much that is excellent within its covers that it seems to us the author, in following in this too well beaten track, is deviating from his course without a necessity. These things are all very well in their way, but we think are not to be expected in general natural history books. We cannot do more than skim over the many capital subjects which the writer discusses for his little friends. The book is divided into ten chapters; the first of these is upon a tarn side, and it gives us an almost poetical sketch of a picturesque country pond side; then come the

* "Half-hours in the Green Lanes;" a Book for a Country Stroll. By J. E. Taylor, F.L.S., F.G.S. London: Hardwicke, 1873.

fishes, mollusks, &c., of the tarn. Next we have a chapter on the reptiles in the tarn and green lanes. Then we are treated to the birds, of which there are some excellent woodcuts, representing the kestrel, the short-eared owl, the kite, the hobby, the heron, the kingfisher, the cuckoo, the ruff, the fieldfare, the lapwing, the hawfinch, the bullfinch, the siskin, the nuthatch, the jay, the sedge warbler, and lastly the goatsucker. There is a separate large woodcut for each species, and this part of the book seems admirable indeed. And here we must step aside to say a word for the printers, who certainly merit the highest praise for the manner in which the engravings are brought out; nothing but the greatest care could have produced so excellent a result, and we think that infinite credit should be awarded to Messrs. Clowes for their efforts. Next in order to the birds come the butterflies and moths; and this chapter furnishes us with some valuable illustrations of that wonderful resemblance between certain butterflies and the plants on which they rest—a subject which we are glad Mr. Taylor introduced, for there are many facts to be yet discovered in connection with this wonderful means of preserving species. Then follow the beetles and other insects, the slugs and snails, and the flowering plants, all of which chapters have special points of interest. But it appears to us that the chapter on ferns, rushes and grasses, and that on the mosses, fungi and lichens, will furnish the young reader with the greatest number of absolutely novel facts. We are glad to see, too, that they are amply and ably illustrated. Indeed, we doubt not that many of our readers will have had the book themselves, and will almost be angry with us for treating it so briefly.

THE HOUSE WE LIVE IN AND THE CLOTHES WE WEAR.*

THE well-known Munich chemist, Professor Max Von Pettenkofer—whose name every medical student is familiar enough with—has here given us a most valuable and important lesson, which we thank Dr. Augustus Hess for having translated into English. We thank the editor the more, inasmuch as we know of no popular work in English which has rendered, in such a clear, forcible and comprehensive manner, the very first and most essential duties of the medical officer of health. The book, which is a small one, within the reach of all, contains the substance of three lectures which were delivered before the Albert Society at Dresden. And these three are upon the clothes we wear, the house we live in, and the soil we dwell upon. But what will, perhaps, astonish our readers not a little, is the fact that the Society before which Professor Pettenkofer delivered his addresses is one composed exclusively of ladies, whose aim is the training of efficient female sick-nurses. Further, it was at the request of the President of the Society, no less a person than H.R.H. the Crown Princess Carola of Saxony, that

* "The Relations of the Air to the Clothes we wear, the Houses we live in, and the Soil we dwell upon." Three popular lectures delivered before the Albert Society at Dresden, by Dr. Max Von Pettenkofer, Professor of Hygiene at the University of Munich. Abridged and translated by Augustus Hess, M.D. London: Trübner, 1873.

Professor Pettenkofer gave the three lectures. How admirable an institution, and what an honourable example for us, the leaders of Western civilization, to follow. These lectures are not merely popular expositions of old and well-known facts, but they are a series of facts of the utmost importance to the health of the community, which have been arrived at by careful study of the hygienic requirements of an ordinary mansion. Of the three portions into which the volume is divided, and which are all of exceeding value, one portion is extremely interesting. Sanitarians who have given any study to the subject, are aware that the author of this work differs from many able men in his views as to the mode in which cholera is transmitted. Water is, in the opinion of most, a customary channel for the diffusion of the cholera poison. He, however, stands apart by asserting that the poison is not alone transmitted by water, but that soils have much to do with its conveyance. We do not say that we ourselves incline towards his theories in this respect, but we are bound to say they are well supported by various careful experiments. Look for example at the following ingenious argument. He says, pointing to an apparatus that is represented in the book: "You see this high glass cylinder, with a smaller glass tube inside, open at both ends. The cylinder is filled with gravel, and the glass tube connected with a manometor by some india-rubber tubing. As soon as I blow gently on the upper surface of the gravel you see the liquid in the manometer moving. The motion of the air which I produce acts in the first instance on the surface of the gravel, propagates itself through the same to the bottom of the cylinder, enters the lower end of the tube, rises through it, and through the tubing into the manometer, where it presses on the column of liquid and sets it in motion." He further shows that the force of the air is nearly sufficiently strong to blow out a candle. This experiment goes far to convince us of the force of the author's view, but he has many more experiments in hand. Indeed he has produced an excellent little work, which Dr. Hess has done well to translate, and has performed his portion of the work in a most estimable manner.

GEOLOGICAL SURVEY OF INDIANA.*

THIS volume contains the results of the Indiana Survey made by the State geologist and his assistants during the years 1871 and 1872, and forms the third and fourth Reports on the geology of this State. Some of the counties of the State have been fully surveyed, whilst of others only a preliminary examination has been made. Besides the geological structure and typographical features, the distribution and character of the various economical substances are also given, as well as tables of the analyses and calorific power of coals. The carboniferous rocks and coal-measures are more or less extensively developed in Perry, Dubois, Parke and Pike counties, occasionally covered by beds of gravel and glacial drift and other more

* "Geological Survey of Indiana." By E. T. Cox, State Geologist; assisted by Professors J. Collett, B.C. Hobbs, R. B. Warder, and Dr. Levette. Indianapolis, 1872.

recent deposits. The coal-seams, of which numerous sections are given, vary in number, thickness and character, in the different counties; one seam, the "block coal," has a great reputation for smelting iron ores, and is also in great demand at Chicago, Louisville, Cincinnati, and other places. Parke county appears to expose almost a complete series of the regularly recognised coal-seams found in the State; these alternate with beds of shale, clay, sandstone and limestone, sometimes full of marine remains, and many identical with species of Brachiopoda and other mollusca characteristic of British carboniferous limestone, showing, as in our coal-fields, intercalations of marine remains with a land vegetation; although Professor Collett remarks in the Report on Dubois county, "The internal evidence recorded by either the coal or the limestones considered separately, shows facts which can scarcely be harmonized with the adopted 'bog or swamp' theory for the deposition of coal and coal-measure limestones." The prevailing rocks of Dearborn, Ohio and Switzerland, are chiefly lower Silurian, the upper Silurian occupying small areas in the north-west parts of the last two counties, more or less drift being found on all the high land.

There is an interesting Report by Professor Cope, on the Wyandotte cave, which traverses the St. Louis carboniferous limestone of Crawford county in south-western Indiana, and which seems, from its extent and stalactites, to be as well worthy of popular favour as the Mammoth Cave in Kentucky, with the fauna of which the life of the Wyandotte cave has much resemblance; of sixteen forms noticed the genera are identical, and one, the blind fish *Amblyopsis spaleus,* is the same in both caves.

The concluding chapters contain papers on the Meteorology of Switzerland county by C. B. Boerner, and on the manufacture of Spiegeleisen by Hugh Hartmann.

THE SEA AND ITS WONDERS.*

IF anything were wanting to assure the publishers of this book that it has met the wants of the general public, assuredly it must have been met by the demand for a fourth edition. Indeed the fact is almost surprising, the more so when we remember that the book made its first appearance little more than a dozen years since. And it is equally astonishing from the fact that many and infinitely superior books have been for a vastly longer period in their first and only issue. This of course may be intelligible enough if the explanation be offered that the entire number of volumes in each edition was something extremely small; otherwise, in our opinion, it is a singular and remarkable circumstance. For the book is simply an enlarged zoology, to which has been added a certain amount of lore anent the ancient discoveries of the continents and islands which now form our globe. Furthermore, the illustrations are, with the exception of a few page-plates, of the worst possible description. They are

---

* "The Sea and its Living Wonders;" a Popular Account of the Marvels of the Deep, and of the Progress of Maritime Discovery, from the Earliest Ages to the Present Time. By Dr. G. Hartwig. 4th edition. London: Longmans, 1873.

numerous, it is true, but then their size is ridiculously small, for so large a book. Just imagine a large 8vo. work with illustrations of the salmon and cod which hardly exceed an inch in length, and of the seal and walrus which are almost smaller, if anything. To be sure the plates are handsomely printed in Messrs. Spottiswoode's best style, but then they have not the scientific importance which necessarily attaches to the purely zoological engravings. We regret this the more because, though the book is really full of interest, it is not of course a zoology, for the descriptions it gives are utterly unworthy of any scientific value; but then they are most interesting and instructive, and in some cases are well nigh marvellous. Withal, the book, though written by a German, is exceedingly well composed; indeed, in some of the passages, it is infinitely better written than nine-tenths of our English bookmakers could have done. We think, too, the author has discharged the labour of bringing up the work to the present state of science with some degree of ability. His classification of the animals is in many cases in accordance with recent systems; and we observe that he has quoted Darwin on points of importance, and where Darwin is really the most worthy authority; as well as that he has endeavoured to give a portion of the recent writing on the subject of the deep-sea investigations of the "Porcupine." All this is right. The accounts, too, of the different animals are interspersed with anecdotes; and though some of them are hardly novel to the reader of this class of literature, they will all be nevertheless read with avidity and interest by the young. To our mind, the most exciting portion of the book is that which relates to the manifold excursions and the bitter sufferings of our noble Arctic explorers. This part of the work is exceedingly well written, and few can peruse the last pages, descriptive of the wondrous undertakings of Sir James Ross and Sir John Franklin, without a feeling of pride in the fact that those great men were also members of the Anglo-Saxon race.

THE INSECTS OF MISSOURI.*

AMERICA is far before us, if in no other at least in this respect, that she makes some governmental provision for a portion of her subjects. This is seen in the plan she has adopted in not a few of her States, of founding an appointment for the naturalist who has devoted his attention to entomology. And in doing so she shows her extreme wisdom as a student of agriculture. For assuredly of all the plagues which the farmer has to encounter—especially in warm climates—that of insects is by no means the least. There are some insects which will, even in this country, so completely destroy a crop in its infancy as to compel it to be sown again, and it is fortunate if indeed the destruction of the plants has not come too late to admit of re-plantation. There are few, even of our own farmers, who have not occasionally lost an entire crop of turnips through the

* "Annual Report on the Noxious, Beneficial, and other Insects of the State of Missouri, made to the State Board of Agriculture." By Charles V. Riley, State Entomologist. Jefferson City, U.S. America, 1873.

influence of the beetle, and various other instances might be cited. What a benefit to agriculture, then, it must be to have a person employed by the State, whose sole duty it is to go about and investigate the nature of those insects which inhabit farms, and to find out the injurious and beneficial forms, and also the means of encouraging or exterminating them. Such a work is that of the author of the volume before us, who has pointed out various insects which are injurious, and has furnished the means of exterminating them. This Report is furnished with an introduction to the study of entomology, which gives illustrations of the different plans of capturing and preserving insects, whilst the book itself is full of interesting and valuable details.

RELIQUIÆ AQUITANICÆ.*

THIS lavishly executed work, which has been in progress for so many years, was, as our readers are aware, originally from the joint authorhip of M. Edouard Lartet and Mr. Henry Christy. These distinguished *savants* are no longer in existence, and the work on which they bestowed their united labours is now committed to the charge of Professor Rupert Jones, F.R.S. And it has not been delivered over to idle hands, or to those who will not expend as much time and research as the original authors bestowed upon it. Indeed Professor Jones has already given evidence of this in the manner in which he has brought out another portion of this work beside the present one; and as there are in all but fifteen parts to appear, and this is the twelfth, we may soon anticipate the completion of the treatise. The main portion of this, the twelfth part, is occupied by an able paper from the pen of J. Evans, F.R.S., whose splendid treatise on the Flint Implements of Great Britain our readers are already familiar with. It is upon certain bone and cave deposits of the Reindeer period in the South of France. The remarks were originally read before the Geological Society, but were only printed in abstract in its "Quarterly Journal." Mr. Evans' observations, which are abundantly illustrated, are fully descriptive of many caverns and hollows which contain prehistoric remains, but withal there is exhibited a considerable reticence as to the expression of an opinion regarding the absolute age of these deposits. In reference to relative antiquity he is more decided in opinion; for he, as others do, especially M. Gabriel de Mortillet, regards the Moustier remains as unquestionably of a higher antiquity than those of other caves. Apart from this paper of Mr. Evans, the number concludes the observations on the Reindeer and Hippopotamus, and is as usual illustrated by a number of exquisite plates of flint weapons and carved horns. These are splendid engravings as work of art; they are immensely superior to any work executed in these countries, being drawn and lithographed by Louveau, and printed by Becquet, both of whom are Parisian artists.

---

* "Reliquiæ Aquitanicæ;" being contributions to the Archæology and Palæontology of Périgord and the adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy. Edited by T. Rupert Jones, F.R.S. Part XII. London: Williams and Norgate, 1873.

RESEARCHES IN ZOOLOGY.*

ALTHOUGH this is the second edition, it is nevertheless an absolutely new book to the great majority of our readers. The first edition was published nearly forty years ago, and we think that the well known author of the "British Spiders" did well to bring it again before the public. It of course is not a book on any distinct subject, but is a collection of very valuable papers on subjects of general interest to every true naturalist. It is without exception the book of books for the observant country gentleman. What is it about? Well, we must give some of the contents. First are a couple of good papers on birds and their migrations, and there are two further articles on the cuckoo. Then follow chapters on the desertion of their young by swallows; on the pied flycatcher; on the formation of the bill of birds; on the diving of aquatic birds; on the growth of the salmon; on the means by which animals adhere to the vertical surface of highly-polished bodies (this paper is of especial interest, for it shows by exactly similar experiments to those recorded in a very recently published paper, the precisely same result, that the flies do not adhere by means of atmospheric pressure, for on exhausting the air from a glass vessel the flies still continue to adhere to the glass); on one of the *Ichneumonidæ*, whose larva is parasitic; on spiders; and experiments and observations on geometric, aëronautic, and other spiders. It must be borne in mind that we have only given a portion of the contents of this interesting book, which is, of all the works we have lately seen, especially the book for the country naturalist.

WORKSHOP APPLIANCES.†

MESSRS. LONGMANS continue to bring out their series of text-books of science suited to the intelligent working man, and we think they have not yet published a book which is more admirably suited to the class to whom they are addressing these volumes, than the present one. It is clearly a book which every one who delights in a workshop should possess. We do not mean the workman alone; for there is a very large number of country gentlemen, and not a few town ones, who have a certain love for the workshop, and who spend a good deal of their time over the lathe and the chisel, hammer and plane. To such, as well as to the workman, we heartily commend Mr. Shelley's volume. It is essentially a book which ought to be in every workshop; and we confess that we have learnt something from it ourselves, in the chapters on grinding edge-tools, and stones

---

* "Researches in Zoology;" illustrative of the Structure, Habits, and Economy of Animals. By John Blackwall, F.L.S. 2nd edition. London: Van Voorst, 1873.

† "Workshop Appliances;" including Descriptions of the Guaging and Measuring Instruments, the Hand Cutting-tools, Lathes, Drilling, Planing and other Machine Tools used by Engineers. By C. P. B. Shelley, C.E. Professor of Machinery in King's College. London: Longmans, 1873.

and oilstones, which we did not know before. Further, it has more than 200 illustrations, many of which are novel to most readers. The plan of the work is to describe the different apparatus which are to be found in a thoroughly well-furnished workshop, and to show the young student how he may best use them, and in what way they get out of repair, and how they may be set in the best working order. In treating of these very important subjects, we think the author has done his work fully and well. We feel, in reading his book, that we are in the hands of a thoroughly practical man, who will teach us in a complete and masterly manner.

AMONG THE DOLOMITES.*

It is not often that we find in a book of travels—especially in a lady's book — the subject that is likely to attract the pedestrian coupled with the matter of highest interest to the man of science. Yet, most assuredly, we have found this in the present instance. In this book of travel, which Miss Edwards has given the excursionist world, we find matter not alone of general interest, but of a character to excite the attention of the geologist also. To be sure the subject-matter—as far as geology is concerned—is present to an exceedingly small extent, and is moreover of a nature not unknown to those who have studied the works of the French and Austrian geologists. But to the great mass of English readers the Dolomite mountains are an utterly unknown region, and to many even of our skilled local geologists their character and lithological features are more unknown even than the Andes or the Himalayas. Miss Edwards's book will therefore prove to all such a most interesting and instructive volume, and the marvellous sketches which she has given will do more to make its structure comprehended than pages of mere writing. For some of these exceedingly clever engravings we are indebted to the publishers, who have kindly placed them at our disposal, so that we are enabled to place some of Miss Edwards's handiwork before our subscribers. Miss Edwards is, of course, no ordinary tourist; she is evidently a woman who possesses material strength, and who is above those petty wants and cares which render an average woman such a terrific bore on an alpine excursion. She is able to bear the eleven hours on a mule's back, which is one of the conditions of excursionising amid alpine mountains, and she is then enabled to put up with a dish of Liebig's beef-tea brewed with the aid of a pocket-lamp which accompanies her. All these are things which to an ordinary woman would appear something terrific. But she is used to it; and hence she has been enabled to see and examine a district which is at present, and probably will be for a time, cut off from female expedition. She states that a knowledge of Italian and German are indispensable for the excursionist, and she says that "the Dolomite district is most easily approached from either

---

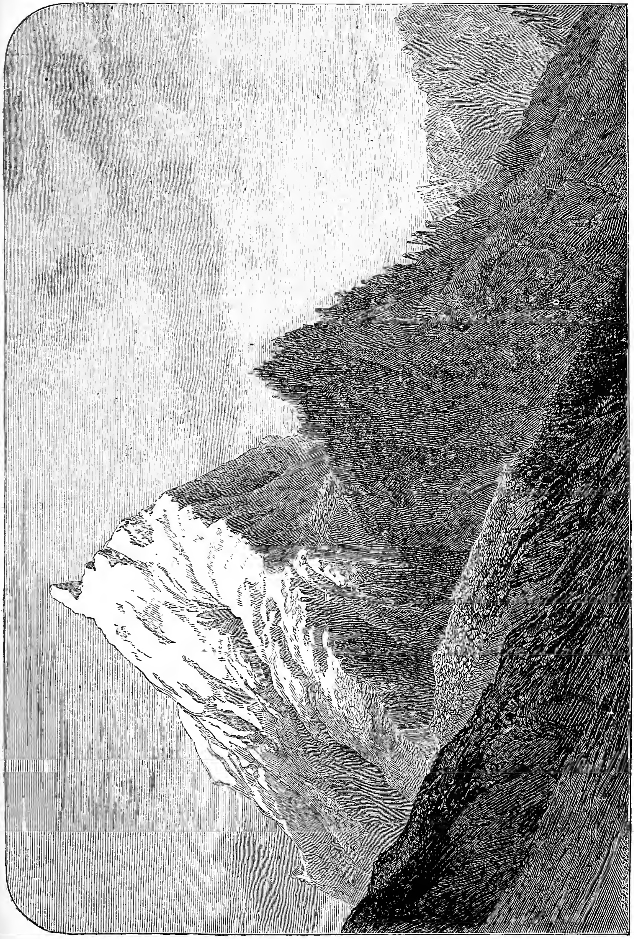
* "Untrodden Peaks and Unfrequented Valleys; a Midsummer Ramble in the Dolomites." By Amelia B. Edwards, author of "Barbara's History." London: Longmans, 1873.

Botzen or Bruneck, the nearest railway stations being Toblach on the north, Atzwang on the west, and Conegliano on the south. All that is grandest, all that is most attractive to the artist, the geologist and the alpine climber, lies midway between these three points, and covers an area of about thirty-five miles by fifty. The scenes which the writer has attempted to describe all lie within that narrow radius." The greatest beauty of the district, or almost so, seems to our mind to be the fact dwelt upon by the authoress, that she travelled "sometimes for days together without meeting a single traveller, either in the inns or on the roads." But apart from this, there can be no doubt, we think, that the country is singularly wild and beautifully picturesque; the fact that many of the mountains exceed 10,000 feet in height, and some, "as the Cima di Fradusta, the Palle di San Martino, and the Sass Maor, are so difficult, that the mountaineer who shall first set foot upon their summits will have achieved a feat in no way second to that of the first ascent of the Matterhorn," must in itself prove attractive to the reader. The authoress adopts Richthofen's views as to the origin of the mountains, and gives a brief summary of his theory of the coral-reef origin of the mass; but of that we need not say anything. Suffice it to describe, in Miss Edwards's own words, the three exquisite cuts which we have borrowed from her publishers. And first of the Monte Antelao.

Here, says the authoress, "from a grassy knoll, the writer devoted a long time to making a careful drawing of the Antelao, which is here seen to its greatest advantage. . . . The first ascent of the highest peak of this mountain was achieved by that famous climber Dr. Grohmann, in 1863; and the second in 1864, by Lord Francis Douglas, of hapless memory, accompanied by Mr. F. L. Latham and by two guides. . . . The ascent is taken from a pass called the Forcella Piccola, which divides the mass of the Marmarole from that of the Antelao. . . . It was supposed to be inaccessible till Dr. Grohmann's time, when the fortunate discovery of a certain cleft by one of his Cortina guides opened the way to the German cragsman." And assuredly the climb must have been no easy matter, to judge from the sketch which Miss Edwards has given of the snowy mountain. But this is not all. Another view which we have obtained from Miss Edwards's book is that represented here—the Monte Cristallo and Piz Popena.

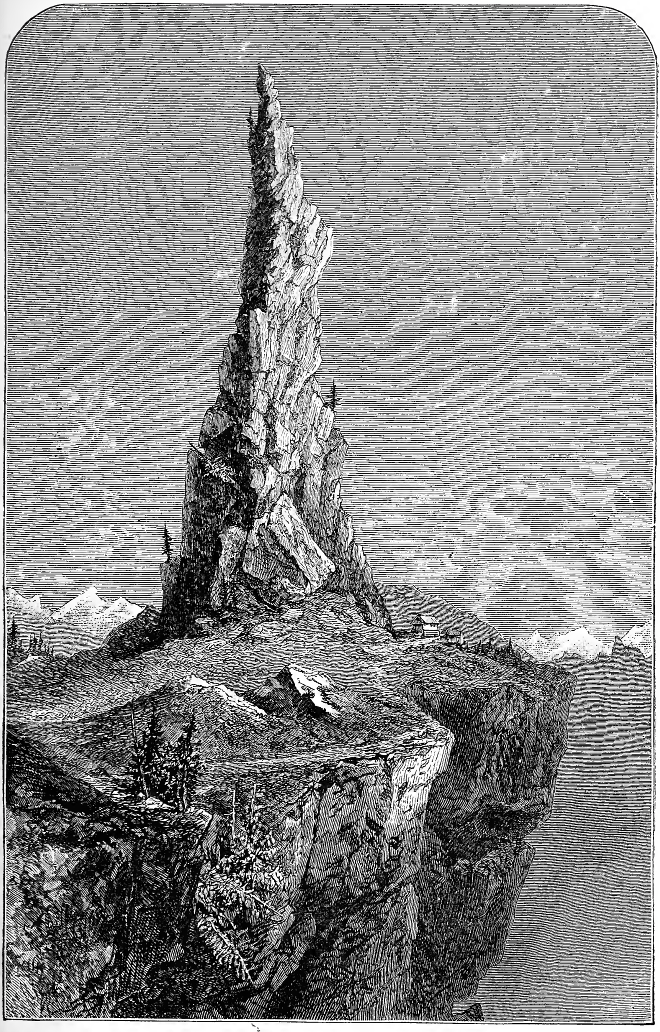
She says, "Passing Schluderbach, a clean-looking roadside inn, we come presently in sight of the Dürren See, a lovely little emerald-green lake, streaked with violet shadows, and measuring about three-quarters of a mile in length. Great mountains close it in on all sides, and the rich woods of the lowly hills slope down to the water's edge. The clustered peaks, the eternal snows and glaciers of Monte Cristallo; the towering summit of the Piz Popena; and the extraordinary towers of the Drei Zinnen, come one after the other into view." And certainly the sight must have been grand indeed, for we know of very few even of the well-known alpine picture-spots that can at all compare with this grand combination, as it were, of Killarney and Mont Blanc.

There is only one other picture which we have taken from this book, to which we have to direct the reader's attention, and that is of the Sasso di Ronch. This the authoress very briefly describes, but she alleges that the view obtained in going up to it was singularly grand. Indeed, all through



The Monte Antelao.

The Monte Cristallo and Piz Popena.



The Sasso di Ronch.

the book the reader is touched with magnificence of scenery sufficient to make him sincerely envy the writer, and make secret vows as to his next autumn's excursion. We ourselves cannot do better than advise his following in Miss Edwards's footsteps, with this additional proviso, that he must first get her interesting book and read it.

THE PHILOSOPHY OF EVOLUTION.*

THE Actonian prize, which is in the gift of the Royal Institution, was this year awarded to two works which we fancy have very different aims. The present is one of the two, and is by a clever, well-known enthusiast, Mr. Thompson Lowne. We ourselves do not hold the author's views—we may as well state this at once—but we think he has shown particular cleverness in advancing his opinions; and if he were to go a little further than he has done, we should most heartily agree with him. However, as the author was bound to certain conditions in presenting his writing for an Actonian prize, we must make some allowances, and we will even go so far as charitably to suppose that certain views admitted as *possibly* correct are not necessarily those to which the author would bind himself. With regard to the main object which the author has had in view, we of course entirely agree with him, but in reference to some of his arguments we must decidedly take exception. It would be out of place in so short a notice as the present one to point out where we differ from the author in some of his conclusions, especially as it would be idle to point them out without endeavouring to place before the reader the opposite views. But we may observe that though we differ from Mr. Lowne on some matters, we agree with him wholly in the great bulk of his arguments; and on no point, singular to say, more than in his observations on the markings of the diatomacæ, for we feel sure that advanced microscopic research will eventually prove the truth of what Mr. Lowne advances. In any case, no matter what view we were to take of the evidences the author brings forth, we think he has produced a capital argument in favour of evolution; and the plates, though not numerous, help out his ideas. From what we have seen of the book, however, it increases our objection to the prize essay system. Mr. Lowne would have done better if he had not had the Actonian prize before his eyes.

---

* "The Philosophy of Evolution" (an Actonian Prize). By B. Thompson Lowne, M.R.C.S., F.L.S., Lecturer on Physiology at the Middlesex Hospital School. London: Van Vorst, 1873.

THE MOON.*

MR. PROCTOR has in this instance, we think, excelled his previous efforts, and has produced a book not only excellent in character and clear in style, but of a nature to command a large circulation, and to make selenography, from an unknown, an extremely popular pursuit. We know of no book in the whole literature of astronomy which deals so thoroughly with its subject, is so admirably illustrated, and withal so clear in style, as this treatise on the moon. Although the earlier portions treating of the moon's peculiar motions are difficult, yet the difficulty vanishes before even an unmathematical persevering student; and the latter portion of the work is of a character so absorbingly interesting that it is difficult to lay down the treatise without finishing its perusal. We think that considerable credit is to be awarded to Mr. Proctor for his efforts to make the moon's motions intelligible to the general student. He has spared no pains to make the subject completely clear, and he has given such a number of plates containing plans and diagrams, that we feel assured none will feel difficulty in completely understanding even the difficult questions he discusses. But to our mind the most interesting portion of the work is that which relates to the general contour of the moon, and to the manner in which it has been produced; as also to the important question whether there is volcanic action still going on in that portion of the orb which is visible to us. Mr. Proctor gives all the views of those for and against the opinion that volcanic action is taking place, and he sums up as follows:—"The only explanation available therefore appeared to be this—that a mass of matter had been poured into the crater from below, and had overflowed the barrier formed by the ring mountain, so as to cover the steep outer sides of the ring. Instead, therefore, of an outer declivity, which could throw a shadow, there appeared to be an inclination, sloping so gradually that no shadow could be detected, the whole surface thus covered with eruptive matter shining with the same sort of light, so that a spot was seen somewhat lighter than the Sea of Serenity, and larger than the original crater." To be sure this explanation may seem rather vague to the reader of this notice, who has not had the work before him, but it really is an admirably clear summary. However, it turns out that it has been shown "by Browning in 1867 that Linné changes remarkably in aspect in a very short space of time, under changing solar illumination; and the inference would seem to be that the supposed changes have been merely optical." It will be found that on every other part of the subject the author is as particular in laying the arguments *pro* and *con* before his readers. Altogether Mr. Proctor has given us a book for which our most sincere thanks are due.

And to him also, and Mr. Rutherford and the Rev. T. Webb, our gratitude is owing for the magnificent atlas which accompanies Mr. Proctor's book. This contains enlarged copies of Rutherford's splendid photographs,

* "The Moon: her Motions, Aspect, Scenery, and Physical Condition." By R. A. Proctor, B.A., Hon. Sec. R.A.S. London: Longmans, 1873. "The Moon" (three photographs—several maps). By Rutherford and Proctor. Manchester: Brothers, 1873.

representing (in 1½ft. by 1ft. size) the full moon and both halves, and a series of maps by Proctor, Webb, and Schmidt, of Athens; a splendid enlarged copy of Beer and Mädler's Map of the Moon; and a couple of admirable lunar landscapes. All these add to the importance of Mr. Proctor's book, and together with it constitute a complete history of our nearest heavenly neighbour.

DARWINISM AND THE ORIGIN OF MAN.*

WE are sorry our space does not permit us to notice this very clever and interesting book. It is clearly and decidedly anti-Darwinian, and is in its second edition—a fact that tells in its favour as being a popular work in Belgium. We cannot, however, see the force of the author's opinions, and we can only account for them on one supposition, viz. that he has had nothing but a book-knowledge of the subject on which he writes. Still, he has combatted the Darwinian side with some cleverness, and his book merits being read by Darwinians, who, we are not disposed to think, will have their opinions seriously modified by its perusal.

* "Le Darwinisme et l'origine de l'homme." Par l'Abbé A. Lecompte, docteur en sciences naturelles. 2ème édition. Paris: Victor Palme, 1873.

SCIENTIFIC SUMMARY.

ASTRONOMY.

ARRANGEMENTS *for observing the approaching Transit of Venus.*—We are disappointed to learn that, although the Astronomer Royal has assented to the proposal of the Greenwich Board of Visitors that application should be made to Government for expeditions to survey the sub-antarctic regions, to find additional localities for observing the whole duration of the Transit of Venus in 1874, the application has been so made as almost to ensure failure. It is proposed simply that the *Challenger* should be commissioned to report on Heard Island (sometimes called Macdonald Island), and that, should the report be favourable, an observing party should be left on that island by the same ship which carries an observing party to Kerguelen Land. This arrangement is altogether inadequate, simply because Macdonald Island is in the same region as Kerguelen Land, and will probably present the same meteorological conditions. It is a serious misfortune for science that the Astronomer Royal, though he has now been forced by the united voice of all the leading astronomers of England (headed by the greatest of them all) to move from the position in which he had intrenched himself, nevertheless moves so slowly and unwillingly as to occasion serious risk of failure. It seems worse than a fault, it is a blunder; since nothing can render less complete his admission of the justice of views he formerly opposed, and his present perversity (we can use no milder term) enforces his opponents to repeat statements which they would willingly leave to be forgotten.

We perceive that Admiral Richards, Hydrographer to the Admiralty, has entered the lists in Sir George Airy's cause, writing to "The Times" in terms implying that Mr. Proctor had considered only the geometrical relations of the matter, while the Astronomer Royal had taken other circumstances, and especially geographical ones, into account. Mr. Proctor's rejoinder was easy and ready. It was actually Admiral Richards himself who most authoritatively indicated, in 1868, the possibility of these very expeditions which he now opposes. He and other eminent naval men urged in very strong terms that which Sir George Airy had urged, the desirability of Antarctic expeditions to view the transit of 1882. Now that Mr. Proctor has shown, and it has been universally admitted, that Antarctic stations would be useful in 1874 only, and much more useful then than Sir G. Airy had mistakenly supposed they would be in 1882, is it not manifest that the opposition to Antarctic expeditions for 1874 can have but one interpretation? Such expeditions would in point of fact stultify the utterances of the Astronomer Royal in 1868. But whose fault is that? Must science be allowed to suffer merely that a result personally unpleasant to the Astronomer Royal may be avoided?

Dr. Oudemans' Photographs of the Solar Eclipse of December 11-12, 1871.—Lieut-Col. Tennant makes the following remarks on two photographs of the corona taken for Dr. Oudemans by Mr. Dietrichs, at Buitenzorg, in Java:—"These consist of two paper proofs from the original negatives and two transparent enlargements on glass. In the negatives the diameter of the lunar disk is about 3 m.m., so that the equivalent focus of the lens must have been about 41 c.m., or 16 inches. Dr. Oudemans describes it as No. 10 C. by Liesegang, of Elberfeld. The exposure in each case was half a second, and the glass enlargements show that the amount of corona depicted was not very materially less than in the photographs at Dodabetta and Bekul. The Moon's limb is, however, very sharp, and the small negative has borne enlargement to a lunar diameter of 2 c.m., with singularly little loss of definition of the dark edge; which, too, is very free from halation or encroachment from the prominences. In the transparencies sent me, however, there is very much less detail in the corona than in the Indian photographs. The principal thing to be noted is the very complete resemblance of the general form of the corona in the Java photographs and in our Indian ones, though there was an hour of difference in absolute time. I can recognise almost every depression of outline, and the form and relative sharpness of the edges of the southern rift, and even of the less definite northern one, are very markedly similar. I presume no one now believes the corona to be an atmospheric phenomenon; but these photographs show a considerable amount of permanence in its features, and it would be very interesting to compare the original negatives, for which purpose perhaps those of Mr. Dietrichs could be procured."

The Radiation of Heat from the Moon.—In his discourse on this subject, at the Royal Institution, on May 30 last, Lord Rosse made the following remarks relative to his recent observations for determining the heat radiated to us by the Moon:—

"The observations made during the seasons 1868-9 and 1869-70 were found to follow pretty well Lambert's law for the variation of light with phase. It was found also that a piece of glass which transmitted 80 per cent. of the Sun's rays suffered only about 10 per cent. of the Moon's rays to pass through; thus a large amount of absorption before radiation from the Moon's surface was shown to take place. In the earlier experiments no attention had been paid to the correction to be applied for absorption of heat by the Earth's atmosphere; but, as the apparatus was gradually improved, it became indispensable to determine the amount of this correction before attempting to approach more nearly to the law of variation of the Moon's heat with her phases than had been done in the earlier investigation. By taking long series of readings for lunar heat through the greatest ranges of zenith distance available, a table expressing the law for decrease of heat with increase of zenith distance, closely following that deduced by Seidel for the corresponding decrease of the *light* of the stars, was obtained. By the employment of this table, the determinations of the Moon's heat at various moments of the lunation were rendered comparable and available for laying down a more accurate "phase-curve" than had been previously obtained. This curve was found to agree more nearly with Professor Zöllner's law for the Moon's light, on the assumption that her surface acts as if it was *grooved* meridionally, the sides of the grooves being inclined at the uniform angle of 52° to the surface, than with Lambert's law for a perfectly *smooth* spherical surface.

"The laws of absorption in the atmosphere, and of variation of heat and light, are indicated in the following abbreviated tables:—

Zenith Distance	Light of Stars transmitted by Atmosphere	Moon's Heat transmitted by Atmosphere
°		
0	1·000	1·000
30	0·984	0·988
40	0·962	0·958
50	0·902	0·907
60	0·800	0·836
70	0·642	0·698
80	0·407	0.465
85	0·208	—

"N.B.—Before entering the atmosphere the Moon's heat = 1·262, so that at the zenith fully $\frac{1}{5}$th is absorbed before it reaches the Earth's surface.

Distance from Full Moon	Lambert's Formula	Phase-curve for Heat (Observed)	Phase-curve for Heat transmitted by Glass	Curve representing Zöllner's Photometric Observations	Zöllner's Formula for Moon's Light
°					
100	96	44	—	—	—
90	128	62	—	—	—
80	165	89	—	—	—
70	205	117	11·4	88	—
60	246	149	16·7	109	—
50	286	186	22·0	132	154
40	324	228	27·3	166	212
30	355	276	33·5	212	278
20	381	335	46·3	271	346
10	398	394	64·3	342	417
0	404	403	69·5	390	488
10	398	367	56·7	327	417
20	381	323	44·5	269	346
30	355	278	33·5	218	277
40	324	234	24·4	167	213
50	286	191	18·1	122	157
60	246	155	14·5	84	109
70	205	127	11·8	58	71
80	165	103	9·2	49	—
90	128	78	6·5	—	—
100	96	54	3·8	—	—
I.	II.	III.	IV.	V.	VI.

"N.B.—To compare the heat transmitted by glass with Zöllner's photometric observations (Column V.), the quantities in Column IV. must be multiplied by 5·792.

"On examining the phase-curve which had been obtained, a certain want of symmetry on the two sides of full Moon was perceived, which was ascribed to the unequal distribution of mountain and plain on the lunar surface, as was shown by a rough diagram of the lunar surface with its so-called 'seas.' It had also been found that the percentage of the Moon's heat transmitted by a sheet of glass diminished from 17·3 per cent at full Moon to about 13·3 per cent. at $22\frac{1}{2}°$, 11 per cent. at 45°, and 10 per cent. at $67\frac{1}{2}°$, distance from full Moon; a circumstance which might have been accounted for by supposing that there is a constant amount of radiant heat coming from the Moon in addition to that which, like the light, varies with the phase, had it not been found that as the Moon approached tolerably near the Sun—as for instance, on March 27, 1871, when her distance from full was 138°—no perceptible amount of heat radiated from her surface. The less rapid decrease of the Moon's heat than of her light on going farther from full Moon, and the increase of percentage of heat transmitted by glass towards the time of full Moon, may probably be explained on the assumption that when the Sun's heat and light strike the Moon's surface the whole of the former and only a certain proportion of the latter, depending on the intrinsic reflecting power or 'Albedo' of the surface, leave it again, and consequently the shaded portions, which are inclined more towards the position of the Earth at quadrature than at full Moon, reflect a larger amount of heat as compared with the light of the former than at the latter time, and a greater flatness of the heat- than of the light- phase curve is the result. With a view of obtaining a decisive result on the question, whether or not the Moon's surface requires an appreciable time to acquire the temperatures due to the various amounts of radiant heat falling on it at different moments, simultaneous determinations of the amount of the Moon's heat and of her light were made, whenever the state of the sky allowed of it, during the eclipse of Nov. 14, 1872. The eclipse was a very partial one, only about $\frac{1}{40}$ of the Moon's diameter being in shadow; but although this circumstance, coupled with the uncertain state of the sky, rendered the observation far less satisfactory than it would otherwise have been, yet it was sufficient to show that the decline of light and heat as the penumbra came over the lunar surface and their increase after the middle of the eclipse were sensibly proportional. Both were reduced to about one half-what they were before the eclipse."

The Transit of Venus in 1882.—Mr. Proctor has supplied a stereographic chart illustrative of the transit of 1882, and intended specially for comparison with the corresponding chart of the transit of 1874, supplied by him a month earlier. He remarks that it is very desirable, in considering what preparations should be made for observing the transit of 1874, to take carefully into account the relations which will be presented during the transit of 1882. "To neglect this precaution," he says, "would be as serious a mistake as for one nation to arrange its plans for either transit without a careful reference to the arrangements of other nations. It has been with the object of supplying this want that I have constructed the accompanying chart of the transit of 1882; for although the circumstances of the latter transit have been to some degree considered (by myself amongst other students of the subject), I do not think they have as yet been sufficiently brought into comparison with those of 1874. A comparison has indeed been instituted betwen the two transits in the 'Monthly Notices' for December 1868, wherein it is remarked that Halley's method 'fails totally for the transit of 1874, and is embarrassed in 1882 with the difficulty of finding a proper station on the almost unknown Southern continent.' This statement, however, does not by any means accord with the results of my own investigation. On the contrary, I find that Halley's method may be said to fail totally in 1882 ; while, as is now well known, I find (I may even say I have demonstrated) that Halley's method is the best of all methods depending on *contacts*, for 1874. If we assume, in fact (which I think will be generally admitted), that no station can be regarded as suitable for Halley's method where the difference between the actual duration and the mean duration is less than half the maximum acceleration or retardation, or where the Sun is less than 10° high at ingress or egress, then absolutely no station whatever is available in 1882, unless the south pole can be approached much nearer even than it was approached by Sir Jas. C. Ross in the famous expedition when Possession Island was discovered. I confess that the prospect of successful observation at Possession Island, with a Sun only 5° high at ingress, seems to me so slight that I should hear with regret of any attempt to carry out the suggested scheme for wintering at Possession Island in 1882."

Note on Jupiter in 1873.—Mr. Knobel, who has observed this planet with one of Browning's 8-in. reflectors, remarks that this year "the most striking feature has been the great change in the equatorial zone; the port-hole markings, which were conspicuous at the previous opposition, have disappeared, and long, irregular, broken masses, horizontal and inclined at a considerable angle to the equator, have taken their place. The north temperate dark belt, which has been previously depicted as single, is really a double belt, as in the drawings. On April 20th and May 11th the south tropical dark belt appeared thinned out towards the east. The south temperate dark belt has appeared of irregular width, widening towards the west; atmospheric influences this year have been fatal to observations of colour; but on May 11th, definition being remarkably good, the south tropical dark belt was observed of a brick-red tint, more decidedly red than the darker parts of the equatorial zone." Mr. Browning remarks on the same subject: "The colour of the equatorial belt of Jupiter was fading during the last weeks of the previous opposition ; during the present opposition the colour has been scarcely, if at all, perceptible; there is a conspicuous absence of any intense markings on the surface of the planet, the copper-coloured belts being fainter than usual. Great changes have taken place in the fainter markings, and some of these with great rapidity. On several occasions the belts have appeared inclined at a considerable angle to the equator. During the whole of the opposition the definition has been so uniformly bad that I have found it useless to make drawings of the planet."

BOTANY.

Mr. Hiern's Monograph of Ebenaceæ.—This essay, which, however, we have not seen, we are enabled to give an account of from Professor Asa Gray's analysis of it in "Silliman's American Journal" for July. It is written by Mr. W. P. Hiern, M.A., and is published by the Cambridge Philosophical Society (vol. xii. part i.). Professor Gray says, that "In a brief account of the economical products of the order, 18 species of *Diospyros*, 2 of *Maba*, and one of *Euclea*, are said to supply ebony; not to speak of other hard woods, such as box-wood and pear-tree, which are artificially died black, and used in commerce as ebony; nor of the ebony of the ancients, which, according to Bertolini, was furnished by a *Leguminosa*. Fourteen species of *Diospyros* yield edible fruits. Much the best, no doubt, is that of the Japanese *D. Kaki*, perhaps because it has been immemorially cultivated; the next may be our N. American *Persimmon*, which is said to be better fit to eat after it has suffered frost. It is hardly edible without it. Characters are assigned for distinguishing *D. Virginiana* from the Asiatic *D. Lotus*; but it is added that some specimens, of which the native country is unknown, are extremely difficult to assign with certainty. For his very full list of the numbered collections, with names assigned to the numbers, our author has earned hearty thanks. Only five genera are admitted; and one of these is a new one, of a single species, from Madagascar, *Tetraclis*, well marked by the valvate æstivation of the corolla. Not only are lists given of the species of each geographical region, but a complete chronological enumeration of all the published species. The treatment of the systematic part of the monograph, the Latin diagnoses and the English descriptions, and the displayed synonomy, &c., seems wholly creditable; but there is a surplus of punctuation in the diagnoses, each adjective being isolated by a comma. The fossil species are all described in an appendix, but the author disclaims responsibility for them."

Gigantic Evergreens in California.—In the "Proceedings of the Academy of Natural Science of California," Dr. Kellog says he had just returned from under the shadow of the finest evergreens that there were in California—true chestnut trees, *Castanea chrysophylla*, from 100 to 200 feet high, 4 to 6 feet in diameter, with a clean trunk of 50 to 75 feet. Similar statements he had made times unnumbered from the Academy's first existence, and were in the "Proceedings," but seemed to be overlooked by his Eastern friends. He would also state that, on the trip, he had met with the *Rhus aromatica*, a shrub found in Sacramento City, on his first arrival, in 1849, and often brought to his attention since. This also had often been brought to the attention of the Academy. A *Viburnum* is among the Academy's collection from this part of California (Mendocino County), recently presented, besides two specimens of huckleberries, if no more.

Dr. Dawson's View as to Prototaxites.—This has been recently expressed by Dr. Dawson in the "Monthly Microscopical Journal" for August, as opposed to Mr. Carruther's doctrine. Dr. Dawson says that, in discussing affinities, he must repeat that we must bear in mind with what we have to deal. It is not a modern plant, but a contemporary of that "prototype of gymnosperms" *Aporoxylon*, and similar plants of the Devonian. Further, the comparison should be not with exogens in general, or conifers in general, but with *Taxineæ*, and especially with the more ancient types of these. Still further, it must be made with such wood partly altered by water-soakage and decay and fossilized. These necessary preliminaries to the question appear to have been altogether overlooked by Mr. Carruthers. His original determination of the probable affinities of Prototaxites, as a very elementary type of taxine-tree, was based on the habit of growth of the plant; its fibrous structure, its spirally-lined fibres, its medullary rays, its rings of growth, and its coaly bark, along with the durable character of its wood, and its mode of occurrence; and he made reference for comparison to other Devonian woods and to fossil taxine-trees.

Activity in the Growth of Plants.—A recent number of the "Gardener's Chronicle" expresses itself on this point. It says: — "How little we think of the prodigious activity manifested in the growth of plants during a few weeks. The process is gradual and noiseless; moreover it is of everyday occurrence, and hence is disregarded. How much water must be absorbed and exhaled, how much air inhaled and exhaled, how much carbon fixed, during the process? Here, by way of illustration of our remarks, are some measurements of an ordinary plant of *Abies Nordmanniana*, which we took a day or two since. The shrub is only 2 feet 6 inches in height, the number of young shoots of this year's growth upon it is five hundred and eighty-five (585); the shoots vary in length from half an inch to 6 inches, their aggregate length is eleven hundred and seventy-one (1,171) inches, or nearly ninety-eight (98) feet. Dividing the aggregate length of the shoots (1,171 inches) by their number (585), we find the mean length of the shoots to be about 2 inches. The average number of leaves on each inch of a number of shoots taken at random was 34, so that the total number of leaves on these 585 shoots may be set down at 39,814. Assuming each leaf to be only one inch in length—which is considerably under the mark, even when all the small undeveloped leaves are taken into consideration—we should have for the leaves a length of about three thousand five hundred and one (3,501) feet, so that, in round numbers, we may say that, including the shoots and leaves, the growth in length alone of this very moderate-sized young tree, during this season, has amounted to the prodigious number of three thousand six hundred (3,600) feet, so that if the shoots and the leaves could all be placed end to end in a continuous line they would occupy considerably more than half a mile!"

Death of the Chief of American Botanists.—A late number of "Silliman's American Journal" states that "John Torrey, M.D., LL.D., died at New York on the 10th of March, 1873, in the 77th year of his age. He has long been the chief of American botanists, and was at his death the oldest, with the exception of the venerable ex-president of the American Academy (Dr. Bigelow), who entered the botanical field several years earlier, but left it to gather the highest honours and more lucrative rewards of the medical profession, about the time when Dr. Torrey determined to devote his life to scientific pursuits."

A peculiar Arrangement of Wood and Bark in the Stem of Wistaria Sinensis has been pointed out by Mr. Thomas Meehan. The vertical section showed by the annual rings of wood that it was about twelve years old. After the eighth year's circle there was a layer of bark, and over this layer two more circles of wood. On a portion of the section another layer of bark had formed between the tenth and eleventh years' circles of wood. The bark seemed to be wholly of liber, the cellular matter and external cortical-layer of the regular bark appeared to be wanting. A longitudinal section showed where these internal layers of bark extended no further upwards, and at this point there was an evident show of wood from the interior over and down this layer of inclosed bark. He remarked that this section of wood was taken from a stem which had been led to support itself in an upright position. When the *Wistaria* is permitted to trail along the ground, numerous rootlets are formed along its length. He thought, from the appearance of the wood in the specimen presented, that rootlets had partially formed in these erect stems, pushing through the liber; and then, instead of penetrating entirely through the bark, and forming perfect rootlets, they remained within the cellular matter, and descending joined with the regular woody layer in forming an annular course of wood. This explanation was the more plausible, he thought, from the fact that woody stems formed on the ground. Where the rootlets went quite through into the earth, the stems were nearly regularly cylindrical; but these upright stems, on which rootlets were never seen, had an irregular fluted appearance; of course, this explanation does not accord with the formation of wood in ligneous structures as generally understood; but he could not understand how the appearance presented could have occurred in any other way than as he had supposed.—"Proceedings of the Philadelphia Academy of Science."

The History of the Fresh-water Algæ of North America.—"Silliman's Journal" contains a short notice of Dr. Wood's recent work on this subject, which, as it is of interest, we give in full. It is now fully twenty years since the Smithsonian Institution performed an appropriate and most acceptable service by publishing the *Nereis Boreali-Americana* of the lamented Professor Harvey, thus enabling our students to study the marine *Algæ* of our coasts. It proved to be one of the most popular of the Smithsonian Contributions to Knowledge. The institution has now enabled our students, and all who are curious in microscopic life, to enter upon the more difficult but not less interesting investigation of the fresh-water *Algæ*, by bringing out Professor Wood's important contribution. The systematic part of this goodly volume consists of 239 pages, of imperial quarto size, in which all the United States species known to the author (exclusive of *Diatomaceæ*) are arranged and described; they are illustrated by twenty-one coloured lithographic plates, which appear to be excellent. A supplement contains six species, which are described in Professor Harvey's "Nereis," which Professor Wood did not consult in season to include in their proper places; and in the preface a fine list of fresh-water species collected by Mr. Olney in Rhode Island and named a long time ago by Professor Harvey, is reprinted from Mr. Olney's "Algæ Rhodiacæ." Any student of these interesting forms may thus infer how much remains to be known of them, and all should unite in thanking Professor Wood in thus opening the way to their investigation; also for the elaborate bibliography appended to the volume. This fills thirteen pages in double columns, and is an almost exhaustive enumeration of the works and scattered papers which relate to this group of plants.

Distribution of Potassa and Soda in Plants.—In a recent number of the "Comptes Rendus," M. E. Peligot has endeavoured to determine whether a plant, watered during the entire period of its growth with water holding in solution common salt and nitrate of soda, absorbs a certain quantity of soda; and whether it takes from the soil other elements from plants of the same species cultivated under identical circumstances, but watered, some with common water and others with potassic and magnesian solutions. The tabulated observations show that the common salt and the nitrate of soda have been totally left by the plants; none of the ashes contained soda. Nitrate of soda acts only in consequence of the acid it contains, which probably combines by double decomposition with potassa or lime.

Pith of the Balsam Fir.—According to Dr. Dawson's researches, the pith of the balsam fir (*Abies balsamea*) has the same curious structure of pith that he years since found in Sternbergia, the pith of a Devonian conifer. It is well seen in young twigs one or two years old, and closely resembles that of *Dadoxylon Materiarium* of the upper coal formation of Nova Scotia. The structure is in each case an "organic partitioning of the pith by diaphragms of denser cells opposite the nodes."

Concealed Chlorophyll in Plants.—M. Prillieux ("Comptes Rendus," June 26th), discusses the structure of the bird's-nest orchis (*Neottia nidus-avis*), which is generally considered a non-parasitic plant not containing chlorophyll. He observed that if a plant is placed in alcohol it turns green, and then imparts that colour to the alcohol. Under the microscope it is seen that the brown colour of the petals is due to small elongated brown bodies scattered without order through the cells and grouped round the nucleus in each cell. These bodies have the power of swelling, and are what he regards as proteinaceous analogues of crystals. The application of alkalies or acids, or even of heat, immediately turns them green, and any re-agent which dissolves chlorophyll itself in like manner becomes green. M. Prillieux ("Academy," August 1st) believes, however, that chlorophyll does not exist as such in the living plant, the most careful experiments showing no disengagement of oxygen, but rather of carbonic acid; the chlorophyll is probably rather a product of the action of the re-agents applied. The tissues contain abundance of starch, which they probably absorb in that state.

CHEMISTRY.

The direct Synthesis of Ammonia.—An interesting experimental manufacture of ammonia by mixing dry hydrogen and nitrogen, and sending the electric spark through them, has been recorded by Mr. W. F. Donkin, who has lately read a paper on the subject, which has appeared in abstract in the "Proceedings of the Royal Society." He says, that "The action of induced electricity on mixtures of certain gases has been lately shown by Sir Benjamin Brodie (P. R. S. April 3, 1873), to yield very interesting results. An obvious application of his method was to treat a mixture of dry hydrogen and nitrogen in a similar manner as those referred to above, with the view of effecting the synthesis of ammonia; and Sir B. Brodie kindly allowed me the use of his apparatus for the purpose of the experiment, which was conducted as follows:—A mixture of about three volumes of hydrogen with one of nitrogen in a bell-jar over water, was passed through two tubes containing pumice moistened with alkaline pyrogallate and sulphuric acid respectively, then through a Siemen's induction-tube, and into a bulb containing dilute hydrochloric acid. The whole apparatus being first filled with pure hydrogen, about half a litre of the mixed gases was sent through the apparatus, the induction coil not being in action; the bulb containing the acid was then removed and another substituted, containing an equal volume of the same acid. About half a litre of the mixed gases was now passed through the apparatus, submitting them to the action of the electricity. The contents of the two bulbs were next transferred to two test-tubes; and after adding excess of potash to each, Nessler's test was applied. The first solution gave a faint yellow coloration, the second a rather thick reddish-brown precipitate. No attempt was made to estimate the quantity of ammonia formed, as it would vary with many of the conditions of the experiment."

Activity of Chlorine in Darkness.—This is an interesting subject, especially as chlorine is supposed to act almost exclusively in the light. However, M. Melsens has observed that carbon in the form of coke, purified by repeated washings and ignitions in a current of dry chlorine, can absorb nearly its own weight of this gas. If now a current of hydrogen, previously dried over phosphoric oxide, be passed over this chlorinated carbon, even cold and in absolute darkness, notable quantities of hydrochloric acid gas are disengaged. A true combustion of hydrogen in chlorine takes place, the temperature being actually lowered by the return of the chlorine to the gaseous state.—*Vide* "Comptes Rendus," lxxvi. p. 92.

Amount of Ozone absorbed by Water.—M. L. Carius has previously shown that ozone can be absorbed by water unchanged, in quantities not inconsiderable. He now finds that at a temperature of 0°, and a pressure of 0·76 m.m., 1·346 c.c. of ozone were absorbed by 100 c.c. of water; this is independent of the amount of oxygen absorbed. The ozone used in these experiments was obtained by electric action.—"Berichte der Deutschen Chemischen Gesellschaft zu Berlin," July 14.

Improvement in Photo-lithography.—In one of the numbers of the "Chemical News" for August, M. Paul gives the following description of his process: "The paper is coated with a layer of white of egg beaten up, and mixed with a concentrated solution of bichromate. When dry it leaves a hard smooth surface. After a sufficient insolation under the negative, the paper is covered with lithographic ink, then immersed in cold water to dissolve out the unchanged albumen, which is then removed with a fine sponge."

A new Deodoriser for Prevention of Epidemics.—In "Les Mondes" (August 14) M. Chodzko declares that the phenols, the hypochlorites, and chlorine, merely mask deleterious emanations without destroying them. He professes to have discovered a means of disinfection which neutralises all putrid effluvia. The process can be executed with rapidity, and costs only 10 centimes per cubic metre. ("Unfortunately," says the editor of the "Chemical News," who abstracts the paper, "no indication is given as to the nature of this new disinfectant.")

Waterproof Glue.—The "Chemical News" (August 29) says that bichromate of potassa has the property of rendering insoluble, under the influence of light, certain organic bodies, such as gum, glue, glycerin, &c. If a paper covered with gum mixed with bichromate is exposed to light, the coating becomes quite insoluble even in boiling water. This property is utilised in the so-called "carbon" photographic process. Strong glue becomes insoluble more rapidly than gum, and the action takes place slowly even in the dark. A concentrated solution of bichromate is prepared, which is kept in the dark, and a little of which is added to boiled gelatin. Objects glued with this, after some time, can be washed either with cold or hot water.

Mr. S. J. Mellhuish appointed Photographer to the Shah of Persia.—We learn from the "Chemical News" that Mr. Mellhuish, F.R.A.S., has received the honour of special appointment as Photographer to His Imperial Highness the Shah of Persia; the reason assigned by the Shah for conferring this honour being that he had never had portraits which pleased him so much, although he had sat to artists at St. Petersburg, Berlin, and Paris.

An Improvement in the Manufacture of Gelatin.—M. F. Heuze, who describes this method in the "Bulletin de la Société Chimique" (of Paris, August 5, 1873), says that his object is to obtain white gelatin from products of low quality. He attempted first to bleach the brown or nearly black gelatin, which is obtained as a secondary product in the manufacture of neats'-foot oil. This gelatin is applicable to very few uses on account of its dark colour, and is sold at 42 francs per 100 kilos. To prepare it, the feet—after removal of all parts useful for the turners—are digested in water or superheated steam at a pressure of 3 atmospheres. After three hours of digestion, and half-an-hour for settling, the strongly ammoniacal solution of gelatin is concentrated, the supernatant oil having been previously removed. A dark brittle gelatin is thus obtained. The author tried to bleach it with sulphurous acid, or with a sulphate in presence of hydrochloric acid, but the results were unsatisfactory. He attempted then to modify the process of manufacture itself, diminishing the duration of the action of the superheated steam. Instead of drawing off all the liquor at the expiration of three hours, it was drawn off three times from hour to hour. The solution was then mixed with wood charcoal mixed with 25 per cent. of animal charcoal, and after standing twelve hours was treated as above. The solution requires 4 per cent. of the charcoal mixture. The product is a gelatin of good quality, which only presents a yellow tint when seen in large masses. It is tasteless and scentless, and is even fit for alimentary purposes.

A new Mode of Analysis for Rocks is given by M. Fouqué, in a recent number of the "Comptes Rendus." It is briefly as follows:—One to two kilos. are reduced to a coarse powder ($\frac{1}{4}$ millimetre in diameter): the powder is divided into two portions, the one for mechanical, and the other for chemical examination. The former is submitted to a powerful electro-magnet set in action by six to eight Bunsen elements. All the ferruginous parts are thus removed. The chemical treatment consists in the use of concentrated hydrofluoric acid for a short time. This process has been applied successfully in an examination of the lavas of Santorino.

How to Prepare Triferrous Phosphate is a question answered in a paper at one of the late meetings of the Chemical Society, by Mr. R. Schenck, who prepared this substance by pouring a solution of ferrous sulphate into a flask in which phosphoretted hydrogen was being evolved by the action of potassic hydrate on phosphorus. The precipitate of ferrous hydrate at first formed rapidly becomes grey, and finally black. After removal of the phosphorus, the iron phosphide was purified by boiling it with a solution of potassic hydrate, and subsequently with hydrochloric acid. The results of the analyses corresponded to the formula Fe_3P_2; the phosphorus appearing to be trivalent. The ferrous phosphide dissolves slowly in boiling acids, with evolution of gas, and in the dry state takes fire below 100°, burning to a reddish-brown powder. The author intends to apply the same method to the preparation of other phosphides.

Silk Dyeing. Does Silk form Compounds with Acids?—M. E. Durwell, who has a paper on this question in a late number of the Paris "Bulletin de la Société Chimique," takes for the foundation of his views the hypothesis that silk forms, with acids, true compounds, capable of uniting with the coal-tar colours and with other dyes. Having ungummed silk to set the fibroine at liberty, he boiled it for a day in distilled water, to remove the last traces of the soap employed in this operation. It was then extracted with alcohol, so as to leave pure fibroine, which invariably gave an alkaline reaction. This silk was then dyed in a bath of litmus and very dilute sulphuric acid. The litmus serves here at once as reagent and as colouring matter. The colour is thus entirely fixed in the silk; but, on neutralising the bath with a trace of magnesia or of caustic soda, the blue litmus went back into solution, except a trace which was still absorbed by the silk. This experiment may be indefinitely repeated on the same colour-bath by rendering it alternately acid or neutral. It is the same with the coal-tar colours; but as these have a great tinctorial power, the experiment is less striking and decisive than with litmus. On treating two parts of fibroine with one part of sulphuric acid in the cold, combination at once takes place. Heat is developed, which must be kept down as much as possible by cooling the capsule, otherwise the silk will be completely resolved into glucose and ulmic compounds. After an hour's time, the reaction is complete. The brown liquid is filtered over asbestos, diluted with three or four times its bulk of water; the excess of acid is neutralised with baryta, filtered, and evaporated. A mass is thus obtained which, on treatment with alcohol, leaves a true compound of fibroine and of sulphuric acid. It is a white, transparent, horn-like body, soluble in water. The solution, if treated with an alkali, gives a precipitate of fibroine.

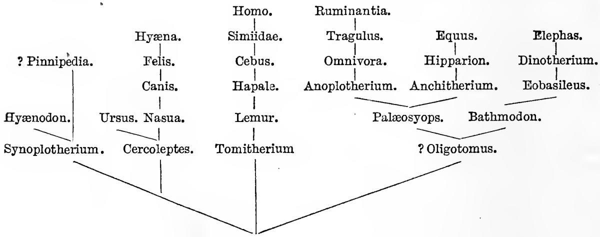
GEOLOGY AND PALÆONTOLOGY.

The Coal of Upper Burmah.—"This mineral," says Captain G. A. Strover, who has an important paper in the "Geological Magazine" for August, "is known to exist at Thingadaw, about seventy miles above Mandalay, on the western bank of the Irrawaddy; at Shuaygoo, below Bhamo; at Meimbaloung, in the Shan States east of Mandalay; to the south-west of Mandalay, in the Yaw district, at Yaignaw, east of Nat-taik. It is found at Pagan and Shimpagah, and it is probable that it exists near Meuhla and Yeynangyoung. At Thingadaw the coal has been extracted, but it is of an inferior description, and more resembles lignite than true mineral coal. An attempt was lately made here to ascertain the productiveness of the coal-beds. It is nearly certain that plenty of coal exists in the locality, and a few more borings would probably prove this. The coal-bed in the Shan States at Meimbaloung contains true mineral coal, and consequently a valuable coal. It has been inspected by an experienced mining engineer, and highly approved of as equal to the best English coal. There is little doubt that the beds are extensive, but unfortunately the distance inland is great, and no easy means are available for transporting the coal to the low lands; indeed, the only method at present is by floating it down mountain streams and rapids on rafts, which entail considerable risk and loss of coal. European skill and enterprise would soon make a safe route of one description or another if really required by the Government. It remains at present, with neighbouring wealth, where nature placed it, awaiting development in times to come."

Geological Map of the United States.—This map, which is on a small scale (36 by 24 inches), presents us nevertheless with a fair notion of the geological features of this vast and well-favoured country. To the geologist, as to the public at large, the most important area to be noticed at this time is that occupied by the Carboniferous system; and if arguments were needed to favour the old-established belief that the general movement of peoples is in a westerly direction, and that the country of the future is North America, let our American cousins point with perfect confidence to their almost inexhaustible coal-fields, which are, practically speaking, unworked, so great hitherto has been the supply of surface-fuel in the clearing of boundless forests, now changing into broad fields of corn and pastures for vast herds of cattle. The older rocks, named Eozoic by the authors, comprise all the formations earlier than the *Paradoxides*-beds, including the oldest known metamorphic Appalachian schists. We hope to see larger maps issued in future. Why, it is not so large as our own excellent pocket map of England and Wales by Professor Ramsay.

Skull of a Dentigerous Bird from the Isle of Sheppey.—This has been described at the last meeting of the Geological Society by Professor Owen. The bird is *Odontopteryx toliapicus.* The specimen described by the author consisted of the brain-case, with the basal portion of both jaws. The author described in detail the structure and relations of the various bones composing this skull, which is rendered especially remarkable by the denticulation of the alveolar margins of the jaws, to which its generic appellation refers. The denticulations, which are intrinsic parts of the bone bearing them, are of two sizes—the smaller ones about half a line in length, the larger ones from two to three lines. The latter are separated by intervals of about half an inch, each of which is occupied by several of the smaller denticles. All the denticles are of a triangular or compressed conical form, the larger ones resembling laniaries. Sections of the denticles show under the microscope the unmistakable characters of avian bone. The length of the skull behind the fronto-nasal suture is two inches five lines; and from the proportions of the fragment of the upper mandible preserved, the author concluded that the total length of the perfect skull could not be less than between five and six inches. The author proceeded to compare the fossil, which he declared to present strictly avian characters, with those groups of birds in which the beak is longer than the true cranium—a character which occurs as a rule in the *Aves aquaticæ*.

The Phylogeny of the Mammalian Orders.—This has been attempted to be formed by various palæontologists, with several degrees of success. The latest is that by an American geologist, Professor E. D. Cope, in a paper which was read before the American Philosophical Society on April 18, and published May 6, 1873. The paper is too long for abstract here; but we may give the tabular plan, of which the author says:—"The accompanying diagram is designed to express to the eye more clearly the propositions made above. By comparing it with a similar table published by Prof. Gill ('Proceedings of the American Association for the Advancement of Science' for 1871, p. 295), a close resemblance between the two may be observed, as well as certain differences." He wishes to be understood that the genera named in it as ancestors are to be regarded in the light of types of groups. There is no other mode of explaining the facts, than that in accordance with the law of "homologous groups," *i.e.* that several genera of one group have undergone similar modification into corresponding ones of a second group.*



The Volcanoes of Hawaii.—In a late number of "Silliman's Journal," the Rev. T. Salt gives a graphic account of them. He says: "You have seen an account of the eruption within the great summit-crater of Mauna Loa in August, 1872. This continued for two or three weeks. On the 27th of January

* See "Origin of Genera," p. 79, Prop. V.

of the present year we had the grandest display from the crater that I have ever seen. The action within it was vehement, and the scene marvellously brilliant. The great mural pit was in awful ebullition, and so violent was the raging of the molten sea within, that herdsmen of Reed and Richardson's ranch, on the eastern slope, reported the mountain as constantly quivering like a boiling pot. At Kapapala in Kau, at the base of the mountain, both foreigners and natives assert that they distinctly heard the swash of the fiery liquid, like the roaring and surging of a rushing river. The sheen of light, which rose thousands of feet heavenward and spread like a burning firmament over the mountain, was truly magnificent. At times the splendour was so vivid and so extended that observers called out the whole neighbourhood to witness the scene; some thought they saw the fiery river rushing down the side of the mountain; and numbers were sure that it was half way down the side, and that it was coming towards Hilo in hot haste. This, however, proved an optical delusion. The molten sea was confined within the deep crater, but it was fearfully grand. Parties were planning a visit to the scene of action, when suddenly the great furnace ceased blast. This was a little tantalising, but as we had all been favoured with free tickets to a royal display of fireworks, we could not mourn."

A Salt Deposit of Western Ontario.—Mr. J. Gibson, B.A., gives an account of this. The following is the depth of one of the wells:—

	Feet.
1. Gravel, sand, and clay	25
2. Stratified dark-gray limestone	400
3. Stratified magnesian limestone, followed by a very hard layer of chert	200
4. Crystalline siliceous limestone, containing magnesia	110
5. Blue clay, shale, and limestone	250
6. Gypsum, shale, and salt	50
7. Rock salt	100
Total depth	1135

The drilling done in this well was unprecedented in the annals of this system of mining, both for speed and absence of mishaps. Actual boring commenced on the 10th of March, 1870, and the salt-bearing stratum was reached on the eve of the 22nd of the same month. After passing through 100 feet of pure rock salt, without the least evidence of change, the boring was abandoned. The great success attending this boring led to the sinking of two other wells, viz.:—Sparling and Merchant's, in the immediate vicinity; both, however, giving records similar to the above. Truly in no other portion of the American continent has there been discovered a deposit of salt so magnificently great. The supply is practically illimitable, and may favourably compare with the production of the salt-mines of Droitwich, in Central England, or with that of the solid salt-hills of Cordova.

Rock Fissures and their Causes.—In a paper in the "Geological Magazine," Mr. T. Clifton Ward, F.G.S., after giving a long account of the subject, says, "How are such fissures to be accounted for? Does any one of the following suppositions seem likely?—1. That they are strictly of the nature of slips; that is, the mass of the mountain, or any part of its mass, is pressing outwards or towards the flanks. 2. That they have been caused by earthquake-shocks, perhaps very long since. 3. That they are the outward expressions of faults slowly taking place, and represent much greater disturbances or shifts at considerable depths. I can conceive," he says, "of no other theories than these to account for their formation. Let us consider their respective merits. With regard to (1) the facts that the mountain-*side* has no slipped appearance, and that the fissures often occur on a more or less flat-topped mountain, are against this supposition, though the ease with which one can imagine a great slip inclines one rather naturally towards it. That (2) is a possible cause no one will deny, though in this case it seems almost strange that the fissures should not be more frequent than they are, seeing that the shocks must always have been more or less felt over so small a district whenever they occurred strongly at one part. Against (3) an objection might be raised that they occurred only among certain rocks of the district, whereas faults would be likely to be found without any such marked restriction. But I do not think such an objection would hold; the non-occurrence of the fissures of this class among the Skiddaw Slate mountains is probably due to the nature of the rock; if fissured gradually, or even suddenly, the readily splintering and shivering slate would close the crack almost directly, so that it would be unperceived, whereas among the hard and *blocky* rocks of the Volcanic Series the fissure would stand open, or have large angular blocks wedged in it."

The Structure of Crinoids.—Mr. J. Rofe, F.G.S., has published a capital paper on this subject. He says that through the kindness of Mr. E. Hollier he has procured pieces of columns from the Silurian formation at Dudley, including *Taxocrinus, Periechocrinus, Actinocrinus, Marsupiocrinus, Cyathocrinus,* and two columns undermined, as they were without heads. Of these he has had slices mounted for the microscope, and finds on examination that, although there appears to be a general similarity in construction with the round columns of the Mountain Limestone, as they are more metamorphosed by crystallisation, the details are more difficult to distinguish. Some of them exhibit pentaphylloid sections of the central canal, as the *Taxocrinus* and *Cyathocrinus*, whilst the *Marsupiocrinus* shows a rosaceous section, the petals being wide and the divisions between them forming very acute angles; but he cannot satisfactorily make out the fibro-cartilaginous structure round the canal, though, from appearances, it is probable that it would be found by further examination with a great number of specimens. This paper, which is of some length, will repay perusal.—"Geological Magagazine," June.

MECHANICS.

Improvements in Lamps for Diving Operations.—It appears that M. Pasteur has discovered that the vitiated air discharged by divers contains oxygen enough to support the flame of a petroleum lamp. He accordingly connects, with the flexible escape-pipe of a diver's helmet, a suitable lamp of the above description. The lamp may be carried in the hand of the diver or attached to any part of his person. The flow of the escaping air from the helmet through the lamp gives a bright flame, enabling the diver to see in all directions, rendering the employment of the expensive electric light no longer necessary.

A Pneumatic Sewing-machine.—An apparatus of this description has been lately patented by Mr. J. E. Holmes. It consists of a sewing-machine having, below the table, a train of gear-wheels and an air-pump, operated by a crank, the pump being used to exhaust the air from a cylinder, underneath a piston which traverses the cylinder. The exhaustion of the air causes the piston to descend and drive the sewing-machine. If a vacuum equal to 14 lbs. to the inch can be obtained, the piston being nine inches in diameter, the pneumatic pressure on the piston will be 890 lbs., equal to a weight of that amount falling say three feet, the height of the sewing-machine table under which the piston is placed.

Improved Railway-carriage Brakes.—These have been described to the Society of Engineers by Mr. W. H. Fox, C.E. His conclusions are that every engine and carriage should be fitted with brake apparatus capable of reducing it from a speed of sixty miles per hour to a state of rest in a distance not exceeding 220 yards on a level, in ordinary weather; that a retarding force of 18 per cent. of the weight of the train is sufficient to do this; that cast iron is generally more suitable than wood as a material for brake-blocks; and that experiment shows that a pressure of $2\frac{1}{2}$ tons is required to be applied to the cast-iron blocks fitted to each of the four wheels of a carriage weighing 10 tons, and 1·8 ton if wooden blocks be used in like manner. The author considers that the atmospheric brake complies with nearly all the conditions necessary to be fulfilled by a perfect continuous brake. See also "Scientific American."

An Instrument for bringing up Portions of the Ocean-bed has been discovered by a blacksmith on board the ship *Hydra.* The *Challenger*, the exploring ship now on a voyage of discovery round the world, is supplied with a number of these instruments. The machine consists of a hollow metal rod, fitted with valves, and on which are rove cast-iron weights of 100 lbs. each, one for every 1,000 fathoms of estimated depth. The whole is so adjusted that the weights detach themselves on striking the bottom, and only the rod, with the soil within it, is recovered. When the *Challenger* started on her voyage, some months ago, she had thirty of these weights, which will probably have to be replenished before she has completed her work. A much better instrument (in the opinion of the "Scientific American") for deep-sea sounding is that invented by Sidney E. and G. L. Morse, brother and nephew of the late Prof. S. F. B. Morse, patented in New York in 1866. This machine consists of a rod containing a series of hollow glass balls, by means whereof (the number of balls being increased or diminished) any desired degree of buoyancy may be imparted to the instrument. Bags of sand or stones are attached, by which the rod is carried down, and the lower end made to scoop up a portion of the ocean bottom. The sand-bags become detached when the rod strikes bottom, and the rod then rises with amazing velocity to the surface, shooting up into the air as if discharged from a gun. This instrument is also provided with glass-pressure chambers and mercury, so arranged that the pressure of the water will drive the mercury from one chamber to the other. The depth of the ocean bottom will be indicated by the quantity of mercury so exchanged. The register of depth is very exact. This sounding instrument requires no line, and is, we believe, the first of the kind ever invented.

How to Ascertain the Strength of Metals.—Various plans for this purpose have been used from time to time. That of Prof. Thurston is thus described: "Work has now been commenced upon the metals, and the Professor desires to obtain samples of all well-known brands; the specimens to be 3¾ inches long, and of 1 inch round bar or ¾ and ⅞ square bar, with, in each case, statements as concise as possible of the ores used and method of manufacture of the sample, with the understanding that the results may be published. The specimens may be sent to the Institute at any time. The work was interrupted May 24, and during the absence of Prof. Thurston to attend to his duties as a member of the United States Scientific Commission to Vienna, but have been resumed on his return in September. We noticed a specimen of Ulster iron taken from open market, which had twisted to the limit of the machine, over 200°, without breaking off. The specimens are turned down in the middle, the neck being 1 inch long and ⅝ inch in diameter, by Whitworth gauges."

MEDICAL SCIENCE.

Spontaneous Coagulation of Milk is Caused by Microzymas.—According to a paper by M. A. Béchamp in a late number of the "Journal de Pharmacie," the main cause of the spontaneous coagulation of milk is the presence therein of minute living organisms, which may be detected in the milk by first diluting it with from five to six times its bulk of creosote water (neither the degree of concentration nor the mode of preparation of this fluid are quoted), and next filtering the milk, care being taken to protect the filter from dust. The filter is first washed with ether, for the purpose of eliminating the butter; next, with a dilute solution of carbonate of soda, for the purpose of dissolving some caseine; and lastly with distilled water. On inspection with the microscope (magnifying power 500 diameters) the microzymas will be seen.

Is there such a thing as Muscular Sensation?—The results of M. Bernhardt's experiments to determine whether the so-called "muscular sense" comes from the muscles or from some other source are not without some interest. The author does not deny a "sense of force," but claims that it may be only a consciousness of the degree of excitement in the nervous centre which acts on the muscle, or that it may be owing in part to sensations in the soft parts adjacent to the muscle. Bernhardt passes in review the various arguments *pro* and *con.* Spiess and Schiff pronounce decidedly against sensation in the muscles. Mechanical and chemical excitements of the muscles produce neither pain nor reflex movements, as has been shown by Pikford and Arnold. Cramps, indeed, cause pain; but this may result from compression of nervous filaments traversing the muscles. It is doubtful, moreover, whether the muscles receive sensory nerves; for it has been shown by Schiff that, after section of the anterior roots, all the muscular nerves after a while are found in a state of degeneration. The knowledge of the position of the limbs may come from the nerves of the tendons and of the soft parts about the joints. In a comparatively recent number of the "Archiv für Nervenkrankheiten," M. Bernhardt describes how he arranged some pulleys at the foot of a bed, so that an unseen weight might be raised by the hand or foot. The experimenter determined first with what accuracy he could estimate the weight attached to the cord when raised by voluntary motions. Then he caused the muscles to contract by electric stimulus, and found that, in the absence of a volitional impulse, it was much harder to tell how much weight was raised.

Irritability of the Heart of the Frog.—The "Lens," in its last number, has a short note on this subject. It says of Batrachians generally that besides being obliged to pump air down into their own lungs, which explains why the gular membrane underneath the under jaw is so elastic, acting on the volume of inhaled air in the cavity of the mouth on the mechanical principle of bellows, they catch game with the point of the tongue, drink through the spongy texture of the skin on the back, and live months in succession concealed in the mud bed of a pool without respiring; and yet the systole and diastole, or in plainer words, the contraction and expansion of the heart, is not suspended. Their vitality is remarkable, since the small amount of oxygen introduced into the arterial blood when making the final plunge in autumn keeps the spark of life alive till emerging from the water in the spring. If the heart of a frog is cut from its connections within the pericardium and placed on a table, it will pulsate and throb energetically for some minutes. When apparently quiescent, the point of a needle will rouse it again into spasmodic energy. Finally, by the touch of irritants, its irritability is completely exhausted. After experimenting full half an hour in that manner, we were struck with the lively vaultings of the frog from which the heart had been taken. Certainly it was conscious of its relations, for it avoided many cautious attempts to capture it on the part of the operator. It was some hours before death closed the scene. The vital tenacity of reptiles, particularly batrachians and chelonians, which include the tortoise family, is remarkable, and worthy of more extended scientific investigation.

Action of Certain Substances on the Spinal Cord.—The "Lancet," in a late nnmber, has an important article on the influence of substances on the reflex excitability of the cord. It states that Dr. S. Meihuizen gives, in Pflüger's "Archiv" (Band vii., Heft 4 and 5), the results of a series of experiments he has made on the effects of various agents on the reflex irritability of the spinal cord. The animals were chiefly frogs, and the disturbing influence of the brain was removed by section of the cord below the medulla oblongata. The test of the degree of irritability of the spinal cord was in most instances very dilute ($\frac{1}{5}$ per cent.) sulphuric acid, which was applied to the surface of the skin at intervals of a quarter of an hour, and the time before contraction occurred noted. Meihuizen finds that *bromide of potassium* rapidly depresses the excitability of the spinal cord, and ultimately entirely abolishes it, and he gives certain experiments which show that it is not due to the action of this salt on the periphery, or on the nerve cords, but upon the cord itself. The *salts of zinc* have a similar action. He considers the acetate might properly be regarded as a narcotic. *Chloral hydrate* lowers the reflex activity, and its action is also central. Experiments with *strychnia* brought out the curious fact that whilst the nerves and muscles become highly sensitive to *mechanical* irritation, there is no material increase in their reaction upon the application of chemical stimuli. *Quinine*, even in moderate doses, rapidly diminishes, and ultimately extinguishes, the reflex activity of the cord; but this action is apparently not direct, but in great measure indirect, through disturbance of the circulation and arrest of the heart's action. *Alcohol* (ten per cent.) first and for a long time greatly lowered and then exalted the irritability of the spinal cord. *Caffein* rapidly lowered it ($\frac{1}{2}$ c. c. of 10 per cent.), almost entirely abolishing it in four hours. *Morphia* first depressed, then exalted, and finally abolished the excitability of the cord. *Digitalis* has no influence on the spinal cord as a centre, but it acts as a depressant upon it, through its action on the vaso-motor system.

Inquiry into the Antecedents of Scientific Men.—The "Medical Record," which continues to supply most interesting information, says that following out a line of inquiry suggested by the remarkably interesting recent work of M. Decandolle, Mr. Francis, F.A.S., has issued a schedule of minute and searching questions as to their personal and family antecedents to about 250 of the most eminent scientific men in the United Kingdom. The object is to set forth the influence through which the dispositions of original workers in science have most commonly been formed, and have afterwards been trained and confirmed. The inquiry is one of much interest, and a considerable amount of curious information is sure to be obtained in this way.

The Nerve Supply of the Lachrymal Gland.—It appears that in his experiments in this direction Dr. Demtschenko (Pflüger's "Archiv," Sept. 1872) has operated on animals narcotised by means of morphia. The subjects were dogs, cats, and rabbits. The electric stimulus was applied by means of DuBois Reymond's apparatus. The quantity of fluid discharged by the lachrymal glands was estimated by the number of square centimetres of blotting-paper that were moistened. In the dog and cat the lachrymal nerve could be reached from the orbit; but in the rabbit the skull had to be opened. The chief results obtained by Demtschenko (*vide* "Lancet") were that the temporo-malar nerve exercises no influence on the lachrymal gland. Excitation of the great sympathetic augments the secretion; it augments also the quantity of fluid secreted by the conjunctiva, even when the nerve is irritated after ablation of the gland. The augmented flow of tears which follows irritation of a large number of cranial nerves (as the frontal, infra-orbital, nasal, lingual glosso-pharyngeal, and pneumogastric) is not interfered with by section of the sympathetic, but is stopped directly by section of the lachrymal. This reflex action is not wholly abolished during the sleep induced by chloroform. The author proceeds to compare the results of irritation of the sympathetic and of the fifth on the quantity and quality of the tears. The great violence requisite to expose the fifth throws a doubt upon the value of these experiments. The tears, however, were clear and limpid when the fifth was irritated, but cloudy when the sympathetic was excited. On the whole he thinks he may conclude from these and other experiments that the great sympathetic presides over the normal humectation of the globe of the eye; and this is supported by pathological facts, since the eyes of patients suffering from paralysis of the fifth retain their proper moisture, though the power of shedding tears is abolished. Disturbances of the circulation caused variations in the lachrymal secretion. After ligature of the carotoid artery, irritation of the lachrymal nerve caused a less abundant flow of tears than on the sound side. Ligature of the veins increased the flow of tears. All troubles of the respiration caused increased flow.

Alcoholism detected by Increase in Temperature.—Mr. Magnan, says the "Medical Record," quoted from the "Gazette Hebdom," points out signs which distinguish the serious from the passing form of acute alcoholism, and establish the prognosis. The most important is the course of the temperature. In grave cases it rises from 104.4° Fahr. to 102.2° Fahr. on the first day, and goes on to 104° Fahr. and 107.5° Fahr., and in one case reached 110° Fahr. before death. In cases ending in recovery, the temperature during the first four or five days oscillates towards defervesence; when during two or three days the temperature oscillates around 86° Fahr., the case is simple and recovery may be expected. Another sign to which M. Magnan attaches importance is the existence not only of the ordinary "tremblings," but of muscular tremors—fibrillar contractions—produced on pressure or percussion, and during sleep, as well in the deep as in the superficial muscles. This is of unfavourable omen.

How different Agents affect the Secretion of Bile.—Dr. Stricker has recently made some experiments on this subject which are decidedly of interest. In a paper read before the Gesellschaf der Aerzte, the defects of the former methods of obtaining the secretion were pointed out, and a new method suggested by which a canula was introduced into the ductus communis choledochus; from this depended a flexible caoutchouc tube, which ended in a mouthpiece that was kept constantly at the same level in a vice, thus avoiding apparent variation due to different height of the orifice of exit. These experiments showed that all circumstances causing hyperæmia of the blood-vessels of the liver increased the secretion of bile; whilst, on the contrary, all circumstances producing anæmia caused diminution. Thus the secretion was arrested in fasting animals, whilst it augmented after food Water introduced into the stomach or intestines caused a slight but transient increase. The introduction of purgative medicines, as croton oil, colocynth, jalap, calomel, Epsom salts, &c., materially increased the secretion of bile. It was at once stopped by ligature of the vena portæ and vena hepatica. Ligature of the hepatic vein alone materially diminished the secretion; ligature of the aorta at the diaphragm materially diminished the secretion, but did not entirely stop it; ligature below the origin of the cœliac artery augmented it; ligature of the vena cava ascendens immediately caused stoppage of the biliary secretion. All circumstances causing contraction of the vessels diminished the amount of secretion, as, for example, irritation of an exposed nerve, division of the spinal cord just below the medulla oblongata, and injection of strychnia.

METALLURGY, MINERALOGY, AND MINING.

The Specific Gravity of Rubies and Diamonds.—Mr. Greville Williams, F.R.S., says that in his paper entitled "Researches on Emeralds and Beryls," * he stated that the artificial rubies made by him by Gaudin's process had a lower specific gravity than that of the true ruby. He there assumed the density of the ruby to be 3·53, on the authority of Brisson,† and that of the sapphire as 3·56, according to Muschenbroek.‡ Having occasion, in extending his experiments on the subject, to take the specific gravity of several rubies and sapphires, he found their density to be very much higher than the numbers given in Gmelin's "Chemistry." On referring to other works,§ he found the numbers given in them to be generally between 3·9 and 4·0; Prof. Church also found a blue sapphire to have a density of 3·979, and a yellow one 4·030. His own determinations, made upon very fine stones, gave him for rubies 3·95, and for sapphires 3·98. Assuming 3·95 as the average specific gravity of the ruby, it will be seen that Gaudin's rubies, as first made by him (Williams), were 0·5 lower in density than the native ruby, instead of 0·08 as given in his former communication. He has, however, recently succeeded in preparing some fresh specimens of artificial rubies by the same process, but with a higher density, namely 3·7; this number is only 0·25 lower than the native ruby, and he thinks it probable that the true density of the ruby might be attained if the frothing, which takes place to a greater or less degree under the intense heat of the oxyhydrogen blowpipe, could be completely avoided.—*Vide* "Chemical News," August 29.

Hungarian Transylvanian Dacites.—These would appear, from the recent researches of Herr Dr. C. Doelter ("Verhandl. der Geol. Reichsanstalt," 1873, No. 6, 107), to be mostly hornblende and augite andesites, the former always having quartz as an essential constituent, the latter appearing to be mostly free from this mineral. The essential constituents of the dacites are a plagioclase felspar, quartz, sanidine, hornblende, biotite, augite, magnetite, and apatite, the accessory minerals being chlorite and epidote. The quartz occurs as crystals in dihexagonal pyramids, and in grains for the most part porphyritically distributed. Sanidine is a constant constituent in all varieties of the dacites, varying in amount from ten to twenty-five per cent. of the whole of the felspars, and is usually distributed in a fine state of division through the ground-mass. The structure of the quartz-bearing andesite (hornblende andesite) admits of its being divided into three groups —granitoporphyritic, porphyritic, and trachytic, the latter much resembling the true trachyte. The sanidine in these varieties never exceeds in amount fifteen per cent. of the felspar; the hornblende crystals are very distinct and terminated at both ends, and augite is often present.

Soldering Iron and Steel.—It appears from a paper published by Herr Rast in the "Bayerisches Industrie- und Gewerbe-Blatt," that so-called German silver may be applied to soldering steel to iron and iron to copper.

* "Proceedings of the Royal Society," 1873, No. 145, p. 409.
† Gmelin's "Chemistry," Cavendish Society's translation, vol. iii. p. 305.
‡ Loc. cit.
§ "Brooke and Miller," "Watts's Chem. Dict.," "Rammelsberg," &c.

Borax should be used as a flux, and the German silver granulated as is done for hard brass solder.

The Mechanical Properties of Bronzes.—In a paper in the "Comptes Rendus," M. Tresca arrives at the conclusion that there are bronzes more homogeneous, ductile, resistant, and elastic than those produced in the State foundries; and he calls on the Artillery Department to examine the products of private works so as to determine the bronze most serviceable for cannon.

Action on Iron Pipes of the Sulphur contained in Water.—An important notice of this peculiar effect is given in a paper by Dr. E. Priwoznik in a late number of "Dingler's Polytechnic Journal." It appears that when the iron mains conveying the mineral water from a source near Hainburg, Austria, were taken up after having been for more than a dozen years underground, the iron thereof had been strongly acted upon, as exhibited by the difference in structure upon the fracture. On being analysed, the author found the interior layer to consist, in 100 parts, of—Hydrated oxide of iron [$(Fe_2)_2O_3(OH)_6$], 81·08; free sulphur, 12·29; sulphuret of iron, 4·48; hygroscopic water, 0·57; nickel, cobalt, magnesia, silica, traces of carbon, and chlorides of ammonium and sodium, 1·58. The second layer was found to contain only 79·2 per cent. of iron, but no sulphuret or excess of carbon was discovered; while the third outermost layer was almost pure cast-iron.

A New Mineral Trautwinite.—In the "Proceedings of the Academy of Natural Science of Philadelphia" (1873, p. 9), Mr. E. Goldsmith has given this name to a green mineral occurring in microscopic hexagonal crystals (pyramids with the prism, the latter sometimes three-sided) on chromite from California, specimens of which he received from Mr. John C. Trautwine. Chemical and blowpipe examination showed that it contained oxides of chromium, iron and magnesium. Heated to redness in the closed glass tube, it gave a little water and turned bluish green. Not dissolved in acids.

MICROSCOPY.

A Fact against Spontaneous Generation.—One of the most important papers for some time contributed to Natural Science is that in the "Monthly Microscopical Journal" for August, by Messrs. Dallinger and Drysdale, entitled "Researches on the Life History of a Cercomonad." These authors have done what has not been done before. They have, with the highest objectives and the utmost patience, completely watched the entire development of the creature at which they were working. They have "continuously examined, during sometimes as long a period as fourteen days, a peculiar monad, hitherto undescribed, but which is under some circumstances developed in enormous quantities in the fluid resulting from the maceration of the head of the cod. This form passes through a remarkable series of changes, each of which might be taken for a distinct and independent creation were not its evolution perfectly regular. Whilst working on this they observed a second form, which possessed only one flagellum instead of two.

When mature of this form multiplies by fission for a period extending from two to eight days, it becomes peculiarly amaboid, two individuals coalesce, slowly increase in size, and become a tightly distended cyst. The cyst bursts, and incalculable hosts of immeasurably small sporules are poured out as if in a viscid fluid and densely packed; these are scattered, slowly enlarge, acquire flagella, become active, attain rapidly the parent form, and once more increase by fission. Experiments were next made to determine the influence of heat. An ordinary slide containing adult forms and sporules covered in the ordinary way was in seven several cases allowed to evaporate slowly and placed in a dry heat which was raised to 121°C (250°F). It was then slowly cooled, and distilled water was taken up by capillary attraction. On examination all the adult forms were absolutely destroyed, and no spore could be definitely identified. After being kept moist in the growing stage for some hours and watched with the 1-50th, gelatinous points were seen in two out of the seven cases, which were recognised as exactly like an early stage of the developing sporule, and by careful watching these were observed to attain the small flagellate state." The paper is a most valuable one, and well merits being read by those who have not yet done so.

A Mode of rubbing down Needles for Microscopical Work.—At a late meeting of the Reading Microscopical Society Dr. Shettle described a method of rubbing down needles so as to produce a cutting edge, and yet retain the sharp point, by running the needle edgeways through a slice of cork, allowing such portion only of the pointed edge to project as it is desirable to convert into the knife-blade. The cork, with the needle thus inserted, is then firmly fixed in a small hand-vice, the edge of the cork being brought to the edge of the vice. The needle should then be laid upon a block of metal or other hard material, and rubbed carefully with an oil-stone hone, the two sides of the needle-blade being easily produced by inclining the vice in a particular manner. The edge of the blade should always (for convenience of rubbing) be kept in one direction, and its place determined by keeping the needle much nearer one side of the vice than the other. The paper also referred to a form of handle, with tapering ferule, by which the knife-edged needle is very firmly fixed, and by the use of which a change of needle is easily effected.

Mr. Stephenson's Examination of Diatoms.—This method, which is described and illustrated very fully in the "Monthly Microscopical Journal" for July, is perhaps the most valuable novelty of the kind that has been yet recorded. Mr. Stephenson has conceived of the method of examining diatoms (and of course other objects) in solutions of different densities, and watching the result. The following paragraph from the paper will give a notion of the mode of working, but the original paper must be read by all who are interested in microscopy. Mr. Stephensons says: "If diatoms are examined in air, *i.e.* dry, they are, in some instances, too opaque for transmitted light, but on immersing them in water, of which the mean index is 1·336, they become more translucent; with media of higher refractive power the translucency increases until the mean index of strong sulphuric acid (1·434) is attained, in which they become practically invisible. As every object which is transparent and colourless becomes absolutely invisible when immersed in a colourless medium identical in refractive power with itself, we know approximately that the refractive index of diatomaceous silex is 1·434 (much below that of quartz), and this is accordingly, for diatoms, our neutral point. Although I have said colourless objects mounted in a colourless medium become invisible, it is of course equally true if both are of the same colour and of the same index. By progressively increasing the refractive power of the mounting medium, the diatoms gradually again become more and more visible until, as we all know, when mounted in Canada balsam (1·540) the coarser species are sufficiently defined for all ordinary purposes; but if we require a still greater departure from the neutral point or invisible condition, we must select some other substance of still higher refractive power. This we find in bisulphide of carbon, the index of which is 1·678, being, I believe, the highest of any known fluid."

The Mode in which Bacteria Multiply.—Herr Grimm, in the "Archiv für mikrosc. Anatomie," describes the reproduction of Bacteria and Vibriones from his own investigations. He has observed their conjugation and fissiparous multiplication, and also has seen leucocytes breaking up into granular matter, which ultimately assumed the form of Bacteria.

Irish Support to Microscopy.—The Royal Irish Academy has given the sum of 40*l.* to Mr. G. H. Kinahan, in order that he may continue his valuable researches into the microscopical structure of rocks, a subject on which for some time Mr. Kinahan has been engaged.

Mode of Observing Tissues in the Living State.—This subject, which is of the utmost importance at the present moment, was dilated on as follows by Mr. Schäfer, at one of the meetings of the Medical Microscopical Society. The report says that Mr. Schäfer, having dwelt briefly on the importance of the subject, remarked that the investigation of a subject was not complete till it had been microscopically studied in the living state, and that such examination, at least for warm-blooded animals, should be carried on at the temperature of the body. Much was to be learnt from the investigation of tissues still attached to the living body, for thus had cell migration been discovered by Cohnheim in the frog's mesentery, and experiments on embolism had been made in that animal's tongue; while the tail of the tadpole had taught us much about connective-tissue corpuscles, and the development of blood-vessels. Muscular tissue was best seen in the living state, in the smaller crustaceæ. Living tissues, removed from the body, allowed of being studied in many ways: some immediately without any addition whatever, as red blood corpuscles, and striated muscular fibre; while if any addition were necessary, a saline solution of 0·75 per cent., or serum would be best. For some purposes a moist chamber might be necessary, such as Recklinghausen's, in which frogs' blood had been preserved for days in a living condition (Schultze's "Arch." 1866). Another form was Stricker's putty stage, which was also useful for the application of electricity in microscopical research by means of two electrodes of tin-foil, the points of which nearly meet in the centre of the stage. Mr. Schäfer finally described and exhibited various forms of warm stages, one kind of which, as Schultze's, was heated by means of a lamp applied to metal arms, which conducted the heat to the object-bearers; another kind, as Stricker's, in which a constant temperature was maintained by means of a current of warm water kept continually flowing through it; while another very ingenious form of stage, somewhat similar to Stricker's, was so arranged that a constant circulation of warm water was kept up in a closed system of tubes, the temperature of which was regulated by a mercurial gas-regulator, and measured by a thermometer, the bulb of which lay close to the central chamber.

How to make Atomic Lenses.—This very valuable prescription is given by Mr. F. Wenham, V.P., R.M.S., in the "Monthly Microscopical Journal" for July. His account is as follows: "Strips of clear thin window-glass were drawn out into threads with the blow-pipe flame; a portion was then held in the point of the flame and fused into a spherule of the desired size. A number of these may be formed in a short time. The spherical figure is pretty accurate up to one-twentieth of an inch in diameter. One precaution must be observed. The strips of glass from which the threads are drawn must be broken, *and not cut off with a diamond*; if so, the spherules will not retain a clear polished surface, as the rippled cut of the diamond leaves its mark to the last. The blow-pipe may be an ordinary portable one, and the flame of a common stearine candle gives heat enough. The glass used should be quite clean, and always be held as near the point of the flame as possible, in order to avoid the deposit of smoke. *Large* spherules so made take an elliptical figure. Should they be required above one-twentieth they are best formed thus:—Select a clean fragment of window-glass, *broken off* (not cut), of such a bulk as will form the desired sphere. Attach this by one corner, with heat, to the point of a platinum or iron wire. Now rotate the mass while in a state of semi-fusion by twirling the wire back and forwards between the finger and thumb, holding it sometimes up or down, horizontally or inclined, according to the way that the glass seems inclined to sink. With very little dexterity spheres up to one-fifth of an inch in diameter may be so obtained, the rotation of the wire enabling the figure to be appreciated with some accuracy. When cool the spheres are pulled off the wire, which enters but a little way. These spheres are useless things enough alone."

The High-power Definition of Organic Particles.—On this subject a short but important paper appears in the "Monthly Microscopical Journal" for September. Dr. Pigott, F.R.S. (the author), endeavours to show that the markings on a Podura are purely spherical, just like those on *Angulatum.*

Progress of Microscopy in England during the last Three Months.—The following is a list of the titles of the several papers which have appeared in the "Monthly Microscopical Journal" for July, August, and September:—

Observations on the Optical Appearances presented by the Inner and Outer Layers of Coscinodiscus when examined in Bisulphide of Carbon and in Air. By J. W. Stephenson, F.R.A.S., Treasurer R.M.S., and Actuary to the Equitable Assurance Society.—Remarks on Aulacodiscus formosus, Omphalopelta versicolor, &c., with Description of a New Species of Navicula. By F. Kitton, Norwich.—Measurement of Immersed Apertures. By F. H. Wenham, Vice-President R.M.S.—On Bog Mosses. By R. Braithwaite, M.D., F.L.S.—On the High-Power Definition of Minute Organic Particles. By Dr. Royston-Pigott, M.A., F.R.S., F.C.P.S., F.R.A.S., M.R.I.—The Preparation of the Brain and Spinal Cord for Microscopical Examination. By H. S. Atkinson.—Researches on the Life History of a Cercomonad: a Lesson in Biogenesis. By W. H. Dallinger, F.R.M.S., and J. Drysdale, M.D.—The Angular Aperture of Objectives. By Robert B. Tolles, U.S.A.—Remarks on the Confirmation given by Dr. Colonel Woodward to the "Colour Test." By Dr. Royston-Pigott, F.R.S., &c., &c.—Remarks on Mr. Carruthers' Views of Prototaxites. By J. W. Dawson, LL.D., F.R.S.—On Ancient Water-fleas of the Ostracodous and Phyllopodous Tribes (Bivalved Entomostraca). By Professor T. Rupert Jones, F.R.S., F.G.S.—The Pathological Relations of the Diphtheritic Membrane and the Croupous Cast. By Jabez Hogg, Surgeon to the Royal Westminster Ophthalmic Hospital, President of the Medical Microscopical Society of London, &c.—On Organic Bodies in Fire Opal. By Henry J. Slack, F.G.S., Sec. R.M.S.—On the High-Power Definition of Organic Particles. No. II. By G. W. Royston-Pigott, M.A., M.D., F.R.S., &c.—On the Apparent Relation of Nerve to Connective-tissue Corpuscles, &c., in the Frog-Tadpole's Tail. By R. L. Maddox, M.D., H.F.R.M.S.—On a New Sub-stage for the Microscope, and on certain Appliances for Illumination. By Edwin Smith, M.A.—The "Colour Test" and Dr. Pigott. By F. H. Wenham, Vice-President R.M.S.—Experiments on the Development of Bacteria in Organic Infusions. By C. C. Pode, M.B., Demonstrator to the Regius Professor of Medicine, and E. Ray Lankester, M.A., Fellow and Lecturer of Exeter College.

PHYSICS.

A Note on the Spectrum of Chlorophyll.—M. Chautard has a note on this subject in a late number of the "Comptes Rendus." After specifying the changes produced in chlorophyll by light, he makes reference to the persistence of green matter in certain plants late in the autumn season; he considers this due to the presence of fatty and resinous matters. He finds that a solution of chlorophyll in fixed oils (oil of belladonna, *e.g.*) is not sensibly altered after several days' exposure in full sunlight. The most luminous spectral rays are the most active in changing chlorophyll solution; and rays which have already traversed a layer of chlorophyll have no effect on a second layer so long as the first is not discoloured. In this experiment he used vessels with two or more compartments. Heat modifies chlorophyll, but does not readily destroy it at temperatures under 100°. Above 100° the chlorophyll undergoes various alterations, according to its degree of dryness and the nature of the solvent. Dried chlorophyll is completely disorganised at a temperature about 200°; whereas, solutions of it in essential oils only undergo a slow, gradual change at this temperature, and may even resist 225° or 250° for several hours.

Galvanic Reduction of Iron under the Influence of a powerful Electro-magnetic Solenoid.—M. Jacobi, of St. Petersburg, covered the interior walls of two glass vessels with cylinders of sheet-iron, and placed in these vessels two similar rods of wax, coated first with a thin electro deposit of copper, and then with plumbago. The vessels were then filled with a solution of sp. gr. 1·27, containing 135 parts of ferrous sulphate, and 123 parts of magnesium sulphate, rendered neutral by the addition of magnesium carbonate. One of these vessels was surrounded by a tube of sheet iron, in which was coiled a helix of insulated copper wire. A reducing current from one Smee cell was now passed through the solution in the two vessels, while another current from four Bunsen cells went through the magnetizing helix. At the end of twenty-eight days the wax rods were examined, with the following results: An equal weight of iron was deposited on each rod; but, while the iron on the rod not exposed to the heliacal current was smooth and fair, the iron on the other rod was principally on its upper and lower portions, in the form of tufts, having a crystalline structure, and resembling somewhat the appearance presented by a bar magnet after its introduction into iron filings. He found that both deposits were very feebly magnetic, and further experiments showed that iron deposited by electrolysis receives a remarkably high charge of temporary magnetism, and has very feeble coercive force; he therefore recommends such iron for the construction of electro-magnetic cores.

Recent Estimate of the Velocity of Light.—M. Cornu has, we understand, repeated, with all the precautions suggested by the recent progress in physical science, the experiment of Fizeau to determine the velocity of light. His researches, which have extended over a period of three years, lead him to conclude that the toothed wheel used in this method is capable of giving more accurate results than the revolving mirror employed by Foucault. The principal station, containing the toothed wheel and the mechanism for rotating it, the means of illumination, the telescope, the velocity-register, &c., was at the École Polytechnique. The other station, in which the collimating telescope and the reflector were placed, was at Mont Valerien. The distance between them was carefully measured and found to be 10,310 mètres, with a probable error of less than ten mètres. The wheel was carried upon the arbor of the minute-hand of an improved clock-work. Three of these wheels were made use of, having respectively 104, 116, and 140 teeth. To the clock-work an electric apparatus to register the velocity of rotation was attached, and also the means for regulating its motion, and even reversing its direction. A velocity of 700 to 800 revolutions per second could be thus obtained, which was uniform, and perfectly under control. The registering apparatus consisted of a chronograph, upon the revolving cylinder of which three electro-magnetic pens made their marks; one of these marked seconds, the second marked the rotations of the toothed wheel, and the third, controlled by a key in the hands of the observer, marked the instants of eclipse. The calcium-light was generally employed as the source of illumination, though a simple petroleum lamp was also occasionally used. Over a thousand separate observations were made and registered upon the chronograph; but only the best of these, six hundred and fifty in number, were reduced. These reductions gave the following values in kilomètres, for the velocity of light as deduced from the various orders of the occultation:—

1st order.	2nd order.	3rd order.	4th order.	5th order.	6th order.	7th order.
. . .	302,600	297,300	298,500	298,800	297,500	300,400
. . .	(17)	(236)	(376)	(480)	(91)	(27)

The numbers in parenthesis express the relative value of the corresponding observations, and are obtained by dividing by 10 the product obtained by multiplying the number of observations by $2n—1$ (n being the order of the eclipse) and by 1, 2, 3, or 4, according as the observation was recorded as fair, good, very good, or excellent. The mean result is 298,400 kilomètres; multiplying this result by 1·0003, the refractive index of air, 298,500 kilomètres is obtained as the velocity of light in a vacuum. This, Cornu believes, is accurate to $\frac{1}{300}$ of its value. It is a close approximation to the result of Foucault, 298,000 kilomètres, and also corresponds very closely to the value obtained from the solar parallax, which has recently been calculated by Leverrier, from observations upon Mars and Venus, to be 8″·86. Cornu believes that with stations separated from 20 to 30 kilomètres, it would be possible by this method to obtain a value accurate to within a thousandth.—See the "Comptes Rendus," lxxvi. p. 338.

ZOOLOGY AND COMPARATIVE ANATOMY.

Kingfishers and Fish.—This subject, which is of some interest to Naturalists, has a note upon it in the "Scientific American" for Aug. 16. The writer, dating from California, says that "Mr. Darwin, in his last book, states that the kingfisher always kills the fish before swallowing it. Dr. Charles C. Abbot states that the fish is swallowed without killing, and often while the bird is on the wing. "So far as my observation goes, when a fish is large, or about two and a half inches long, it is killed before being swallowed. I once saw a kingfisher light on a limb close to the surface of the water in a creek; and the bird, having an eye to the business on hand, did not see me (I was about fifteen feet off). It presently dived into the water, and returned to its perch with a fish in its bill, about the above stated length. The bird then began to beat the head of the fish against the limb on which it was standing; after a few beats it would stop to see if the fish was dead or not; this was done three times, when the head of the fish was bleeding, and the limb against which the head was beaten was stained with blood. The fish was dead, and it was then swallowed. Now the above-named gentlemen may both to a certain extent be correct. The kingfisher may swallow the small fish without killing them; in my mind there is no doubt that they do."

A new and large Amphipod has been captured by the *Challenger* expedition, and is described in a letter addressed to the Royal Society. The author of the description, Herr Von Willemöes-Suhm, says that, among the Amphipods known to us, *Phronima* is its nearest relation. But there are so many points in which this genus differs from *Phronima*, that it cannot form a member of the family *Phronimidæ;* and he therefore proposes to establish for it a new family, *Thaumopidæ,* belonging to the tribe of *Hyperima.* The form of the *head* is totally different from that of *Phronima*; the antennæ are not situated near the mouth, but at its front, and the enormous faceted eyes occupy its upper surface. The first two pairs of thoracic appendages are not, as in *Phronima,* ambulatory legs, but maxillipeds, so that only five pairs of legs are ambulatory in *Thaumops*. The *thorax* is composed of six segments, the first of which has, on its under side, the vulva and one pair of maxillipeds; and the second, representing two segments, bears two pairs of appendages, the larger maxilliped and the first pair of ambulatory legs. The *abdomen* consists of five segments, with three pairs of pedes spurii, the caudal appendages being attached to the fourth and fifth segments. The animal being beautifully transparent, the *nervous system* could be carefully worked out without dissecting it; the position of the nerves going out from the cephalic ganglion, as well as that of the five pairs of thoracic and the three pairs of abdominal ganglia, could be ascertained. The *eyes*, having at their borders very peculiar appendages, were examined, and a description is given, in the paper here abstracted, of the structure of the large crystalline bodies which are to be seen in them. Organs of hearing and touch have not been discovered. The *mouth* is covered with a pair of maxillæ and a small labium. There is a recurved œsophageal passage leading into a large cæcal stomach, and an intestinal tube departing from near the end of the œsophagus and running straight to the anus. The *heart* is an elongated tube extending from the second to the fifth segment, with probably three openings. Three pairs of transparent sac-like gills are attached at the base of the second, third, and fourth pairs of feet.

Experiments on Spontaneous Generation.—One of the best papers that have been published on this important subject is that of Mr. E. Ray Lankester, M.A., and W. C. C. Pode, M.B. It goes very fully into the subject, and is so far a very complete answer to the belief in the origin of organic life *ab initio*. It is to be found reprinted (from the "Proceedings of the Royal Society") in the "Monthly Microscopical Journal" for September.

Development of the Pig's Head.—A most valuable and exhaustive paper on this subject is that by Mr. W. K. Parker, F.R.S., which was read lately before the Royal Society. It appears in a long abstract in "The Proceedings of the Royal Society" (last number).

Pre-historic Houses in the Aleutian Islands.—These latter islands are so interesting to the zoologist that anything recording the habits of their ancient inhabitants must be of value. Such, we think, is the following extract from a paper in the "Proceedings of the Californian Academy,' which we have just received. After describing various preliminary operations, the author, Mr. W. H. Dall, goes on to observe "that the first thing noticed was a sort of wall of rough stones, evidently obtained from the neighbouring beach, with here and there a whale-rib, in a perpendicular position, which had probably assisted in supporting the roof. Further excavation for a couple of feet revealed a human skeleton in perfect preservation. The body had been doubled up, so as to bring the knees up to the chin. It was lying on the right side, in a horizontal plane facing the south-east. Two others were afterwards discovered in an exactly similar position. They were about three feet from the surface, but not so far from the inner wall of the house; one was the skeleton of a woman. A few rough flat stones were placed around and under them, but no articles of use or ornament were with the skeletons. It is a matter of record that the ancient Aleuts, when a person died in one of their houses, built up the body in the compartment which had belonged to the person when living, and continued to occupy the remainder of the yourt as usual. The position in which these skeletons were found indicates that such was the manner in which they had been interred. It is still a common practice, among tribes of the Orarian stock, to tie up the body of a dead person in the manner just described. Further digging showed that a great part of the mound was composed of materials foreign to the locality. These principally consisted of bones of cetaceans, fur seal (*Callorhinus ursinus*), sea lion (*Eumetopias Stelleri*), and sea birds, principally ducks and gulls or petrels. There were also large accumulations of the shells of edible molluscs, among the most conspicuous of which were the common mussel (*Mytilus edulis*), *Saxidomus squalidus*, Desh., *Tapes staminea*, Conr., and *Modiola modiolus*, L. All the above are still living in these seas, most of which are still found in Captain's Bay, and form a portion of the food of the existing native population. The sea lion and walrus are no longer found in Unalashka, and the fur seal but rarely."

Ancient Greek Crania have been recently discovered, in a perfect state of preservation, at Athens. The first is that of a woman named Glykera, as we learn from the tombstone, which was found as it had been placed by affectionate survivors. In the tomb beside the skeleton were two small painted vases, and on the tombstone was sculptured a parting scene of no great artistic merit. The second is that of an old man. It was found May 17, 1871, in a tomb, lying from west to east, and containing, besides, about thirty vases, a silver fibula, two gold rings, a gold plate, and some articles of bronze, but no inscription from which we might gather any knowledge of its tenant. The vases are of what is called the earliest style, that is, the style which prevailed in Greece previous to the introduction of the human figure as a subject of decoration in vase painting. Supposing the transition from the earlier to the later style of painting to have taken place shortly after the death of this old man, and assuming his cranium to be a normal cranium of his nationality and time, it is interesting to see how what has always been a remarkable feature in the earliest vases on which the human figure occurs—the smallness of the cranium—comes to be justified as a correct observation of nature. Of both crania, indeed, though that of Glykera cannot be regarded as of an early date, Virchow (who gives elaborate measurements and descriptions of them in the "Zeitschrift für Ethnologie," Berlin, 1872, iv. p. 147) remarks that their capacity is much under the medium of modern civilised people, and rather resembles that of savage races. At the same time the form of both is very beautiful, the vaulting of the male head being particularly fine. In occipital development it is much inferior to that of Glykera. But in spite of this difference, the similarity between them is so great in the formation of the brow and face that there can be little doubt of both persons having been types of the same race.—See the "Academy," May 15.

Costanti, a Curiously-tattooed Man.—It is much to be regretted that Costanti, after yielding so far as to go to Berlin for the purpose of being more closely examined by Virchow and Bastian, should have been overtaken at the last moment by an illness which he made the pretext of returning at once to Vienna. There is little doubt, says the "Academy," but that the real cause of his sudden departure was the dread of being subjected to a fresh examination as to the circumstances under which he was tattooed, a subject of which his previous accounts are in a high degree conflicting and unsatisfactory. Fortunately we have photographs of him as well as a detailed description in the "Wiener Medicinische Wochenschrift," 1872, No. 2, and an engraving on a large scale in Hebra's "Atlas der Hautkrankheiten." From these it appears that the tattooing covers the entire body with the exception of the nose and such parts as the soles of the feet. The colours are mainly dark blue with an occasional touch of red, while the design, embracing figures of animals, flowers, weapons, and other objects with written characters in some places, particularly in the palm of the hand, is carefully carried out. The skin, instead of suffering in the process, is quite soft and delicate to the touch. Its feeling is unchanged, and in point of sensitiveness to temperature if anything increased. According to his account, the instrument employed was a metal cylinder, pointed and split at the point like a pen, with a heavy metal handle. This cylinder being charged with coloured liquid was then placed against the skin, and resting on the left forefinger of the operator the point was driven with a steady movement under the skin. With three hours of this daily the whole work was completed in three months, and that it should have occupied so long a period is not to be wondered at when we consider the elaborate and truly artistic character of the design. All doubts as to the tattooing having been done in Burmah are now at an end, through the assurance of Bastian that the letters which occur in it are Burmese. Costanti had called them Arabic. Though it is possible that he may have been subjected to the process as a proper punishment for a mercenary soldier captured in war, it is more likely that he had himself so carefully tattooed only for the ulterior object of gain.

Mr. Gwin Jeffreys' Errors in American Conchology are pointed out with some severity in a recent number of "Silliman's American Journal" by Professor A.E. Verrill. He says that the special errors to which he wishes to call attention occur in the table of species, showing their geographical distribution. These relate both to the names and specific identity of certain shells, and to their geographical distribution. Although not agreeing with the author in regard to many of his remarks concerning the generic relations and names of species, he does not propose to discuss them here; for there seems to be no danger of their general adoption, either in Europe or America. The following marine species (named as in Gould), which Mr. Jeffreys puts down as belonging to the region north of Cape Cod, actually belong properly to the region south of Cape Cod, extending in most cases to the Carolina coasts or beyond, while north of Cape Cod they are rare or local, viz.:—*Cochlodesma Leanum, Mactra lateralis, Petricola pholadiformis, P. dactylus, Gouldia mactracea, Cytherea convexa, Venus mercenaria, V. notata, Gemma gemma, Liocardium Mortoni, Arca transversa, Modiola plicatula, Pecten irradians, Ostrea Virginiana, Anomia electrica* (not of Linn.), *Diaphana debilis, Cylichna oryza, Placobranchus catulus, Crepidula fornicata, C. plana, C. convexa, C. glauca, Ianthina fragilis, Bittium Greenii, Odostomia bisuturalis, O. seminuda, Turbonilla interrupta, Pleurotoma bicarinata, P. plicata, Nassa obsoleta, Buccinum cinereum, Diacria trispinosa, Loligo Pealii.*

The following, to which a northern distribution is likewise given, are also found far south of Cape Cod, and many of them belong quite as much to the southern as to the northern division; and some of them are decidedly southern, extending even to the Gulf of Mexico:—*Teredo navalis, T. megotara, T. chlorotica, Solenensis, Machæra costata, Pandora trilineata, Lyonsia hyalina, Mactra solidissima, Kellia planulata, Macoma fusca, Tellina tenera, Astarte castanea, A. quadrans, A. sulcata, Nucula proxima, Yoldia limatula, Mytilus edulis, Elysia chlorotica, Crucibulum striatum, Littorina rudis, L. tenebrosa, L. palliata, Lunatia heros, L. triseriata, Nassa trivittata, Melampus bidentatus, Alexia myosotis.* Many others, not named in the above lists, are not limited by Cape Cod; but as they belong properly to the northern division, they are here omitted. The distribution indicated for our land and fresh-water shells is even more erroneous. It is sufficiently evident that Cape Cod is in no sense a proper boundary between the northern and southern fluviatile and terrestrial species; but, disregarding this, there are no reasons whatever for most of the special indications that he gives.

INDEX.

END OF VOL. XII.

LONDON: PRINTED BY
SPOTTISWOODE AND CO., NEW-STREET SQUARE
AND PARLIAMENT STREET