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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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THURSDAY, AUGUST 31, 1871

ON THE VARIOUS TINTS OF FOLIAGE

ALTHOUGH we cannot yet say—

> Far, far o'er hill and dale green woods are changing,
> Autumn her many hues slowly arranging,

still it may be interesting to put together certain facts with reference to the tints of foliage which have recently been acquired to science.

Up to the present time I have been able to distinguish several dozen colouring matters in the leaves of different plants, and far more in the petals and fruits, and no doubt further inquiry will very greatly increase this number. The subject would, therefore, be quite unmanageable, if we could not divide them into well-marked groups by means of their optical characters. This is still more important when, as on the present occasion, it is desirable to give a condensed summary of the leading facts. I shall, therefore, not attempt to describe the individual colouring matters, or to explain how they may be distinguished or identified by means of their spectra, either in their natural state or after being acted on by re-agents; but merely point out the general relations of the various groups, and refer to my published papers for illustrations of the methods employed in the inquiry.* The colours of these groups are not only related to one another optically and chemically, but also have a very similar connection with the growth of the plants, and thus it is possible to give a general explanation of the very various tints of foliage, without entering into technical details. For a more complete account, I beg to refer to a paper on this subject, just published in the July number of the *Quarterly Journal of Microscopical Science.*

One of the chief difficulties in studying the colours met with in plants is, that they are often mixtures of quite distinct colouring matters. Sometimes these may be easily separated, for one may be soluble, and the other insoluble, in such reagents as water, alcohol, ether, or bisulphide of carbon; but in many cases they are so closely related, that anything like a complete separation is perhaps impossible; even then, however, it may be possible so to effect a partial separation, that the presence of two different substances may be recognised, and with proper care a very good opinion may be formed as to their general properties. Nature, also, herself often assists us in this inquiry, for different plants, or the same in different states, may furnish particular colouring matters comparatively pure, or so variably mixed that the character of the mixture may be recognised.

For the purposes of the subject before us, I have found it desirable to divide the different colouring matters into the following groups:—

1. The *Chlorophyll* group is distinguished by being insoluble in water, but soluble in alcohol and in bisulphide of carbon. There are three or four species, giving well-marked spectra, with several narrow, dark, absorption-bands, one or more of which occur at the red end. The mixed chlorophyll of ordinary green leaves may be obtained in a tolerably satisfactory state by heating in alcohol dark green holly leaves, previously crushed so as to insure rapid solution, and then, when cold, agitating in a test tube with bisulphide of carbon. This sinks to the bottom, holding nearly the whole of the dark green chlorophyll in solution, whilst nearly all the xanthophyll remains dissolved in the alcohol. Leaves having an acid juice must not be used, for that would change the normal chlorophyll into another modification, nor should the solution be left long in contact with them, for then the separation is much less perfect.

2. The *Xanthophyll* group also contains several distinct species, but only two are common in leaves, one being more, and the other less, orange. They are characterised by being insoluble in water, but soluble in alcohol and in bisulphide of carbon; and when dissolved in this latter their spectra show two not very distinct absorption-bands at the blue end; but the red, yellow, and yellow-green rays are freely transmitted. They may be obtained from yellow leaves, by the use of alcohol and bisulphide of carbon.

3. The *Erythrophyll* group comprises a number of colours soluble in water, in alcohol, and in ether, but insoluble in bisulphide of carbon. Those met with in leaves are more or less purple, made bluer by alkalis, and redder by acids; and thus sometimes plants containing the same kind may vary more in tint, owing to a variation in the amount of free acid, than others coloured by entirely different kinds. The erythrophyll may be obtained, free from chlorophyll and xanthophyll, by heating the leaves in alcohol, evaporating to dryness, redissolving in water, filtering, and evaporating at a gentle heat; but, on the whole, it is better to digest the leaves for a day or so in sufficient cold ether to dissolve all the contained water, and then to agitate with water, which subsides to the bottom, with nearly all the erythrophyll in solution, but mixed with more or less of the colours of the following group. There are many species of erythrophyll, some of which have very interesting botanical relationships, being so far found only in particular classes of plants.

4. The *Chrysotannin* group contains a considerable number of yellow colours, some so pale as to be nearly colourless, and others of a fine, dark, golden yellow. They are soluble in water, in alcohol, and in ether, but not in bisulphide of carbon. Their spectra show a variable amount of absorption at the blue end, usually with no bands when in their natural state, but sometimes with one or more sufficiently distinct when they are oxidised. They may be obtained free from chlorophyll and xanthophyll by processes similar to those made use of in the case of erythrophyll, and leaves should always be selected which are as free as possible from colours of that group. Some of the chrysotannin colours strike a dark colour with ferric salts, and constitute the tannic acid sub-group, of which there are at least six different kinds, whereas others do not give any such reaction, and constitute the chrysophyll sub-group. In both sub-groups the intensity of colour is usually greatly increased by partial oxidisation, and they are thus altered into colours of the following group.

5. The *Phaiophyll* group comprises a number of more

* Proceedings of the Royal Society, vol. xv., p. 433 (*Philosophical Magazine*, vol. xxxiv., 1867, p. 144); *Quarterly Journal of Microscopical Science*, vol. ix., 1869, pp. 43 and 358; *Monthly Microscopical Journal*, vol. iii., 1870, p. 229; *Quarterly Journal of Science*, new ser., vol. i., 1870, p. 64.

or less brown colours, insoluble in bisulphide of carbon, and of very variable solubility in water or alcohol. The spectra show strong absorption at the blue end, extending over the green, often the red is very dull, and sometimes there are definite absorption bands, when the solution is acid, neutral, or alkaline. On the whole they are in that state of oxidisation which has a maximum intensity of colour, and are simply decolourised by further oxidisation.

The very numerous tints of foliage depend almost entirely on the relative and absolute amount of the various colours of these different groups, but much remains to be learned before we can explain all their relationships. The colour of green leaves is mainly due to a mixture of chlorophyll and xanthophyll and the variation in the relative and absolute amount of these easily accounts for the darker and brighter greens. The tints are also much modified by the pressure of colours of the erythrophyll group, which, according to circumstances, may give rise to lighter or darker browns, approaching to black, or to reds. Healthy unchanged leaves also contain various substances belonging to the chrysotannin group, but in many cases when these belong to the more typical kinds of tannic acid, their colour is so faint that they have little or no influence on the general appearance of the leaves.

The relation of these groups to one another is still somewhat obscure. There are facts which seem to indicate that chlorophyll may in some cases pass into xanthophyll by oxidisation, and xanthophyll into chlorophyll by deoxidisation, but neither point can be considered to be established. There is manifestly some connection between the formation of chlorophyll and erythrophyll; and those conditions which are favourable to the production of one are unfavourable to the development of the other. In the present state of our knowledge it seems most probable that chlorophyll is formed when the vital functions of the leaves are very active, and erythrophyll when they are less active but not destroyed. Exposure to light also appears to be necessary, and we often see rough natural photographs of superjacent leaves produced in this manner. As I have already said there are several different kinds of erythrophyll, giving very different spectra, but the most prevalent are two which are related to each other in an interesting manner. One of these is more especially found in very young leaves, and when slightly oxidised artificially it passes into the other. This more oxidised kind is that found in the greater number of leaves which are red in autumn. Both are completely decolourised by further oxidisation, and most probably this occurs in leaves themselves when their red colour is lost. Since many contain erythrophyll in early spring and lose it as the season advances, whilst it still continues to be present in the leaf-stalks, I am much inclined to believe that its disappearance is due to the ozonised oxygen given off from the chlorophyll, which is developed to so much greater an extent in the leaves than in the stalks, and that its reappearance in autumn in many leaves is characteristic of the period when they are not dead but have more or less ceased to give off ozone.

On the approach of autumn, before the leaves have withered, we have thus in the foliage of different plants an exceedingly variable mixture of chlorophyll, xanthophyll, and erythrophyll, with the different members of the chrysotannin group; and it is to the changes which occur in some or all of these substances that the very variable tints of autumn are due. The most striking of these depend on the alteration of the chlorophyll. So long as it remains green the production of bright reds and yellows is impossible, but when it disappears the yellow colour of the xanthophyll is made apparent; and, if much erythrophyll is present, or contemporaneously developed, its colour, combined with this yellow, gives rise to scarlet or red. In many cases, however, the chlorophyll does not disappear, but is changed into the dark olive modification, easily prepared artificially by the action of acids on the more green, and when this is present, only dull and unattractive tints can be produced. We may thus easily understand why the special tints of early autumn are yellows and reds, or dull and dark greens. In these changes the various pale yellow substances of the chrysotannin group remain comparatively unaltered, and even sometimes increase in quantity; but they soon pass into the much darker red-browns of the phaiophyll group, whilst the erythrophyll fades; and thus later in the autumn the most striking tints are the brighter or duller browns, characteristic of the different kinds of plants or trees.

As already named there are many different species of colouring matters belonging to the chrysotannin group, both of those which are, and of those which are not, closely related to the more typical kinds of tannic acid. So far I have not been able to ascertain whether there is any one particular artificial oxidising process which will in each case give rise to the exact products naturally formed in the leaves themselves; but on the whole there is such a close correspondence between them that we cannot hesitate in concluding that the rich brown tints of autumn are mainly due to the oxidisation of the previously-existing more or less pale yellow colour of the chrysotannin group—a conclusion fully borne out by various independent facts. The difference in kind of tannic acid, and the absence or presence of any considerable amount of a chrysophyll substance, explains in a very satisfactory manner the difference in the tint of the leaves of different trees. Thus, for example, the quinotannic acid found in a comparatively pure state in the yellow leaves of the beech is changed by oxidisation into the fine red-brown colour of those leaves at a later period. This kind of tannic acid also occurs in the elm, but is there mixed with more or less of a chrysophyll, which turns to a duller brown; and thus we find the leaves of different elm-trees vary in tint, and are often of very dull brown colour. The leaves of the oak and Spanish chesnut contain gallo-tannic acid, and this, when oxidised, gives rise to a dull tint, like that seen in the faded leaves of those trees; and similar principles hold good in other cases.

As far as we are able to judge from the various facts described above, we must look upon the more characteristic tints of the foliage of early spring as evidence of the not yet matured vital powers of the plant. In summer the deeper and clearer greens are evidence of full vigour and high vitality, which not only resists but also actually overcomes the powerful affinity of oxygen. Later on the vital powers are diminished, and partial changes occur, but the affinity of the oxygen of the atmosphere is nearly balanced by the weakened but not destroyed vitality. At this stage the beautiful red and yellow tints are developed, which produce such a fine effect in certain kinds of scenery. Then comes more complete death, when the affinity of oxygen acts without any opposition, and the various brown tints of later autumn make their appearance, due to changes which we can imitate in our experiments with dead compounds. This may not be a pleasing way of viewing an otherwise charming subject, but I think we must all admit that it is substantially true.

H. C. SORBY

HUMAN ANATOMY AND PHYSIOLOGY

The Physiological Anatomy and Physiology of Man. By Robert B. Todd, William Bowman, and Lionel S. Beale. A new edition by the last-named author. Part 2 of Vol. i. (Longmans and Co., 1871.)

THIS part corresponds to the third, fourth, and fifth chapters of the last edition; it is now divided into four chapters, one of which is devoted to a general consideration of the properties of tissue, and the others contain detailed accounts of the connective, cartilaginous, osseous, and adipose varieties. Dr. Beale seems to have spared no time or trouble upon the present part, which has been carefully revised throughout; a considerable amount of new matter has been added, and many parts, especially those relating to the development of the different tissues, have been entirely re-written.

The chapter on the forms of connective tissue is very full and complete, and compares very favourably with that in the last edition; descriptions of several well-marked varieties, which were before omitted, being now introduced, such as those occurring in the Whartonian jelly, the vitreous humour, and the cornea. With respect to yellow elastic tissue, Dr. Beale states that the fibres, usually considered to belong to it, which are found in tendons, and resist the action of acetic acid, are not of elastic nature at all, but are merely imperfectly-formed white fibrous tissue; and in his account of areolar tissue he strongly contests one of the most generally-received pathological doctrines of the day, that which supposes in many cases of degeneration that the interstitial areolar tissue of the organ is the active agent, becoming hypertrophied, and then contracting and compressing the structures in its meshes. Dr. Beale considers, on the contrary, that in most cases the areolar tissue is quite passive, and that the phenomena ascribed to it are really produced by the rapid multiplication of parts of white blood corpuscles which have passed through the walls of the blood vessels.

In his account of cartilage Dr. Beale dissents from the opinion held by some, that the capsule of a cartilage cell differs from the matrix in its origin and nature; he points out that in some cases there is no matrix, in others no cell-wall can be demonstrated as distinct from the matrix; and again, in others the capsule passes gradually into the matrix; and maintains that the matrix when present is entirely formed of old capsules, and is *not* developed independently of the cells. Fibro-cartilage and elastic cartilage are both well described; no mention at all of the latter form was made in the previous editions.

The chapter on bone contains a good account of its histological structure, but is chiefly interesting from the views put forward as to the mode of origin of the canaliculi. Virchow states that they are formed by the deposition of calcareous matter round processes radiating from corpuscles contained in the lacuna, while Kölliker thinks they are formed by resorption after the lacuna has been entirely surrounded by calcareous matter. Dr. Beale differs from both—he says the bone corpuscles of the lacuna have frequently no processes, and that when processes are present they are always much shorter and much less numerous than the canaliculi, and he points out that the formation of these little channels begins at their distal end, not at the end next the lacuna, as has been supposed; his own view is that in an early stage of the development of bone, it is all permeable to nutrient fluids, but that as calcareous matter is deposited this permeability gets restricted to constantly narrowing channels, which ultimately remain as the canaliculi, and are at first filled with soft matter (cartilage or membrane), which in fully formed bone dries and shrivels up, leaving the canaliculi as true tubes.

The concluding chapter, that on adipose tissue, is on the whole good, but in the account of its histological structure the impression is conveyed that an adult fat cell consists merely of an envelope containing oily matter—no mention being made of the fact that by proper treatment a nucleus also can be almost always demonstrated. Dr. Beale considers that the fatty matter contained in the cell is formed by the degeneration of the mass of "bioplasm," or "germinal matter," of which it was once entirely composed.

The part is illustrated by a large number of very good figures, and several full-page plates.

OUR BOOK SHELF

Elementary Treatise on Natural Philosophy. By A. Privat Deschanel. Translated and edited by Prof. Everett, M.A., D.C.L., &c., Professor of Natural Philosophy, Queen's College, Belfast. In Four Parts. Part 2.—Heat. (London: Blackie and Son.)

THIS work is intended to be an elementary treatise on the science of Heat. The remarkably fine engravings that embellish it throughout, give it an air of reality which, unfortunately, is not generally possessed by English scientific books. Still, some of the original engravings might have been improved; for example, figs. 223, 240, 245, and 264 are peculiar, and do not represent what is likely to be seen in the laboratory. Having said this much in favour of Prof. Everett's translation, we cannot avoid making some unfavourable criticisms. We decidedly object to the numerous formulæ and equations which may almost be said to disfigure many of the pages; they are not sufficiently explained for a popular work, and might have been more compressed if intended for advanced scientific students. And seeing that formulæ and explanations usually vary inversely as each other within the same volume, we should have been pleased—indeed, we expected—to find as many of the former eliminated as possible. This expectation was occasioned by the translator himself, who complained that oftentimes we are confronted with "unexplained formulæ, which burden the memory without cultivating the understanding." Can Prof. Everett assert that he has explained the formula on page 362 of Part 2? Has he not rather fallen into the very error which he so ably deplores in his preface; failing to see amid V, KT, and other algebraic mystifications, that his H and h are not directly comparable: that the mercury in Gay-Lussac's tube is hot, while a barometer is generally cool? A student of Nature will scarcely be taught much that is satisfactory concerning Gay-Lussac's beautiful method of determining vapour densities, by being led away at once into intricate formulæ "which burden the memory, without cultivating the understanding." This one example will sufficiently indicate the fault which runs through the whole volume before us. Much new and valuable matter, albeit besprinkled with formulæ, has been added by the translator; and various passages in the original have been modified or otherwise corrected. But, though we have no hesitation in saying that the original has been thereby improved, yet the final result is neither remarkable for its novelty, nor edifying from its simplicity.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his Correspondents. No notice is taken of anonymous communications.*]

Thickness of the Earth's Crust

I TAKE in NATURE in parts. Your part for May last has just reached me in Calcutta, and is somewhat rich on the question of the thickness of the earth's crust; for three of its four numbers contain letters on that subject. First, my letter to you, p. 28; two critiques upon it from "A. J. M." and Mr. Green, p. 45; and a third from Mr. David Forbes, p. 65.

Reply to "A. J. M." I do not think it safe to draw inferences from a comparison the members of which differ so materially; a plate of lamp oil, probably a quarter of an inch deep, and the solid crust of the earth resting on a fluid mass 3,856 miles deep, supposing the crust, according to the thin-crust theory, to be 100 miles thick. To be sure, the motion in the experiment is very much greater than precession; but the depth of fluid is also very different, and the cases are not parallel. Moreover, in the one case, the oil rests on the plate, weighed down by gravity, and is easily carried round bodily with the plate. This is different to the hard crust rubbing over a depth of fluid. I see the writer, like M. Delaunay, relies much on the extreme slowness of the motion. More on this soon. We shall have to beware how we adopt the phrase "a rope of sand," for if we use the rope *slowly* enough, it may become in our hands a "rod of iron."

Reply to Mr. Green. By "pushes" I did not mean mechanical knocks, but merely geometrical movements. The pole of the earth goes round the pole of the ecliptic in a circle in about 26,000 years. I divided this circle into a multitude of little pieces. Nor was my description meant to represent this motion as being by fits and starts, but only in portions, to assist the mind in a popular explanation, not of precession, but of the thing I wanted to be understood, the slipping of the hard crust over the fluid. I think it is very likely my own fault that my description has been misunderstood.

Reply to Mr. David Forbes. Mr. David Forbes glides out of the discussion on the plea, that after all I make out that Mr. Hopkins' calculations were based only on "an idea." But so is M. Delaunay's opinion based on an idea. We must start with an idea. Ideas are of two kinds, sound and unsound; and if the idea we rest upon is sound, we cannot possibly do better than build upon it. M. Delaunay thinks his idea is supported by an experiment. I have tried to find a description of the experiment, but without success. I altogether doubt whether any experiment with models can be devised to lead to trustworthy results, regarding such a huge mass as the earth affected by such slight motions as precession. Mr. David Forbes says he went to the Royal Society to hear a paper of mine read on the constitution of the solid crust of the earth. It was natural that he should suppose from the title, that it might bear upon this question of the thickness of the crust. But this is not the case at all, as he would find. M. Delaunay's strictures on Mr. Hopkins' investigation seemed to me so important, that I did *drag in*, I may say, an allusion to them in a note. It is very likely that, as my paper was almost entirely a calculation of mathematical formulæ and their numerical application to the pendulum observations lately made in India, the paper itself was not read aloud, and that conversation turned on the incidental note.

I propose now to view the subject in a new light, and to begin *de novo*; and I feel confident that your readers will see that there is more to be said for Mr. Hopkins' method than they have by this time been led to think.

The precessional motion is no doubt extremely slow: and that because the precessional force is extremely small. But the particles of the earth's mass have a good deal more to do in the matter than to partake of this small motion. Every twenty-four hours they have to undergo a strain, first this way and then that, such that I believe no fluid, however viscous, could sustain. Though the precessional force is so minute, it is the resultant or residuum of an almost infinite number of other disturbing forces nearly balanced; as I proceed to show.

Let G be any point in the earth's mass; b its distance from the centre; a the radius of the earth; c the distance of the sun; θ the angle between b and c; S the sun's mass. Then, considering the sun's action by itself, its attraction on G I resolve parallel and at right angles to c, and from the former position subtract the sun's attraction on the *disturbing* forces on G which are wanted. These are, neglecting the smallest quantities,

$$\frac{4\,S\,b}{c^3}\cos\theta \text{ and } \frac{S\,b}{c^3}\sin\theta.$$

For the sake of a name I will call the plane through the earth's centre, at right angles to the line joining it and the sun, the Boundary Plane, as it intersects the surface almost exactly in the boundary line between sunlight and darkness. It will be observed that at this plane the first of these disturbing forces equals zero, and is positive on the sun side of the plane, and negative on the opposite side. The amount of this force is the same at all points lying in any plane parallel to the boundary plane, and the aggregate of the positive forces on the one side, and of the negative on the other, would be in each case a force acting through the earth's and sun's centres, but for the slight deviation of the earth's figure from a sphere, and the consequent arrangement of its mass. Suppose, for argument's sake, that the particles of the earth's mass are held invariably together as a rigid body; then the disturbing forces parallel to c will amount to an aggregate positive force, and an aggregate negative force, tending to separate the two parts of the earth formed by the boundary plane. These forces are equal to each other, and pass nearly through the earth's centre, at opposite and equal distances from it. They form, in fact, a mechanical "couple," and twist the earth round some diameter lying in the boundary plane. The arm of this couple is a minute quantity depending upon the ellipticity of the earth's figure. Hence the movement of the couple, from which precession and nutation arises, is a minute quantity, while the *force* of the couple (which is the tension of the earth's mass perpendicular to the boundary plane) is not of that minuteness. The other disturbing forces, represented by the second formula, all tend towards c, and compress the mass. They would all balance each other, were the earth spherical. The resultant of these forces on the sun side will be a minute quantity of the order of the ellipticity, and will act at a certain distance from the centre; and the resultant on the opposite side will be an equal force, acting at an equal distance from the centre, but in an opposite direction; so that again there will be a couple of minute power, assisting with the other couple to produce the combined motion of precession and nutation. In this case, although the forces nearly balance each other on each side the boundary plane, parallel to it, and but a small resultant follows, yet the particles of the mass have to undergo the compression from opposite sides, as in the other case they have to sustain the tension caused by the opposing forces tending to separate the two halves of the earth.

The moon will produce forces precisely similar to these, and a little more than twice their amount. The forces of the sun and moon do not come to their maxima and minima at the same time, except at new and full moon. At other times they partly conspire or counteract each other according to their position. Sun and moon together will produce most irregular cross-strains through the mass, if the particles are held together by any degree of rigidity.

It will be seen, then, that as within twenty-four hours *every* particle of the mass in its rotation is carried through the boundary plane *some* days in the year, and most of the particles every day, every part of the mass will be periodically subject to the maximum strain I have described as taking place at that strain, and most parts twice a day, as well as the compressing force at right angles to c.

The same will be the case, and at different times, except at new moon and full moon, at the boundary plane appertaining to the moon. The result is that all parts of the mass are perpetually undergoing considerable cross-strains, for the forces of tension and compression will not relieve each other, as they act at right angles to one another.

If the mass of the earth were not rigid, but sufficiently elastic, like, for instance, a globe of india-rubber, the particles would yield to their small disturbing forces; and the result would be that each particle, as it arrived by rotation at each point of its circuit, would move in proportion to the force acting on it, one way or the other. In this case there would be nothing to cause the axis to move; the earth would steadily revolve, and no precession or nutation would occur. The whole mass would, as it were, breathe, heaving its surface and drawing it in again in a complicated undulation.

But observation shows that the earth *has* precession and nutation; and therefore the mass cannot be thus elastic.

If it be only partially rigid, then there would be a corresponding degree of yielding; but precession and nutation would still be produced, and a strain, in a somewhat diminished degree, affect the mass

Now, mathematical calculation made on the hypothesis of the earth's mass being absolutely rigid, and that throughout, shows that the annual precession would be 51·3566".* Astronomical observation shows that the precession is actually 50·1". The remarkable nearness of these results is sufficient proof that the earth's mass is not the limp thing some take it to be; all viscous-fluid from only 100 miles down to the centre, moving so slowly, that it gives inertia to the hard crust (supposed thin) as if it were all solid! It is more like the highly rigid mass which Sir William Thomson has shown it to be from other considerations. JOHN H. PRATT

Calcutta, July 15

Meteorology in South Australia

As it may be interesting to some of your English readers to hear something of natural phenomena in such an out-of-the-way part of the world as South Australia, I forward a description of three very fine meteors which have lately been seen here, as well as a splendid display of Aurora Australis.

On January 5th, 1871, at about half-past nine P.M., I observed a splendid meteor. It appeared at first like a fixed star about three times as large as Jupiter, or say six or seven inches in diameter, and was probably about 15° above the horizon, or nearly of the same apparent height as a large star which was just below the planet Jupiter, a little to the west of him and within half an hour of the meridian. The meteor, which was very brilliant, somewhat of the appearance of Jupiter, remained apparently stationary for, at least, five seconds; it then gradually began to move from a due north position to a direction about S. S. E., and in a horizontal line; it then burst into several smaller meteors and went out, having lasted fully twenty seconds altogether. The moon was shining brightly at the time, being a few days off the full.

On the same night, and at about the same hour, a large meteor was seen by a survey party at Hookina, a place about 400 miles north of Adelaide. The surveyor in charge of the party (Mr. Hamilton) from whom I obtained the particulars of this meteor, says he was facing the east when he observed it going from N.E. to S.E., describing a large arc at an apparent elevation of 20°. He describes its colour as greenish, and so bright that it almost overpowered the light of the moon. It ultimately burst with a loud explosion into a number of fragments of red and blue colours, and the earth was felt to tremble as though a shock of an earthquake had occurred.

On the 25th March last, at about twenty minutes to three o'clock in the afternoon, I observed a meteor in the full blaze of the sun. It appeared like a bright brass-coloured ball of fire, shooting through the sky like a rocket; it seemed to have a green and blue light round a central brass-coloured nucleus. The meteor appeared about three inches in diameter; it had a whitish comet-like tail, about three feet long, and it came from the N.N.E. and travelled downwards towards the S.S.W., so that as I was looking south it appeared to come over my left shoulder. It lasted about ten seconds, then burst without noise, and became dissipated. This meteor seemed to fall at about 15° from the horizon.

In the S. A. "Register," a few days after seeing the last described meteor, it was stated that a surprising sound was heard at Point Macleay, and other places about fifty or sixty miles to the south-east of Adelaide as of the firing of cannon, and the correspondent of that paper at Mannum (a place on the River Murray, about sixty miles east of Adelaide) writes as follows:—

"On Saturday last (25th March) at exactly 2.45 P.M., I was looking down the Murray River, when suddenly my attention was attracted by a large ball of fire falling from the heavens in almost a perpendicular course. The lakes are from here in the direction which it indicated—almost due south—so that I have no doubt the extraordinary phenomenon mentioned as having occurred on the shores of Lake Alexandrina, may have arisen from one of the causes assigned, viz., a falling meteor or an aerolite. What I saw was evidently the explosion immediately preceding the fall, and it presented the appearance of a luminous meteor." . . . .

The display of "aurora australis" which I observed on the 23rd March last, commenced at about eight o'clock P.M. It increased in brightness till eleven o'clock, when it gradually faded away. At about two o'clock A.M., while at a ball, I came out on the balcony and observed the whole southern sky lighted up by a most gorgeous display of aurora. It occupied about 70° or 80° of the horizon, extending from about S.S.E to S.W., and reached to a height of say 60° above the horizon. It was of a splendid red rose colour and streaked with beams of white light at various distances apart—say two bands of white in every 10°. These white bands appeared about two feet to five feet wide, which would answer to say 5° observed by the eye alone. The display was so bright that by placing my hand with the fingers apart at about two feet from a lady's white dress, I could distinctly see the shadow of each finger. This aurora was also seen in Victoria and New South Wales.

I may mention that Adelaide is situated in south latitude about 35°, and longitude 138° 40' M. M. FINNISS

Adelaide, June 19

The Solar Aurora Theory

IN the very interesting lecture of Mr. Lockyer upon the recent solar eclipse which has just appeared in NATURE, he says, speaking of the green line layer above the hydrogen, "Here obviously we have, I think, merely an indication of another substance thinning out, in spite of the extraordinary suggestion which was put forward that the corona was nothing but a *permanent solar aurora.*"

I agree entirely in this view except as to what would seem to be implied by the expression *in spite of.* I fail to see any inconsistency between the idea of a substance "thinning out" and a permanent solar aurora.

What I intended in adopting and endorsing this auroral hypothesis was simply this: to express the belief (which I still hold, though with no great tenacity) that the substance which composes this green-line layer is also found in the upper regions of our atmosphere in a state of almost inconceivable tenuity, and at an elevation of certainly more than one hundred miles; and, further, that the peculiar filamentary and radiant structure of the corona, and very possibly its luminosity to some extent, are due to solar forces closely analogous to those which produce our terrestrial auroras.

Or in other words, that an observer, at the planet Mars for instance, looking at the earth during a period of auroral activity would see its poles capped by a corona in substance, structure, and to some extent in origin, closely analogous to that which is permanent around the sun.

And if we grant the identity of the 1474 line with that which is, to say the least, so closely coincident with it in the auroral spectrum, it is difficult to see why the hypothesis should be considered "extraordinary," or *per se* improbable.

That the enormous chemical, thermal, luminous, and magnetic activity of the solar surface should be unaccompanied by manifestations of what we call electric energy seems far more unlikely than the contrary; and if such energy operates we should naturally look for phenomena, the counterparts of those by which it shows itself here, but on the *solar* scale of course.

As to the identity of these lines, however, there may fairly remain some doubt. This line in the spectrum of the aurora is so rarely seen, so faint, and so difficult of observation, that, although the few observations thus far obtained show even a surprising agreement with each other and with this idea, it is safer to maintain a cautious reserve. C. A. YOUNG

Dartmouth College, U.S.A., August 16

* See this worked out in my "Mechanical Philosophy," 1st edit. p. 562, 2nd edit. p. 540.

Lecture Experiments on Colour

FOR some time I have been taking an active interest in the phenomena of colour, and have read with much pleasure the papers of Mr. Strutt and other gentlemen, and the abstract of the interesting lecture recently delivered at the Royal Institution by Prof. Maxwell. I have repeated many of the experiments of these observers, and have successfully exhibited them in public in a modified form, and in a way which can be readily repeated by other lecturers without the aid of the elaborate contrivance used by Prof. Maxwell. The following experiments make no pretension to rigid accuracy, but are merely described as striking lecture-table demonstrations of well-ascertained but little known scientific facts. I use the lime light for their exhibition, as it suits my convenience better than the electric light, though many lecturers prefer the latter.

A beam of light from the lantern is passed through a slit, focussed by a lens, refracted by a disulphide of carbon prism, and the spectrum exhibited in the usual way. A flat cell containing a solution of potassium permanganate is next placed in front of the slit. With a weak solution and narrow slit a series of black bands are produced in the green part of the spectrum, but with a stronger solution the green and yellow are completely cut out, allowing only the red and deep blue lights to pass. On widening the slit these bands of coloured light of course increase in width also, gradually approaching each other until they overlap, producing a fine purple by their admixture.

If the experiment be repeated, substituting for the permanganate an alkaline mixture of litmus and potassium chromate in certain proportions, only the red and green light are transmitted, the blue, and especially the *yellow*, being completely absorbed. On widening the slit as before, the red and green bands overlap, and produce by their union a very fine compound yellow, while the constituent red and green are still visible on each side. The effect is most striking when by the widening of the slit a round hole is exposed in its place, when there appear on the screen two circles, respectively green and red, producing bright yellow by their admixture. This experiment is the more striking as it immediately follows the process of absorbing the simple yellow. The mixture above described (suggested by Mr. Strutt) answers better than a solution of chromic chloride.

Of course, it is a well-known fact that all natural yellows give a spectrum of red, yellow, and green, and a common effect illustrating the compound nature of yellow is noticed when exhibiting a continuous spectrum on a screen. When the slit is narrow the green is very fully developed, and only separated from the red by a very narrow strip of yellow, while on gradually increasing the width of the slit the red and green are seen to overlap, producing the brilliant yellow we generally notice. Thus the purer the spectrum the less yellow is observed.

If the continuous spectrum be produced with a quartz prism, a little management and adjustment of the distance of the screen will cause the two spectra to overlap, so that the red of one may be made to coincide with the green, blue, or any desired tint of the other. The same result is obtained by employing two slits at the same time, the distance between which can be adjusted. By this means two spectra are obtained simultaneously, any portions of which can be made to coincide.

I have not tried to use a double refracting Nicol's prism, as is suggested by Mr. Strutt in the number of NATURE for June 22.

A saturated solution of potassium chromate absorbs all rays more refrangible than the green, while a solution of ammonio-sulphate of copper stops all *but* the blue and green. These statements may be proved by placing flat cells containing the liquids in front of the slit of the lantern, and on placing one cell in front of the other in the same position the green light only is transmitted. This experiment serves to explain the reason that the mixture of yellow and blue generally results in green, all other rays being absorbed by one or other of the constituents.

By placing the two cells in front of separate lanterns, and throwing discs of light on the screen, a beautifully pure white is produced where the blue and yellow overlap.

I employ one lantern only for this experiment, using *two* focussing lenses side by side to produce the overlapping circles of light.

I also employ a cell with three compartments, containing solutions of aniline red, ammonio-sulphate of copper, and a mixture of potassium chromate with the last solution, and projecting images on the screen by means of three lenses fitted on the same stand but capable of separate adjustment. I can thus exhibit overlapping circles of brilliant red, blue, and green light, which produce a perfect white by their admixture, while at the same time there is seen the compound yellow produced by the union of red and green, the purple arising from the red and blue, and a colour varying from grass green to sky blue produced by the combination of the green and blue light. This experiment has the advantage of exhibiting *at the same time* the three primary colours—red, *green*, and blue—the compound colours produced by their mixture, their complementary tints, and the synthesis of white light.

The flat cells mentioned are made by cutting thin pieces of board to the desired shape, and cementing pieces of window glass on each side by means of pitch.

Sheffield, June 26 ALFRED H. ALLEN

Mr. Stone and Prof. Newcomb

I AM sorry, indeed, that anything in my answer to Prof. Newcomb should be unsatisfactory to Mr. Stone. It will certainly be hard if after drawing upon myself Prof. Newcomb's indignation by advocating Mr. Stone's claims, I should find that I have unwittingly offended Mr. Stone also.

It is the misfortune of a writer on science that he has often to deal with overlapping claims; and when he adheres unflinchingly (as I have always done) to what he regards as the strict line of truth, he cuts off a little from the claims on either side, and so offends both claimants. I have found myself in the same difficulty as respects the work of Dr. De la Rue and Fr. Secchi, in 1860, and I fear the result may have been the same in that case also.

In another case, that of Mr. Lockyer and his fellow-workers in spectroscopic solar researches, I freely admit that what I regarded as the line of truth when I wrote "The Sun," I now no longer regard as strictly such, evidence having been produced which has satisfied me to that effect. Even in this case, however, I have in the first place very little to correct, and in the second I am by no means certain that I shall be able to satisfy all or any of those concerned.

Fortunately or unfortunately, the writer who cannot please all proves equally his desire to do justice to all by leaving all dissatisfied. This is commonly the fate of the true neutral. I must confess, however, that I cannot see what reason Mr. Stone has for being dissatisfied, since I have ascribed to him, much to Prof. Newcomb's dissatisfaction, the final and complete solution of a problem which both have dealt with very ably. I am still waiting to hear the nature of Prof. Newcomb's objections. Whatever they may be, I am assured of *this*—that in defending (if I can defend) my own work, I shall be advocating Mr. Stone's claims. I hope that in so doing I shall not very grievously offend that gentleman, towards whom I entertain the most friendly feelings.

RICHARD A. PROCTOR

Saturn's Rings

THE reviewer of Lieut. Davies's work on Meteors has somewhat misunderstood the extent to which I have been indebted (in preparing my treatise on Saturn) to Prof. Maxwell's excellent "Essay on the Saturnian Ring-System." I have quoted in all two and a half lines from that essay, with proper reference to it, and I have devoted one-third of a page to summarising the most important section of the essay. All the rest of my chapter on the Nature of the Rings was written before I had seen Prof. Maxwell's contribution to the meteoric theory of the ring-system. I may add that every result in Saturn, which is not distinctly referred to authority, or else obviously common property, has been worked out by myself, as my note-books will abundantly testify. RICHARD A. PROCTOR

Brighton, August 28

A Rare Phenomenon

SUNDAY, the 13th August, and several days before, having been very hot and dry, a great deal of dust was suspended in the atmosphere, which caused without doubt the intense red colour of the setting sun, and might contribute to the phenomenon I am about to describe. This phenomenon may easily be understood by means of a globe bisected by a meridian plane, one half of it representing the celestial vault. Beginning at the eastern end of the equator, the space between the 40th and 50th degree of longitude may be tinged with reddish grey; then the space between the 60th and 75th degree, further, that between the

85th and 105th, and finally that between the 115th and 140th degrees. But the intensity of colour must vary inversely to the breadth of the stripes, and the three stripes left between the red ones be filled with a pretty vivid blue. This hemisphere placed upon a table with its southern pole pointing towards sunset will afford a tolerable portrait of the aspect of the sky as it appeared immediately after sunset, and continued unchanged for more than a quarter of an hour. The stripes were not visible near the horizon, but were very distinct at an altitude of about fifteen degrees, and almost disappeared about the zenith. No cloud was seen during the occurrence of the phenomenon.

These stripes were certainly parallel in reality, and their apparent divergence may be accounted for by perspective. The reddish stripes may owe their colour to sunlight reflected back from the particles scattered in the atmosphere. But why did the celestial vault show so distinct a blue colour in the intervening bands? Yet, probably, this phenomenon is more easily to be explained than the infinite variation of evening colourings that want a valid explanation to this day.

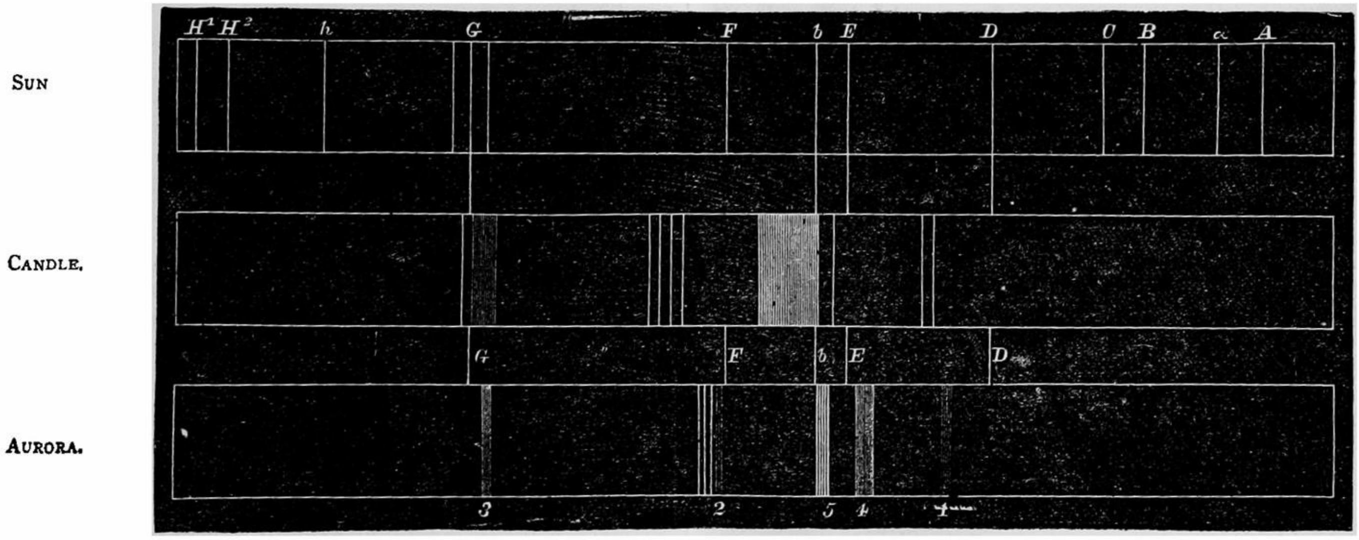
Magdeburg, August 19 A. SPRUNG

THE AURORA

THERE was a very fine display of aurora here on the night of the 21st. It commenced to be visible about 9.30 P.M., reached its maximum about 11, and faded suddenly away about 11.30. In appearance it was of a silvery white, without a trace of that rose colour which characterised the three great displays of last autumn. The main portion of the light was in the north-western quarter of the heavens, and it was sufficiently strong to see large print by. Extending from the north-west and reaching the north-eastern horizon arose three luminous arches concentric with each other, the 1st about 15° altitude, the 2nd about 25° altitude, and the 3rd about 40° altitude. These were connected by radial tongues of light which were ever changing their height. There was another marked and isolated nucleus about and around α Lyræ.

At about 10.45 P.M. there were most curious rays shot up from the arches in the north, and concentric with them These shooting arches, if I may call them so, had at the horizon an apparent angle of about 150° to 180°, but as they approached the nucleus in Lyra, they contracted and lost themselves in sheets of white light. On applying the spectroscope I found one bright line visible all over the heavens excepting on the south horizon for an altitude of about 25°. The spectrum obtained on the north-west gave five bright lines, of which I send a drawing.

From want of convenient measuring apparatus I had resource to the method of superposed spectra. The light I chose for comparison was that of a tallow candle, from which I got the bright lines of sodium and carburetted hydrogen. The instrument I used was one of Browning's direct vision spectroscopes—an instrument that gives the best results with the minimum amount of light. Of the bright lines, two were strong, one was medium, two were very faint. In the accompanying map I have put the solar spectrum at the top and carried the chief lines down for comparison. In putting numbers to the lines I have been directed by their degrees of intensity.



COMPARISON SPECTRA OF SUN, AURORA, AND CANDLE

No. 1 is a sharp, well-formed line, visible with a very narrow slit.

No. 2. A line very slightly more refrangible than F. The side towards D is sharp and well-defined, while on the other side it is nebulous.

No. 3. Slightly less refrangible than G, is a broad ill-defined band only seen with a wide slit.

No. 4. A line near E, woolly at the edges, but rather sharp in the centre. This should be at or near the position of the line 1474 of the solar corona.

No. 5. A faint band coincident with *b*, extending equally on both sides of it.

The barometer stood at 29·574 in.; the thermometer at 61°·3. A gentle wind was blowing from the south-west, and the sky was free from clouds.

Observatory, Dun Echt, Aberdeen LINDSAY

FRUIT CLASSIFICATION *

DR. DICKSON referred to the confessedly unsatisfactory state of fruit-classification, and to the very unnecessary extent of the existing terminology, which is further complicated by a considerable amount of variance among botanists as to the precise application of several of the terms employed. He was of the opinion, which he believed to be a growing one among botanists, that the most convenient method of classification was, in the first place, rigorously to restrict the definition of a "fruit" to the mature or ripe pistil, excluding from that definition the modifications of accessory parts or organs, which, in many cases, are correlative therewith; and, secondly, to base the primary classification upon the general character of the modification undergone by the parts of the pistil in ripening, treating as of minor importance the characters involved in the description of the flower, such as the superior or inferior position of the ovary, &c.

The classification which Dr. Dickson suggests for the consideration of botanists approaches most nearly to that indicated by Schacht in his "Grundriss," of which, indeed, it may be viewed as a modification and expansion. Schacht grouped fruits under three heads—(1) Capsular fruits which dehisce to allow the seeds to escape; (2) splitting fruits or Schizocarps, which

* "Suggestions on Fruit Classification." By Alex. Dickson, M.D.; Regius Professor of Botany in the University of Glasgow. Read before the British Association, 1871.

break into pieces which do not allow the escape of the seeds; and (3) fruits which neither dehisce nor fall into indehiscent pieces, including Berries, Drupes, and Achenes. As this last group is very heterogeneous, Dr. Dickson prefers to consider Berries, Drupes, and Achenes severally, as forms of equal value with Capsules or Schizocarps, and therefore would divide fruits into five groups, viz., "Capsules," "Schizocarps," "Achenes," "Berries," and "Drupes," as will be seen in the following table:—

I. CAPSULE — Dry, dehiscing, to allow the seeds to escape.	Simple. (Probably the two forms included under this head should be embraced by a single term.)	1. *Follicle.*—Dehiscing by one suture, usually the ventral: *e.g.*, Aquilegia, Caltha, Magnolia.
		2. *Legume.*—Dehiscing by both sutures: *e.g.*, Cytisus, Vicia, &c.
	Compound.	3. (Name wanted) Seeds escaping by longitudinal rupture of the wall of the capsule (dehiscence by valves, teeth, or pores): *e.g.*, Brassica, Viola, Rhododendron, Iris, Lychnis, Papaver, Campanula, &c.
		4. *Pyxidium.* — Seeds escaping by transverse rupture of the wall of the capsule (dehiscence circumcissile): *e.g.*, from superior ovary, Anagallis, Plantago, Hyosciamus, &c.; from inferior, Bertholletia, &c.
		5. *Regma.*—Seeds escaping by rupture along the inner angles of the lobes into which the fruit separates: *e.g.*, Geranium, Euphorbia, &c.
II. SCHIZOCARP. —Dry, breaking up into indehiscent pieces.	Breaking longitudinally into indehiscent cocci.	6. *Carcerulus.*—Lobes not hanging from forked "Carpophore:" *e.g.*, Tropæolum, Borago, &c.
		7. *Cremocarp.* — Lobes separating from below, and, for a time, hanging from extremities of forked "carpophore:" *e.g.*, (from superior ovary) Acer, and (from inferior ovary) *Umbelliferæ*.
	Breaking transversely into one-seeded joints.	8. *Lomentum.*—*e.g.*, Ornithopus, &c.
	Breaking first longitudinally, then transversely	9. (Name wanted) *e.g.*, Platystemon.
III. ACHENE. — Dry, indehiscent, not breaking up. (Probably the names applied to the different forms should be abolished and the term Achene applied to all.)	Superior.	10. *Achene* (in restricted sense.—Pericarp not adherent to seed: *e.g.*, Ranunculus, Rumex, Ulmus, Fraxinus, &c.
		11. *Caryopsis.*—Pericarp adhering to seed: *e.g.*, Gramineæ, &c.
	Inferior.	12. *Cypsela.*—Pericarp not much indurated: *e.g.*, *Compositæ*, *Valerianaceæ*, &c.
		13. *Glans.*—Pericarp hard: *e.g.*, Quercus, Castanea, Fagus, Corylus, &c.
IV. BERRY. — Seeds imbedded in pulp. As a rule indehiscent.	Outer portion of pericarp delicate (thin-skinned).	14. *Uva* —Superior: *e.g.*, Vitis, Solanum, &c.
		15. *Bacca* (in restricted sense).—Inferior: *e.g.*, Ribes, Vaccinium, &c.
	Outer portion of pericarp firm, leathery, or hard (thick-skinned).	16. *Amphisarca.* — Superior: *e.g.*, Adansonia, Passiflora, &c. (Citrus should be included here.)
		17. *Pepo* —Inferior: *e.g.*, Cucurbita, Cucumis, &c. (Punica should be included here.)
V. DRUPE. — Endocarp distinctly defined & more or less indurated. Outer portion of pericarp of variable consistence— fleshy, leathery, or fibrous. As a rule, indehiscent.	One-stoned. (Probably the two forms included under this head should be embraced by a single term.)	18. *Drupe* (in restricted sense).—Superior: *e.g.*, Prunus, Cocos, &c.
		19. *Tryma* —Inferior: *e.g.*, Juglans, Viburnum, &c.
	Two or more stoned. (Probably the two forms included under this head should be embraced by a single term.)	20. (Name wanted) Superior: *e.g.*, Ilex, Empetrum.
		21. *Pome.*—Inferior: *e.g.*, Pyrus, Cratægus, Sambucus, &c.
	With one plurilocular stone.	22. (Name wanted) *e.g.*, Cornus.

As the modifications undergone by the fruit in ripening stand in direct relation to the dispersion of the parts by which the plant is disseminated, probably the most philosophical method of classifying fruits would be according to the nature of the parts disseminated. To carry out this principle rigorously, however, would lead to practical difficulties, far outweighing any advantage gained. At the same time, it is evident that the foregoing classification satisfies, in a general way, the conditions of such a method; thus, in capsules and berries, the *seeds*, as a rule, are the ultimate parts disseminated; in Drupes, the *stones;* in Schizocarps, the *mericarps* or *joints*; and in Achenes, the *fruits as wholes.* As refractory exceptions, however, may be mentioned, those cases where the seed *minus* its testa is the part ultimately disseminated, for example, in *Oxalis*, where, on dehiscence of the capsule, the elastic testa becomes ruptured, violently expelling the body of the seed with the tegmen; or in the so-called drupaceous seeds (*e.g.* in *Punica*) which are doubtless devoured by birds, and, after digestion of the pulpy testa, the body of the seed with the hard tegmen is evacuated, and dissemination occurs. Or, again, in such a drupe as the apple, where the induration of the endocarp is slight, we have the fruit behaving as a berry, and dissemination taking place by means of the seeds.

Some botanists may perhaps be surprised to note the omission of the terms *siliqua* and *silicula*, so universally employed to designate the fruits of *cruciferæ*. A little reflection, however, is sufficient to make it evident that, if distinctions so trifling in character, as those which separate these fruits from other valvular capsules, were consistently carried out in practice, the terminology would become altogether intolerable. A similar argument may be adduced in favour of the suggestion made in the foregoing table, as to the propriety of devising some common term which will supersede those of *follicle* and *legume*.

NOTES

WE are happy to say that the Eclipse Committee has been perfectly successful in its attempt to send a complete set of instruments to Australia; and a code of instructions is being drawn up in order to ensure similar observations being made at all stations.

IT is now announced that the Swedish Government has abandoned the intention of establishing a colony in Spitzbergen for permanent scientific observation, mainly, it appears, in consequence of jealousies on the part of the Russian Government.

THE autumn meetings of the Iron and Steel Institute were commenced at Dudley on Tuesday morning, under the presidency of Mr. Henry Bessemer. About 250 members of the Institute were present, and during the course of the proceedings, the secretary announced that forty-seven new members had been elected, amongst whom were the Earl of Dudley, and Sir Antonio Brady, of London. The President, in opening the meeting, described the locality in which it was assembled as one of the most interesting districts this country presented to the iron manufacturers—a district, indeed, in which they might say that the great iron industry took its rise; its very cradle and birthplace. Mr. H. Johnson, mining engineer, read a paper "On the Geological Features of the South Staffordshire Coalfield, in Special Reference to the Future Development of its Mineral Resources." The South Staffordshire coalfield, one of the oldest in Great Britain, he said, was remarkably rich in coal, ironstone, and limestone. The secretary then read a paper by Mr. John Giers, Middlesboro', "On the Ayresome Ironworks, Middlesboro', with Remarks upon the Alteration in the Size of Cleveland Furnaces during the last Ten Years." A paper was read by Mr. Thomas Whitwell, Thornaby Ironworks, Stockton, "On further Results from the Use of Hot Blast Fire, brick Stoves." Mr. T. W. Plum, Shifnal, Salop, read a paper "On the Advantages of increased Height of the Blast Furnaces in the Midland District." The last paper was read by Mr. J. Lowthian Bell, Newcastle, "On Mr. Ferries' Self-coking Furnace." A large party then proceeded by train to Tipton, where the ironworks between that town and Wolverhampton were visited, and a pleasant afternoon was spent in investigating the mechanical processes in some of the largest works of South Staffordshire. The meetings conclude on Friday.

IN his last weekly return, the Registrar-General refers to the westward advance of Asiatic cholera as investing with more than ordinary interest Dr. Frankland's usual monthly report upon the quality of the metropolitan water supply. The water supplied by the New River and Kent Companies is again reported freest from organic impurity, that of the East London and Chelsea Companies the most impure. With reference to the advantage which would be derived from a general application of Dr. Clark's softening process to the London water supply, the Registrar-General adduces the following valuable facts, which have been communicated by Mr. Robert Rawlinson, C.B., C.E. :—"The average daily water supply to the metropolis was 111,292,104 gallons in June, and 112,107,697 gallons in July. Now in each million gallons of these waters there is about one ton of bi-carbonate of lime, or 111¼ tons in June and 112 in July. About two-thirds of this weight of lime or chalk would be removed by Dr. Clark's softening process—that is, in June 74 tons, and in July about 75 tons. In each year about 25,000 tons of useless lime would be removed from the metropolitan waters by the simple and easy process now in use at Canterbury." The Registrar adds: "This riddance of the foreign matter, which deprives water of some of its cleansing properties, is in itself an advantage; but, besides this, the fine precipitate of chalk carries down with it suspended impurities and probably frees it from choleraic and other contagions. It is a most effective filtration." It is a comfort to know that the working classes are beginning to feel their strength. When that is put forward it is certain to be in the direction of sanitary and educational measures. The Registrar-General appends to his report a concise sketch of the steps proper to be taken in view of the threatened epidemic.

A CORRESPONDENT at St. Andrews informs us that Professors Helmholtz, Huxley, Sylvester, Peters, Tait, Wyville Thomson, and Crum Brown, with several other *savans*, are now in that city, where there appears to be a sort of after-glow of the British Association. Our correspondent remarks on some points of interest in connection with the recent meeting of the Association. There was an unprecedented number of senior and second wranglers and Smith's prizemen in attendance in Section A. Among these we may mention, not vouching, however, for the completeness of our list, Prof. Helmholtz and Baron Liebig, M. Dumas, and Profs. Poggendorf, Bunsen, and Hofmann, all expressed great regret that they were unable to attend. Among other distinguished men present under circumstances, in some cases, of great difficulty, were Prof. Delffs, of Heidelberg, Dr. Baunhauer, of Haarlem, Drs. Anderson, Stenhouse, and Apjohn, Prof. Williamson, and others.

A CORRESPONDENT of the *Times* writes that on Monday, at 3.45 A.M., while at Worthing, he felt a distinct shock of earthquake. "My first impression," he says, "was as if some person in the room above had fallen heavily on the floor, again and again. A second followed in about a minute and a half, but of less violence; each was accompanied by a low murmur as of a distant waggon. Again last (Tuesday) night, shortly before midnight, another but slighter shock was felt. On the first occasion many people were much alarmed, and, until able to compare notes, attributed the unusual sounds to a variety of causes. One gentleman drew a sword and searched his house for burglars. A family of unprotected females found relief in hysterics; but, almost to a minute, all were agreed in their statement of the time of the disturbance."

LATE advices from Captain Hall's expedition in the *Polaris* state that the party reached Newfoundland in good condition, and was received with the utmost attention by the authorities. Captain Buddington, the sailing and ice-master of the expedition, has resigned, and will probably be replaced at Disco by Captain Richard Tyson. The United States frigate *Congress* has left New York with additional supplies of provisions, coal, &c., for the *Polaris*, and will proceed by the most direct route to the depôt agreed upon in Greenland. A number of persons accompany this vessel, among them Mr. Bryan, the astronomer of the expedition, and several gentlemen who will return in the *Congress*.

THE total expenses of the Mont Cenis Tunnel amount to 65,000,000f., of which 20,000,000f. are to be contributed by the Railway of Northern Italy, and more than 25,000,000f. by the French Government. The masonry of the tunnel is reported to be excellent throughout, and no inconvenience whatever from smoke, steam, or mephitic air is apprehended.

SIR R. MURCHISON has received a letter from Dr. Kirk, British Consul at Zanzibar, in which he states that Dr. Livingstone is moving slowly but safely, evidently feeling his way, and "determined to leave little doubts behind him this time."

AN association for the promotion of scientific instruction among the working classes, in connection with the Government Science and Art Department, has been formed at West Bromwich, and on Monday evening the movement was formally inaugurated at a meeting held in the schools in Bratt Street. The classes will open shortly for a winter session.

CO-OPERATION on the part of the Dominion of Canada in the storm-signal observations of the United States commenced on the 15th of last month. Telegraphic reports and communications will be made from a number of stations in the Province of Quebec, and published from Washington with the regular series, the observations from the United States being telegraphed back in return. Dr. Smallwood, the well-known meteorologist of Montreal, is in charge of a central office in that city, where the local reports are to be concentrated, and whence they are to be communicated to Washington, and to whom the returns are to be transmitted.

A NATURAL science demyship, of the annual value of 95*l*. and tenable for five years, will be awarded at Magdalen College, Oxford, in October next. The examination will commence on October 3, and candidates must call on the president on the day previous. This examination will be held in common with Merton College, where a Postmastership, of the annual value of 80*l*. for five years, will be awarded at the same time and with the same papers. Each candidate will be considered as standing in the first instance at the college at which he has put down his name, and, unless he has given notice to the contrary, will be regarded as standing at the other college also.

THE Zoology Exhibition, value 40*l*., for two years, at the preliminary Scientific and 1st B.Sc. examinations of London University has this year been obtained by Mr. J. C. Saunders, of Downing College, Cambridge.

DR. H. ALLEYNE NICHOLSON has resigned his Lectureship on Natural History in the Extra-Academical Medical School of Edinburgh, and is now in Toronto.

AN expedition for botanical purposes is in course of formation to the summit of Mount Bellendenker and the Endeavour River in Queensland. This mountain is situated on the east coast, near Cape Grafton, and nearly opposite the head of the gulf of Carpentaria, and the Endeavour River is a little farther north. It is the highest mountain on the Queensland coast. It is very probable that many new plants will be found in the course of this expedition, as the country is almost virtually unexplored. The last explorer was Kennedy, who was killed twenty years ago. It was in the Endeavour River that Captain Cook landed and cleaned his vessel after the discovery of the Torres Straits.

Now that the so-much-dreaded cholera is rapidly approaching our shores, it behoves everyone to be able to recognise the preliminary symptoms of the disease and to guard against them. We would therefore most strongly recommend all who can to read a most valuable and instructive paper by Mr. John Murray, the Inspector-General of Indian hospitals, on "Cholera : its Symptoms and Early Treatment," which was read at the recent meeting of the British Medical Association at Plymouth. It would be a very great boon to society, and probably the saving of many lives, if this paper could be published as a penny pamphlet.

THREE exhibitions, giving free education, and tenable in the department of General Literature and Science, or in that of Engineering and Technical Science, will be open to new students at the Hartley Institution, Southampton, at the commencement of the autumn term next month.

AN earthquake took place in Chiriqui in the State of Panama on the 26th June, at 7.50 P.M. It was rather severe, but no damage was done.

THE U.S. sloop of war *Jamestown* sailed from Valparaiso on the 3rd June, to determine the position of certain reefs and islands reported to have been discovered between the Equator and 24° N.

THE district round Wagga-Wagga, in Australia, was disturbed on June 8 by a somewhat violent earthquake shock ; and, owing to the rarity of the occurrence of such phenomena, it has caused much interest. The shock consisted of a succession of sharp but continuous vibrations, lasting altogether for about twenty seconds, the motion appearing to be from the N.W. to the S.E. There was felt, at 16 minutes to 3 P.M. (local time), a slighter second shock, preceded like the first, by a dull rumbling sound.

IN a letter to the *American Journal of Science and Art*, Dr. B. A. Gould reports satisfactory progress with respect to the Cordova Observatory. Although the enterprise has met with an exceptional amount of obstacles, Dr. Gould, who writes on the 26th of April last, expected to begin the mounting of the instruments in the course of a few days. We shall probably recur to his interesting communication.

OBSERVATIONS OF LUMINOUS METEORS IN THE YEARS 1870-71 *

THE object of the Committee was, as last year, to present a condensed report of the observations which they have received, and to indicate the progress of Meteoric Astronomy during the interval that has elapsed since the last report. A valuable list of communications on the appearances of luminous meteors has been forwarded to the Committee in the course of the year, as well as regular observations of star showers The heights and velocities of thirteen shooting stars obtained by the co-operation of Mr. Glaisher's staff of observers at the Royal Observatory, Greenwich, during the watch for meteors on the nights of the 5th to the 12th of August last, are sufficiently accordant with the velocity of the Perseids, as previously determined by similar means in the year 1863, to afford a satisfactory conclusion that the results of direct observation are in very close agreement with those derived from the Astronomical Theory of the August Meteor Stream. On the mornings of the 13th to the 15th of November last, a satisfactory series of observations of the November star shower (as far as its return could be identified), recorded at the Royal Observatory, Greenwich, and at several other British Association stations, concurs with very similar descriptions of its appearance in the United States of America, in showing the rapid decrease of intensity of this display, since the period of greatest brightness which it attained in the years 1866 and 1867.

Notices of the appearance of more than twenty fire-balls and small bolides have, during the past year, been received by the Committee ; fourteen of the former were compared to the apparent size and brightness of the moon, and the latter include three detonating meteors of the largest class. Descriptions of some of the largest of these meteors are given at length in the report. No notice of the fall of an aërolite during the past year has been received, although the occurrence of large meteors during the Autumn and Spring months was unusually frequent. The locality of one of these, which appeared with unusual brightness in the South of England, on the evening of the 13th of February can be determined at least approximately, as also the elevation of its path.

A table of the height of sixteen shooting stars doubly observed in England during the meteoric shower of August 1870 (independently of the observations made at the Royal Observatory, Greenwich), appeared in the last volume of the British Association Reports. A comparison of the observations made at the Royal Observatory, Greenwich, on that occasion, with those recorded at the other stations, enables the paths of thirteen meteors, seen by Mr. Glaisher's staff of observers (ten of which are new to the former list), to be determined ; and the heights and velocities of the meteors thus identified are entered in the Report. The results are as follows : The average height of 16 meteors contained in the last report was 74 miles at appearance and 48 miles at disappearance ; of 13 meteors (given in the present list), 72 miles at appearance and 54 miles at disappearance ; of 20 meteors (observed in August, 1863), at appearance 82 miles, at disappearance 58 miles. The present average heights are thus somewhat less than those observed in 1863, but they agree more closely with the general average height at first appearance, viz., 70 miles, and that at disappearance, viz , 54 miles. The average velocity of the Perseids (relatively to the earth) observed in the year 1863 was thirty-four miles per second, and that of three Perseids in the present list was thirty-seven miles per second ; while the velocity on the astronomical theory, as calculated by Prof. Schiaparelli, was thirty-eight miles per second.

A considerable shower of shooting-stars was also noted on the night of April 20 last, of which preparations were made to record the progress, with satisfactory results.

The report, which was full and elaborate, contained a description of the new meteor-showers noted during the few last years by Prof. Schiaparelli, agreeing in many points with previous determinations by the Committee from the observations contributed to the British Association, and suggesting considerations of novel and important interest in relation to the probable explanation of certain facts regarding the radiant points of shooting-stars. These are in some cases (more or less exactly) simple, double, or multiple points ; and in other cases present a wide central space or region of "diffuse radiation." On the other hand, distinct radiant points of ordinary shooting stars, observed on several closely adjacent nights, although apparently exhibiting no other connection with each other by meteors observed on the intervening dates, sometimes including many days, are yet so nearly identical in their positions as to make it almost certain that they belong to distinct families or systems of meteor-streams. Prof. Schiaparelli shows, in a preliminary discussion of these results, that if the particles of a small meteor-cloud, entering from extraplanetary space the region of the sun's attraction, is deflected from its primitive course by the attraction of one of the larger planets into an elliptic orbit round the sun, the velocities of its particles, in their elliptic orbits, will, in general, differ slightly among themselves ; and the meteor-group will, in consequence, extend itself into a continuous stream of gradually increasing length along the orbit of the group. Although the continuity of the group will be preserved along its whole length during this extension, yet the stream will only form a continuous meteor-ring (when the foremost particle overtakes the hindmost one in its course) if, while gaining one complete revolution upon the latter, this and the foremost particle of the stream continue to describe the same orbit round the sun, or an orbit which undergoes the same perturbations by the planets. But since the two ends of the stream, during its extension, occupy very different positions in space, the orbits of the extreme particles are, in general, very differently affected by the attractions of the planets ; and, when the particles in advance have gained one entire revolution upon those in the rear, the group will not, in general, form a closed ring ; but an open, spiral curve, the ends of which, instead of exactly meeting, will generally overlap each other. When the first particle has gained a second revolution in advance upon the last, a second convolution of the coil will generally be added to the spiral curve ; and no perfect meteor-annulus, for the same reason as before, will generally be formed by this circuit, or by any succeeding circuits of the meteor-stream, until its length and the number of its circuits are indefinitely increased. Since the thickness and

* Report of Committee, British Association, 1871.

density of the stream diminish as its length increases, its interlacing wreaths will give rise to a group of meteor-showers, more and more difficult to distinguish from each other, as their number becomes greater, until at last the condition of a meteor-belt so formed becomes that of innumerable meteor-particles revolving in orbits apparently independent of each other, and intersecting each other in all possible directions within the general boundaries of the elliptic ring. The appearance presented by a meteor-group of this description, during its first encounters with the earth, will be a periodic star-shower (like that of the November meteors), diverging, whenever it is visible, from a nearly exact and single radiant point. At the end of a certain number of cyclical returns, the star shower will be annually visible on a particular date, diverging from the same, or nearly from the same, radiant-point, but much less abundantly than at first; and a twin meteor-shower with a time of maximum, and a radiant point closely adjacent to the former ones will, at intervals, make its appearance with the original shower. This also, like the latter, after an equal lapse of time, will become annual; and both diminishing together will present the appearance of a double meteor-shower, appearing simultaneously, or very nearly together, with a double or twin radiant-point; while at intervals, a third meteor-shower, of the same general features as the previous two, will begin to be added to the group. Proceeding in this manner, as the antiquity of the meteor-ring increases, the star-shower will resolve itself into a more or less well-defined group of slender streams, producing alternate short lulls, and flights of meteors from a great multiplicity of radiant points, contained within a limited region of diffuse or multiple radiation. The ordinary appearance of the star-shower on the nights of the 9th and 11th of August, answering very closely to the description of a meteor-stream in an already far-advanced stage of its development, the much higher antiquity of the August than that of the November star-shower, already shown by its regular annual return, and by the ancient times in which it appears to have been recorded, must now also be regarded as satisfactorily confirmed by the frequently-recorded multiple, and more commonly observed diffuse character of its radiation. Among the star-showers of less ancient date, of which the November meteors appear to present a conspicuous example, Prof. Schiaparelli includes a meteor-shower observed by Zezioli on October 12, and two others on November 10, 1868; one star-shower on each of these dates radiating very exactly from points in the neighbourhood of the constellation Taurus, as well as the star-shower of October 18, and 20, 1864 and 1865, the radiant point of which was very exactly marked in those years in Orion.

Continued observations of the best-known star-showers being calculated to afford such important information on the present conditions, and on the probable antiquity of their connection with the solar system, the committee propose to re-examine the principal meteor-showers during the coming year, with suitable means for registering the meteors observed on each of the following dates, viz., August 9 to 11, October 18 to 21, November 13 to 15 (A.M.), December 11 to 13, 1871, and January 1 to 3, and April 19 to 21, 1872, and to determine, as exactly as possible, the moments of maximum frequency, the rates of appearance, and the principal points of radiation of the meteors visible on those days.

THE LATE REV. W. V. HARCOURT'S RESEARCHES ON GLASS *

THE subject of the preparation and optical properties of glasses of a great variety of chemical positions, formed, for nearly forty years, a favourite study with the late Mr. Harcourt. As stated in a report published in the British Association Reports for 1844, some experiments on the subject were commenced in 1834, which he was encouraged to pursue further by a request published in the fourth volume of the Transactions of the Association. A report on a gas furnace, the construction of which formed a preliminary inquiry, was published in the reports, but the results of the actual experiments on glass have never yet been published.

My own connection with these experiments commenced at the meeting of the Association at Cambridge in 1862, when Mr. Harcourt placed in my hands some prisms formed of the glasses which he had prepared, to enable me to determine their character as to fluorescence. I was led incidentally to observe the fixed lines of the spectra formed by them; and as I used sunlight which he had not found it convenient to employ, I was enabled to see further into the red and violet than he had done, which was favourable to a more accurate determination of the dispersive powers. This inquiry being in furtherance of the original object of the experiments, seemed far more important than that as to fluorescence, and the increased definiteness caused Mr. Harcourt to resume his experiments with the liveliest interest, an interest which he kept up to the last. Indeed, it was only a few days before his death that his last experiment was made. To show the extent of the inquiry I may mention that at least 166 masses of glass were formed, and cut into prisms for measurement, each mass doubtless involving in many cases several preliminary experiments, besides discs and masses for other purposes.

It is well known how difficult it is, in working on a small scale, to make glass which is free from striæ and imperfections of the kind. Of the first group of prisms, 28 in number, 10 only showed a few of the principal dark lines of the solar spectrum; the rest had to be examined by the bright lines in artificial sources of light. These prisms seemed to have been cut at random by the optician from the mass of glass furnished to him. Theory and observation alike showed that striæ interfere comparatively little with an accurate determination of refractive indices when they lie in planes perpendicular to the edge of the prism. Accordingly, in the rest of the research the prisms were formed from the glass mass that came out of the crucible by cutting two planes passing through the same horizontal line a little behind the surface, and inclined $22\frac{1}{2}°$ right and left of the vertical, and polishing the enclosed wedge of 45°. In the central portion of the mass the striæ have a tendency to arrange themselves in nearly vertical lines by the operation of currents of convection, and by cutting in the manner described the most favourable direction of the striæ is secured for a good part of the prism. This attention to the direction of cutting, combined no doubt with increased experience in the preparation of glass, was attended with such good results that now it was quite the exception for a prism not to show the principal dark lines. Some of the latest prisms were almost equal to prisms of good optical glass.

On account of the difficulty of working with silicates, arising from difficult fusibility and the pasty character of the glasses, Mr. Harcourt's experiments were carried on with phosphates, combined in many cases with fluorides and sometimes with borates, tungstates, molybdates, and titanates. The glasses formed involved the elements potassium, sodium, lithium, barium, strontium, calcium, glucinium, aluminium, magnesium, manganese, zinc, cadmium, tin, lead, thallium, nickel, chromium, uranium, bismuth, antimony, tungsten, molybdenum, titanium, vanadium, phosphorus, fluorine, boron, and sulphur. A very interesting subject of inquiry presented itself collaterally with the original object, namely, to ascertain whether glasses could be formed which would achromatise each other so as to exhibit no secondary spectrum, or a single glass which would form with crown and flint a combination achromatic in that sense. This inquiry presented considerable difficulties. The dispersion of a medium is small compared with its refraction, and if the dispersion be regarded as a small quantity of the first order, the irrationality between the two media may be regarded as depending on small quantities of the second order. If striæ and imperfections of the kind present an obstacle to a very accurate determination of dispersive power, it will readily be understood that the errors of observation thus occasioned go far to swallow up the small quantities, in the observation of which the determination of irrationality depends. Accordingly little success attended the attempt to draw satisfactory conclusions as to irrationality from the direct observation of refractive indices; but by a particular mode of compensation, in which the experimental prism was achromatised by a prism built up of a combination of slender prisms of crown and flint, I was enabled to draw trustworthy conclusions as to the character, in this respect, of these prisms, which were good enough to show a few of the principal dark lines of the solar spectrum.

Theoretically any three different kinds of glass may be made to form a combination which shall be achromatic as to secondary as well as primary spectra; but for a long time little hope of a practical solution seemed to present itself. A prism containing molybdic acid was the first to give fair hopes of success. Mr. Harcourt warmly entered into the subject, which he prosecuted with unwearied zeal. The earlier molybdic glasses prepared were many of them rather deeply coloured, and most of them of a perishable nature. At last, after numerous experiments, molybdic glasses were obtained nearly free from colour, and permanent. Titanium had not yet been tried, and about this time a glass

* Paper read by Prof. Stokes in Section A, British Association, 1871.

containing titanium was prepared. Titanic acid proved to be equal or superior to molybdic in its power of extending the blue end of the spectrum more than corresponds to the dispersive power of the glass; while in every other respect—freedom from colour, permanence of the glass, greater abundance of the element—it had a decided advantage; and a great number of titanic glasses were prepared, cut into prisms, and measured. Some of these led to the suspicion that boracic acid had an opposite effect to titanic, to test which Mr. Harcourt formed some simple borates of lead, with very varying proportions of boracic acid. These fully bore out the expectation; the terborate, for instance, which in dispersive power nearly agrees with flint glass, agrees on the other hand in the relative extension of the blue and red ends of the spectrum with a combination of about one part (by volume) of flint glass with two of crown.

By combining a negative (or concave) lens of terborate of lead with positive lenses of crown and flint, or else a positive lens of titanic glass with negatives of crown and flint, or a positive of crown and a negative of low flint, achromatic triple combinations free from secondary dispersion might be formed, without encountering formidable curvatures, and by substituting at the same time a borate of lead for flint glass, and a titanic glass for crown, the curvatures might be a little further reduced.

There is no advantage in using three different kinds of glass rather than two, to form a fully achromatic combination, except that the latter course might require the two kinds of glass to be made to order, whereas with three we may employ for two of them the crown and flint of commerce. It is probable that enough titanium might be introduced into a glass to allow the glass to be properly achromatised by Chance's "light-flint."

In a triple combination of lenses the middle lens may be made to fit both the others, and be cemented. Terborate of lead, which is somewhat liable to tarnish, might thus be protected by being placed in the middle. Even if two kinds only of glass be used it is desirable to divide the concave lens into two for the sake of diminishing the curvatures. On calculating the curvatures so as to destroy spherical as well as achromatic aberration, and at the same time, to make the adjacent surfaces fit, very suitable forms were obtained with the data furnished by Mr. Harcourt's glasses.

After encountering great difficulties from striæ, Mr. Harcourt at last succeeded in preparing discs of terborate of lead and of a titanic glass, of about 3 in. diameter, almost homogeneous, and with which it is intended to attempt the construction of an actual object glass, which shall give images free from secondary colour.

This notice extends to a greater length than I had intended, but still it gives only a meagre account of a research extending over so many years. It is my intention to draw up a full account for presentation to the scientific world in another way. I need but say that the small grant made to Mr. Harcourt for these researches has been expended over and over again, but it was his wish, in recognition of that grant, that the first notice of the results he obtained should be made to the British Association.

THE BRITISH ASSOCIATION MEETING AT EDINBURGH

SECTION A.

On the Recent and Coming Solar Eclipses, by J. N. Lockyer, F.R.S. The substance of this has already appeared in these pages.

Prof. Tait remarked, after the reading of Mr. Lockyer's paper, that the photography which had been exhibited left no doubt in his mind that the greater part of the solar corona is produced in the earth's atmosphere. The rays are pretty obviously to be attributed to ice-crystals, and the various irregular protuberances sometimes seen may be due to germs and light particles blown off from meteorites before they become incandescent, which, according to a beautiful investigation of Stokes, descend with extreme slowness towards the earth. This simple consideration is sufficient to show the utter absurdity of the sneers with which Sir W. Thomson's suggestion has been received, and to justify it as a scientific possibility—all it pretended to be.

On the Coming Solar Eclipse, by M. Janssen. In the discussion on these communications, Sir W. Thomson said he joined warmly in what Mr. Lockyer and M. Janssen had said. M. Janssen had asked that Britain should join France and Germany in their friendly struggle. There was a challenge from France and Germany, and it would be a disgrace to England if it did not accept that challenge, and do its best to beat its rivals in the struggle.

Report of the Committee for discussing Observations of Lunar Objects suspected of Change.

Mr. W. R. Birt, to whom the execution of the work was confided, read the report on behalf of the committee, consisting of Edward Crossley, Esq., and the Rev. T. W. Webb. The report stated that much attention having of late years been given to lunar objects, the purpose for which the committee had been appointed would be best carried out by confining the discussion to the observations of a small but well-known portion of the moon's surface; and as the spot plate had presented during the last two years a variety of interesting and important features which had been well observed, it had been chosen as the most likely to yield results contributing to the advancement of selenography. Time having permitted the discussion of the observations of the bright spots only, it was requested that a further grant of 20*l.* should be placed at the disposal of the committee for the discussion of the observations of the streaks and markings on the floor which were intimately connected with the spots. Mr. Birt, in alluding to the work which he had executed on behalf of the committee, said that as his report was voluminous, he would content himself with a brief description of the results at which he had arrived. The area of Plato in which the spots exist measured about 2,700 square miles; as many as thirty-seven spots had been observed, but he wished it to be particularly understood that the whole had never been seen together; the greatest number observed on any one occasion was twenty-seven, the mean or average number being not more than eight. With the aid of diagrams drawn on the black board, he showed that the mean number seen at intervals of twelve hours of the luni-solar day varied during the progress of the day, so much so as to indicate that the number of spots visible at any given interval does not depend upon the angle at which the sun's light falls upon the floor of Plato. Some spots, he said, had been seen more frequently at about sixty hours after sunrise upon the floor of Plato than at any other portion of the luni-solar day; the positions of these spots on the floor were pointed out, and it was remarked that they were situated in the western part of the crater, and they agreed in having been more frequently observed in August 1869, than at any other period of the observations. Other spots were observed more frequently at a later period of the observations than in August 1869, and they had been seen more frequently at a later period of the day, or after the sun had passed the meridian. Daylight at the moon is equal to fourteen terrestrial days and nights. These facts Mr. Birt argued were incompatible with the assumption that variations of aspect were entirely dependent upon variations of illumination, and rather pointed to the existence of activity on the moon's surface, the exact nature of which required further observations to elucidate.

Report on Thermal Conductivity of Metals, by Prof. Tait.

Prof. Tait, on the part of the committee appointed to report on this subject, drew attention to the relation that exists between electric and thermal conductivity of metals, and the effect on conductivity of a very small amount of impurity. He also sketched the apparatus made use of in the determination, and said that, as a new gasometer had been introduced, he had recommenced the whole of his investigations under better auspices and with hopes of very great accuracy.

On a New Steam Gauge, by Prof. Zenger.

Experiments on Vortex Rings, by H. Deacon.

Observations of Parallax of a Planetary Nebula, by D. Gill.

On a New Form of Constant Galvanic Battery, by Latimer Clark.

On a Method of Testing Submerged Electric Cables, by C. F. Varley.

Description of Experiments made in the Physical Laboratory of the University of Glasgow to determine the Surface Conductivity for Heat of a Copper Ball, by Donald M'Farlane. The experiments described in this paper were made under the direction of Sir W. Thomson during the summers of 1865 and 1871. A hot copper ball, having a thermo-electric junction at its centre, was suspended in the interior of a closed space kept at a constant temperature of about 16° C. The other junction was kept at the temperature of the envelope; the circuit was completed through a mirror galvanometer, and the deflections noted at intervals of one minute, as the ball gradually cooled.

The method of reducing the observations is explained at length in the paper. The differences of the Napierian logarithms of the differences of temperature of the junctions, indicated by the deflections, divided by the intervals of time, give the rate of cooling, and this, multiplied by a factor depending on the capacity for heat of the ball, and on the extent of its surface, gives the quantity of heat emitted in gramme water units, in the unit of time per square centimetre, per 1° difference of temperatures. Formulæ are given which express the results of the experiments very closely, and a table calculated by them exhibits the rates of emission for every 5° of difference throughout the range.

The first and second series have a range of from 5° to 25° only, which was too small to give decided results, but the third and fourth series, made with a polished copper surface and a blackened surface respectively, gave variations on the emissive power from ·000178 at 5° diff. of temperature to ·000226 at 60° diff. for the blackened surface, and exhibit throughout a nearly constant ratio of about ·694.

On Wet and Dry Bulb Formulæ, by Prof. Everett. He said, August, Apjohn, and Regnault have investigated formulæ for determining the dew point, by calculation, from the temperatures of the dry and wet bulb thermometers; but Regnault's experiments on the specific heat of air were not performed till a later date, and all their authors have adopted in their investigations the value obtained by Delaroche and Berard, which is ·267, whereas the correct value is ·237. But when this correct value is introduced into Regnault's formula, the discrepancies which he found to exist between calculation and observation are increased, and amount, on an average, to about 25 per cent. of the difference between wet bulb temperatures and dew point. August and Apjohn erred in assuming that the air which gives heat to the wet bulb falls to the temperature of the wet bulb, and becomes saturated. These two false assumptions would jointly produce no error in the result if the depressions of temperature in the different portions of air affected were exactly proportional to their increments of vapour-tension, and if some of the air were saturated at the temperature of the wet bulb. But it is probable that, when there is little or no wind, the mass of air which falls sensibly in temperature is larger than that which receives a sensible accession of vapour, and that, in high wind, the supposition that some of the air has fallen to the temperature of the wet bulb, is more nearly fulfilled than the supposition that it has taken up enough vapour to saturate it. The effect of radiation, which is ignored in the formulæ, leads in the same direction as these two inequalities, and all three are roughly compensated by attributing to air a greater specific heat than it actually has. The discrepancies above referred to are thus explained.

On a New Key for the Morse Printing Telegraph, by Prof. Zenger.

On Clean and Unclean Surfaces in Voltaic Action, by T. Bloxam.

On the Corrosion of Copper Plates by Nitrate of Silver, by J. H. Gladstone, F.R.S., and A. Tribe, F.C.S. In some recent experiments in Chemical Dynamics the authors had occasion to study the action of nitrate of silver on copper plates in various positions. They observed that when the plate was vertical there was rather more corrosion at the bottom than at the top. This is easily accounted for by the upward current which flows along the surface of the deposited crystals, and which necessitates a movement of the nitrate of silver solution towards the copper plate, especially impinging on the lower part. It was also found that when the copper plate was varnished on one side, it produced rather more than half the previous decomposition, and was more corroded at the edges of the varnish. By making patterns with the varnish this edge action became very evident. This was explained by the fact that the long crystals of silver growing out from the copper at the border can spread their branches into the open space at the side, and so draw their supply from a larger mass of solution than the crystals in the middle can do; and increased crystallisation of silver means increased solution of copper. This was proved by making the varnish a perpendicular wall instead of a thin layer, when the greater corrosion was not obtained. In a plate completely surrounded with liquid the greatest growth of crystals is also evidently from the angles. It was likewise observed that if a vertical plate be immersed, the lower part in nitrate of copper, and the upper part in nitrate of silver, there is greater corrosion about the point of junction. This was attributable to the greater conduction of the stronger liquid.

The Influence of the Moon on Rainfall, by W. Pengelly, F.R.S.

On Units of Force and Energy, by Prof. Everett, D.C.L.

All authorities are agreed that the units of length, time, mass, and force ought to be so settled as to satisfy the condition that unit force acting for unit time on unit mass generates unit velocity. Now, of the four elements, length, time, mass, and force, the first three can easily be referred to concrete standards available for reference at any part of the earth, but this reference is more difficult in the case of the fourth. The motion of the earth gives the mean solar second, a standard foot can be carried to any part of the earth, and if immersed in a mixture of ice and water, will have everywhere the same length; and a standard pound has the same mass to whatever place it is carried. But no material standard of force is easily provided, so that it is philosophical to make this the dependent unit, and define it in terms of the others; and this plan is that which has recently been followed.

Convenience of expression, however, requires several units of each kind. It is not convenient to express the distance from Liverpool to New York in inches, nor the diameter of a rifle bullet in decimals of a mile. Names have accordingly been provided for several units of time, length, and mass; but a similar provision has not yet been made in the case of units of force. With the exception of two letters by the author of the present paper that appeared in NATURE March 2 and May 4 of the present year, and another letter by Mr. Thomas Muir, no names for units of force dependent on specified units of time, length, and mass, seem ever to have been publicly proposed.

The unit of work stands in a simple relation to the units of force and length. It is the work done by unit force working through unit length. And that amount of energy which, in undergoing complete transformation, performs unit work, is the unit of energy. The same unit which measures work therefore measures energy. The only approach to a name that has been suggested on this subject is the "British absolute unit of energy," and the defect of nomenclature becomes often intolerable.

The author therefore repeated the proposals which had already appeared in NATURE, so that we need only briefly recapitulate a portion of the names proposed. The unit of force, corresponding to a second, a metre, and a gramme, as units of time, length, and mass, was called a *dyne*; the kilodyne was a thousand dynes, the megadyne a million dynes. The unit of energy or work was called the *pone*, and depended on the dyne and metre, the kilopone was a thousand pones, &c. In connection with the British system, the "British absolute unit force" was called a *kinit*, dependent on the pound, foot, and second, and the name *erg* was given to the corresponding unit of energy, the thousand and million ergs being written kilerg and pollerg respectively.

The dyne is about the terrestrial gravitating force of $1\frac{1}{2}$ grains, the kilodyne of $\frac{1}{4}$ lb., the megadyne of 2 cwt., and the kinit of $\frac{1}{2}$ oz. The kilopone is about $\frac{1}{10}$ of a kilogrammetre, the megapone about 723 foot-pounds, the kilerg is 31 foot-pounds, and the pollerg about the work done by a horse in a minute. On this subject a joint committee was appointed with Section G to frame a nomenclature of absolute units of force and energy.

On the general Circulation and Distribution of the Atmosphere, by Prof. J. D. Everett, D.C.L.

The object of this paper was to call the attention of meteorologists to a theory which is jointly due to Prof. J. Thomson of Belfast and Mr. Ferrel of Boston, U.S.A., and which gives the only satisfactory account of the grand currents of the atmosphere, and of the distribution of barometric pressure over the earth's surface, the irregularities arising from the distribution of land and water being neglected. Independent proofs were also given of some of Mr. Ferrel's results.

A body moving along the earth's surface with relative velocity v (units a foot and second) tends to describe a curve concave to the right of the body in the northern and to its left in the southern hemisphere, the radius of curvature being $\frac{6850\, v}{\sin \lambda}$ feet. The deflection from a parallel of latitude into a great circle is usually negligible in comparison, being represented by the curvature of a circle of radius $R \cot \lambda$, R being the earth's radius.

To keep therefore the moving body in a great circle or in a parallel of latitude requires a constraining accelerating force equal to $\frac{v \sin \lambda}{6850}$, and this formula applies alike to all horizontal directions of motion.

The air over the extra-tropical parts of the earth has a relative motion towards the east, and therefore passes towards the tropics with a force which can be computed from the above formula. If v be the eastward velocity at any parallel, the increase of pressure per degree of latitude is ·0019 v sin λ inches of mercury, and this accounts for the observed increase of pressure from the poles to the tropics, which is roughly ·01 inch per degree.

If any stratum of air have less than the average eastward or westward velocity which prevails through the strata above it, it will not be able to resist the differential pressure from or towards the equator which their motion produces. For this reason the lowest stratum of air having its velocity relative to the earth kept down by friction, generally moves from the tropical belts of high barometer to the regions of low barometer at the poles and equator. This is the origin of our S.W. winds and of the prevalent N.W. winds of the Southern Ocean.

The tendency of a moving mass of air to swerve to its own right in the northern hemisphere explains Buys Ballot's law that the wind instead of blowing at right angles to the isobaric lines usually makes an angle of 20° or 30° with them, keeping the region of lower barometer on its left. The rotation of cyclones is an example of this law, and the pressure which the spirally-flowing streams exert to their own right in virtue of the earth's rotation is the main cause of the excessive central depression. The author referred to Prof. J. Thomson's paper (B.A. reports, 1857), to Mr. Ferrel's papers, and to NATURE, July 20, 1871.

Remarks on Aerial Currents, by Prof. Colding.

On a Nutoscope for showing graphically the Curve of Precession and Nutation, by Prof. Ch. V. Zenger.

In the case of a rapidly revolving solid, two things may take place according as the mass of the solid body is or is not uniformly distributed round the axis. In the first case, the axis of rotation steadily holds its position during the rotation, as in the case of the gyroscope. If a shock acts on the one side, the axis will describe a cone and its apex a circle, but if the mass on the disc be unequally distributed (which is practically done by fastening a small circular plate by an excentric hole to the axis) the motion becomes more complicated, and the apex of the axis has a precessional and nutational motion. This motion in the apparatus described is traced on a piece of blackened paper by the apex. The greater the disturbing weight is taken, the greater is the nutational motion, so that when it is very large the apex describes a spiral. The apex of the instrument is kept in slight contact with the blackened paper by means of a micrometer screw.

On a Cause of Transparency, by G. Johnstone Stoney. It is known that a gas becomes opaque if rays are passed through it of the same wave-length as that of the light which it gives forth itself when incandescent, and in the present communication the author proposed an explanation of this fact, and gave an account of some experiments he had made with regard to the motions of the molecules in chloro-chromic anhydride, the spectrum of which contained about 120 lines due to one motion of the molecules.

Prof. Stokes and Sir W. Thomson made some remarks on the paper, in the course of which it was mentioned that in order that a sound might be propagated to a great distance, it was not necessary that the disturbance need be strictly periodic; Sir W. Thomson also remarked that he believed the vibrations of a molecule of a gas would be found to more resemble the vibrations of an elastic plate than those of a string.

Remarks on a new Dip Circle, by Dr. Joule.

SECTION C.

SOME relics of the Carboniferous and other Old Land-surfaces were described by Mr. Henry Woodward. Whilst admitting that during particular eras circumstances may have favoured the development of special groups of organisms, which, in consequence, flourished in greater abundance than the rest, the author deprecated the idea of the prevalence of peculiar conditions at any time since the advent of organic life on the globe. He referred to the fact of sedimentary deposits being formed at the bottom of the sea as positive evidence of the waste of neighbouring land surfaces, and he remarked that if conditions in the sea were favourable to the development of abundance of animal life, those on the land were in all probability equally so. He referred first to the abundant evidence of land-surfaces in Quaternary and Tertiary times. Truly marine deposits (such as the chalk) testify to the presence of land by the fossil remains of Pterodactyles, Cheloniæ, and other shore-dwelling reptiles, whilst the Wealden beds, the Purbeck limestone, and Oolitic plant-shales afford abundant proofs of Mesozoic lands. Even the marine Solenhofen limestone yields swarms of insects, flying lizards, and a true bird, beside plant remains. In the Triassic periods the earliest traces of Mammals appear, while ripple-marked slabs of sandstones show bird-like tracks and Labyrinthodont footmarks, telling of the denizens of the old sea-shores and lakes.

The author then described the Coal-period with its stores of land-plants and Reptilia, both aquatic and terrestrial, its insects and Mollusca. He controverted the arguments of Dr. T. Sterry Hunt as to the exceptional condition of the atmosphere of the Coal-period, and showed that the presence of animal life disproved the existence of an atmosphere charged with carbonic acid gas, and that plants would not be benefited thereby as Dr. Hunt supposed.

On Monday, August 7, a report *On Sections of Fossil Corals* was made by Mr. James Thomson, F.G.S. The structural characters and development of the Carboniferous corals (about 170 in number) were briefly pointed out and illustrated by a number of beautiful photographic plates. He explained the method by which the sections were prepared, and described a new process whereby he transferred the photographs of the structure to copper plates, that faithfully represented the most delicate parts.

Sir Richard Griffith, Bart., F.R.S., gave an interesting account of the Boulder Drift and the Esker Hills of Ireland. Pointing to his large geological map of the country, he gave a brief description of its physical features and general geological structure. He then described the boulder drift as consisting of sandy clay containing numerous stones and boulders, and having a thickness in the eastern part of about 100 feet; and he regarded it as formed by a great torrent moving suddenly and depositing rapidly. He next adverted to those remarkable ranges of hill, which varied in height above the surface of the boulder drift from twenty to sixty feet, the ascent being usually about twenty degrees on the west side, but less steep on the east. These Esker Hills were very numerous in the central portion of the country. Their general direction was from west to east; and one great esker, which extended from the county of Galway to Westmeath was used as the post road from Dublin to Galway for a length of thirty miles. These were formed after the Boulder Drift, by a shallow sea acting upon it. Sir Richard next directed attention to the occurrence of large erratic blocks, totally unconnected with the gravel, which were found resting on the surface throughout the entire district, from Galway Bay in an eastern and south-eastern direction, passing over the summits of the Sliebhbloom Mountains, near Roscrea, and extending from thence through the King's and Queen's counties. These blocks were all angular, and being composed of a peculiar porphyritic granite situated to the north of Galway Bay, they had evidently been transported by a current from the north-west.

In the discussion which followed the reading of this paper, Mr. Milne Home, alluding to the Esker drift, said that similar instances of ridges accumulated by the sea were to be found in Stirlingshire and Berwickshire, and one was now being formed in the Firth of Forth, which went by the name of the Whale's Back, and which was about two miles and three quarters in length; he also thought that the Chesil Bank presented a very similar structure to that of the Eskers, which he regarded as submarine banks. Mr. Geikie regarded the origin of the Eskers as still a puzzle to him. Mr. Symes, of the Geological Survey of Ireland, described the Eskers in County Mayo, which he had minutely examined, and the carved-out ridges of boulder clay in the neighbourhood of Clew Bay and West Port. He said that the Eskers were evidently of a newer creation, and of a different origin from the boulder clay ridges, or "drumlins" as they are called in Ireland. Mr. Kinahan pointed out on the geological map the general lie of the Eskers in the centre of Ireland, and suggested that they must be due to the meeting of two tidal waves in a glacial sea, which came respectively round the north and south coast. Meeting midway, as it were, in the channel, they were forced along what is now the low-lying central part of the country, and on again meeting a northern current in the valley of the Shannon, the Eskers were formed in a curve in a northerly direction, which would thus account for the general way in which these Eskers lie. Mr. Kinahan also said that in the low valley between Ballina and the mouth of the Shannon, there was a newer drift, the coast lines of which can be traced in numerous places in the counties of Mayo and Galway, and then southward to Cork.

A very important paper *On the Systematic Position of Sivatherium Giganteum* was read by Dr. Murie, but it was, perhaps, better suited to the Biological Section, as it met with but little discussion among the geologists. This animal appears to have been a ruminant, about the size of an elephant, in some respects deer-like, in others more resembling the antelopes; still stranger, it seems to have had some of the characteristic features of pachyderms, the tapir for example. Dr. Murie showed that it was one of those radical forms which by some may be regarded as one of the progenitors of diverse herbivorous groups. The *Sivatherium*, according to him, was unlike all other living ruminants but one, the prongbuck, from the fact of its having had hollow horns, evidently subject to shedding. It differs thus from deer, whose solid horns annually drop off, and from the antelope tribe, sheep, and oxen, whose hollow horns are persistent. Save one living form, the saiga, no recent ruminant possesses, as did the *Sivatherium*, a muzzle resembling in several ways the proboscis of the tapirs and elephants. Dr. Murie placed it in the family Antelocapridæ, from which radiated the *Bramatherium*, the prong-buck, the saiga, tapir, and antelopes.

The Relation of the Quaternary Mammalia to the Glacial Period was treated of by Mr. Boyd Dawkins, F.R.S. He divided the animals into five distinct groups, the first of which comprises those now living in the temperate regions of Europe and America, including the grizzly bear, the lynx, the bison, and the wild boar; these animals bind the Quaternary to the existing fauna. The second group comprises those animals which are now confined to cold regions, as the glutton, the reindeer, the musk sheep, and the tailless hare: they constitute the Arctic division of Quaternary Mammalia, and imply a cold climate. The third group consists of those animals which are now only found in hot regions—the canichow, and hippopotamus; and they indicated a hot climate. The only mode of getting over this discrepancy is to suppose that in those days the winter cold was very severe and the summer heat likewise very severe; so that in the summer time the animals now found in warmer regions migrated northwards, and in the winter time those now found in the Arctic regions went southwards. The fourth group consists of such extinct forms as the cave bear, the stag, the mammoth, and the woolly rhinoceros. The fifth group includes the sabre-tooth tiger, the Irish elk, *Rhinoceros megarhinus*, and *hemitœchus*, and they, with some others, show that there is no great break between the Quaternary and the Pliocene, such as would warrant any sharply-defined division of great value. The interest centred more particularly in the Arctic group, and so far as the evidence went, it seemed to be extremely probable that they were in occupation of the areas in Great Britain in which they were found during the time the other areas, in which they were not found, were covered by glaciers; and this period may be put down to that of the latest sojourn of the glaciers in the highest grounds of our islands, and even so far south as the district of the Avon.

Prof. W. C. Williamson, F.R.S., read a paper *On the Structure of the Diploxylon*, a plant of the Carboniferous Rocks.

The Silurian Rocks of Selkirk and Roxburgh were treated of by Messrs. Charles Lapworth and James Wilson. The authors pointed out that these rocks were capable of division into well-defined and well-marked groups. They had discovered a large number of fossils which had been obtained from all parts of the district; from the lowest to the highest beds examined, and many of which were new to Scotland. For the purpose of comparison the strata described were split up provisionally into five formations, namely:—1, The Hawick rocks; 2, The Selkirk rocks; 3, The Moffat series; 4, The Gala group; 5, The Riccarton beds. The Gala group they believed to be of Upper Bala or Caradoc age, and the Riccarton beds were classed with the Wenlock formation.

Mr. Lapworth subsequently enumerated the graptolites of the Gala group, and described two new species.

Two very important papers *On Local Geology* were communicated by Mr. D. J. Brown. Unfortunately from their being postponed until late in the day no time was allowed for their proper hearing or discussion. Mr. Brown endeavoured to show that the Silurian Rocks of the South of Scotland as developed in Dumfriesshire and Peeblesshire do not all belong to one geological epoch, as has been hitherto supposed, but that they belong to different periods—a lower one represented by the Moffat Rocks, well-known by their beds of Anthracite shales and Graptolites, and an upper series of later age, which lies unconformably on the Moffat rocks. These beds have been long known, and more recently they have been pointed out at Galashiels by Messrs. Lapworth and Wilson. Mr. Brown also showed that in the Pentland Hills both the Wenlock and Ludlow divisions of the Silurian Rocks are represented, and that the lower Old Red sandstones formed no part of these beds: also that these Pentland beds are not the equivalent of the Lesmahago, but that these latter are a higher portion of the Ludlow than any found in the Pentlands.

Mr. John Henderson described two sections across the Pentland Hills, and showed that the Felstones cut through, indurate and enclose angular fragments of rocks belonging to the upper portion of the Lower Carboniferous formation, and that the so-called Old Red conglomerates contain limestone pebbles enclosing Carboniferous fossils.

SECTION D.

SUB-SECTION.—BOTANY

PROF. DYER, B.A., B.Sc., read a paper *On the so-called "Mimicry" in Plants.* He said:—In all large natural families of plants there is a more or less distinctly observable general habit or *facies*, easily recognisable by the practised botanist, but not always as easily to be expressed in words. The existence of such a general habit in leguminous and composite plants is familiar to every one. What have been hitherto spoken of as *mimetic* plants are simply cases where a plant belonging to one family puts on the habit characteristic of another. This is entirely different from mimicry among animals, inasmuch as the resembling plants are hardly ever found with those they resemble, but more usually in widely different regions. *Mutisia speciosa* from Western South America, a composite, has a scandent leguminous habit closely agreeing with that of *Lathyrus maritimus* of the European shores. In the same way three different genera of ferns have species (found in distant parts of the world) indistinguishable in a barren state. The term Mimicry seems objectionable in these cases, and I propose Pseudomorphism as a substitute. As to the cause of the phenomenon, I can only suggest that the influence of similar external circumstances moulds plants into the similar form most advantageous to them. An illustration is afforded by the closely resembling bud scales which are found in widely separated natural orders of deciduous trees as modifications of stipules. I do not, however, think that the moulding influence need always be the same. I believe that different external conditions may produce the same result; in this respect they may be called analogous. Several identical plants are found on the seashore and also on mountains. The reason is, I believe, that they are equally able to tolerate the effect of soda salts and also of mountain climate; the tolerance of either unfavourable condition gives them the advantage over less elastically constituted plants, and the two are therefore analogous in their effects.

Professor Dyer's paper gave rise to an interesting discussion, in which Profs Balfour, Dickson, Lawson, Perceval Wright, and Mr. Carruthers joined, in the course of which attention was called to the fact that while there might be "pseudomorphs" in the vegetable kingdom, yet there were also true cases of what is now technically called "mimicry."

Dr. R. Brown read two papers *On the Geographical Distribution of the Flora of North-West America*, and *On the Flora of Greenland.* In the discussion on the latter paper Prof. Dickie stated that the Diatoms which he had catalogued for Dr. Brown had been for the most part obtained from the stomachs of mollusca. Prof. Lawson doubted if we knew more than just the coast flora of Greenland, all the mosses met with were just the commonest British species. Prof. Dyer alluded to the lack of positive knowledge that existed as to whether icebergs were or were not carriers of vegetable life.

Mr. A. G. More exhibited some living plants of *Spiranthes gemmipara* which had been collected by him in the last week in July, at Castletown, Berehaven.

Prof. Balfour submitted some observations on the cultivation of ipecacuanha plants in the Edinburgh Botanic Garden for transmission to India. As a curative for dysentery, the value of this plant was very great, and, in consequence of the partial failure, from various causes—such as the rashness and carelessness of collectors—of its cultivation in its native country (South America), its cultivation here for sending out India became a matter of much importance. A short time ago Mr. James M'Nab, of the Botanical Gardens, discovered that by making cuttings of the rhizome of the plant under the surface of the ground, numerous new shoots could be got, and the plant so propagated much more easily and plentifully. They had thus been able to send out a number of healthy plants to India, which it was hoped would be there equally successfully cultivated. Mr. M'Nab was also endeavouring, with fair prospect of success, to get the perfect seed of the plant, and if that could be done the difficulties of propagation would of course disappear. They had now two varieties of the plant in the Botanical Gardens, one of which had been cultivated there for forty years, and the other had just been got from South America, through the kindness of Dr. Gunning and Dr. Christison.

Dr. Cleghorn, F.L.S., late Conservator of Forests, Madras, expressed his delight at seeing the satisfactory result of the ipecacuanha propagation. Every army surgeon, he said, knew the great value of this remedy in the treatment of dysentery, and he hoped that the result of this experiment would be as successful as had been the introduction of cinchona. He thought much credit due to Profs. Balfour and Christison and Mr. M'Nab in this matter.

Mr. John Sadler read a paper *On the Genus Grimmia (including Schistidium) as represented in the Neighbourhood of Edinburgh.* After alluding to the varied character of the geological formation around the city, he stated that perhaps in no district of equal size in Britain would so large a number of species of this genus be found.

In Hooker and Taylor's *Muscologia Britannica*, published in 1818, a work which has never yet been surpassed for simplicity and correctness of description, there are seven species of *Grimmia* given as native of Britain. Two of these species, however, are now removed to other genera. In Wilson's *Bryologia Britannica*, or the third edition of the former work, published in 1855, there are fifteen species and many varieties described. Wilson, however, following Schimper, places three of these under the genus *Schistidium*, a genus which we think might with advantage to the student be easily dispensed with, seeing that its principal distinction from Grimmia rests on such an arbitrary character as the adhesion or partial adhesion of the columella to the lid. Since 1855 several species have been added to the genus in Britain, and noticed in the proceedings of different learned societies.

Greville, in his *Flora Edinensis*, published in 1824, describes six species of Grimmia as occurring within a radius of 10 miles of the city, viz.—*G. apocarpa, maritima, trichophylla, pulvinata, leucophæa*, and *Doniana.*

In Balfour and Sadler's *Flora of Edinburgh*, published in 1863, ten species, including Schistidiums, are recorded; and in the second edition of the same work issued this day no fewer than fifteen species are given. If we take the rocks of Arthur's Seat we shall there find a wonderful development of Grimmias. They vary much, however, in their distribution over the hill. The most widely distributed are *G. pulvinata* and *subsquarrosa*; next we have *G. conferta, pruinosa, leucophæa*, and *trichophylla*, less widely distributed; while *G. anodon, orbicularis* and its variety *oblonga, commutata*, and *Doniana* are very limited. Another interesting fact is that all these species, with the exception of *G. trichophylla*, which occurs on different kinds of rock, seem to have a preference for the amygdaloidal trap, and very rarely occur on the basalt. If a stray specimen, however, does get on to the last-named rock, it has the most stunted and starved appearance. At one part of the hill, where the upper drive cuts the rocks to the back of the basaltic columns of "Samson's ribs," there is an area of very limited extent where the whole of the species which occur on the hill can be collected. In fact, any one at all acquainted with the plants and the rocks on which they grow would have no difficulty in securing the whole in the course of a very few minutes. In April 1870, in company with Mr. Bell, of the University Herbarium, who has paid much attention to the mosses of Edinburghshire, and to whom we are indebted for the discovery of *Grimmia anodon* in Britain, I collected in the space of one hour specimens of *G. apocarpa, conferta, anodon, pruinosa, subsquarrosa, pulvinata, orbicularis, orbicularis* (var. *oblonga*), *trichophylla* (2 var.), *leucophæa*, and *commutata.*

If we take the species to be met with within a radius of about 7 miles or 8 miles, and classify them in a sort of natural order according to affinity, we have first of all two sections—

1. Capsule immersed in the perichætal leaves.
2. Capsule exserted.

Under the first section comes—*G. apocarpa, maritima, pruinosa*, and *anodon.* The last named resembles the members of the second section in the structure of its leaves.

Under the second section comes—*G. pulvinata, orbicularis, orbicularis* (var. *oblonga*), *subsquarrosa, trichophylla, patens, Doniana, ovata, leucophæa, commutata*, and *torta.*

The author then went over each of the species, giving their distinguishing characters, and pointing out their geographical distribution over the world. The paper was illustrated by a complete set of dried specimens of the species referred to, as well as by drawings of the rarer species.

Mr. Sadler noticed the occurrence of *Cystopteris montana* in great abundance on the Breadalbane mountains this season, and presented dried specimens of this rare fern to the meeting.

Dr. Murie, in communicating a paper *On the Development of Fungi within the Thorax of living Birds*, referred to the circumstance of lowly-organised vegetable structures being not unfrequently found growing in animals and man, both externally and internally. For the most part these affected the skin, giving rise to several cutaneous diseases. They also flourished in the alimentary canal; and among others, one peculiar form (*Sarcina*) had been described by the late Professor Goodsir from the human stomach. In nearly though not in all instances where vegetable organisms flourished within the living body, it was in organs where a certain amount of air had free access. It was more difficult, though, to account for the cases where vegetable parasites arose in, so to speak, closed cavities. The instances of this latter fact which he (Dr. Murie) brought forward as coming under his own observation were three in number—viz., a fungus-like growth in the abdomino-pleural membrane of a kittiwake gull, of a great white-crested cockatoo, and of a rough-legged buzzard. After a general description of the specimens in question, the author referred to them as in some ways bearing upon those doctrines which supposed living organisms to originate out of the tissues themselves. Weighty reasons undoubtedly might be given to the contrary, but as every fact, either furnishing doubtful evidence of, or opposed to the spontaneous generation theory, might be useful at the present juncture, he (Dr. Murie) thought a record of such worthy of being brought before the Association.

In the discussion which followed, Mr. Cooke and Prof. Perceval Wright questioned whether the vegetable structures spoken of by Dr. Murie might not be Algæ instead of fungoid bodies.

Dr. Bastian said that the question calling for most consideration was how these vegetable forms came to be found in a place cut off entirely from communication with the atmosphere. After mentioning the hypothesis that the spores of the fungi or algæ might have penetrated the tissues of the lungs or other vessels, and so reached the thoracic cavity, he explained his own views on the subject, illustrated by his experience in finding in the brain, and other portions of the human body isolated from the atmosphere, immense numbers of living organisms shortly after death, which, so far as could be ascertained, had no existence when the patient was alive, and insisted that either these organisms must have been previously present in the blood in a latent state—their germs being so minute as to be undistinguishable—or they must have come into existence by spontaneous generation.

Prof. Dickson read a paper entitled "Suggestions on Fruit Classification." [We give this valuable paper *in extenso* in another column.]

Prof. Dyer read a paper *On the Minute Anatomy of the Stem of Pandanus utilis.*

The Rev. Thomas Brown exhibited some specimens of fossil wood from the Lower Carboniferous rocks of Langton, Berwickshire. These fossil woods were described as occurring in the same Lower Carboniferous rocks in which Mr. Witham had found the stems figured more than thirty years ago, only that the rocks at Langton lie considerably in the lower series. One stem was particularlarly referred to, and drawings exhibited of the transverse and longitudinal sections. The transverse section was shown to present all the appearance of exogenous structure with pith rays and circular lines of annual growth. The longitudinal section showed that the seeming rays were vascular bundles, and that the stem from the pith to the circumference was a mass of scalariform tissue. Thus the longitudinal section seemed to indicate that this was the stem of a cryptogam, while the transverse section had all the appearance of an exogen. One tissue being obviously scalariform, the chief point of interest was the question whether the dark circles were really rings of annual growth. That they were really such the author argued on three grounds. First, no accidental infiltration of darker matter could account for a series of circular rings keeping their distance. Secondly the longitudinal section showed the same dark lines going down vertically through the stem and still keeping their relative distances, as in the concentric circles. Thirdly, on laying open the structure and examining the cause of the greater darkness of these rings, it is found to be due to the greater narrowness of the vessels forming the wood of the stem. The dark lines at their sides are crowded closer together. Thus it turns out that these circles were formed just as the rings of growth are in exogenous plants of the present day. The external markings of the stem were too obscure to determine the germs of this plant in the Carboniferous flora. Along with it were found specimens of *Stigmaria ficoides*, Flabellaria, and Lepidodendron. But the most abundant organisms in the bed were *Knorria acicularis*, now recognised as the internal cylinder of Lepidodendrons. Probably this was a similar structure of some other trees of the early Carboniferous period.

Prof. W. C. Williamson read a paper *On the Classification of the Vascular Cryptogamia as affected by recent Discoveries amongst the Fossil Plants of the Coal Measures.* After referring to the labours of Prof. W. King on this subject, for a knowledge of whose excellent paper he was indebted to Mr. Carruthers, and having dwelt at some length on the structure as interpreted by him of the stem of Lepidodendra, &c., he remarked that the conclusion to be drawn from the study of the structure of these fossil cryptogamic stems is, that so far as the structure of their medullary axis and ligneous zone is concerned, they are not in any sense *acrogens* but *exogens*; that they have a pith, consisting, in the lower fossil Lepidodendra, of a mixture of cells and vessels; that as we ascend to the higher forms the cells separate from the vessels, the former assuming a central and the latter a peripheral position; that the woody zone surrounding the medullary axis consists of radiating lines of vessels, which increase by successive additions to the external surface of the zone, which vessels are separated by mural arrangements of cellular tissue constituting medullary rays. Consequently, when such a process of growth has gone on until the result was a tree with a stem two or three feet in diameter, the application of the term *acrogen* to such cases is simply absurd. Such being the case, Prof. Williamson proposed to separate the vascular cryptogams into two groups, the one comprehending Equisetaceæ, Lycopodiaceæ, and Isoetaceæ, to be termed the Cryptogamiæ Exogenæ, linking the cryptogams with the true exogens through the cycads; the other called the Cryptogamiæ Endogenæ, to comprehend the ferns, which will unite the cryptogams with the endogens through the Palmaceæ.

Mr. Carruthers said:—The difficulties towards my accepting Prof. Williamson's interpretation of these plants are indicated by the terms which Prof. Williamson uses when he speaks of a vascular pith, and of medullary rays containing vascular bundles. The plants were true cryptogams, and in their organisation agreed in every essential point with the stems of Lycopodiaceæ. It was consequently necessary to apply to vascular tissues which had the position of medulla and medullary rays such names when these agreed with structures in the plants so closely allied to to them. The variations in recent stems of the Lycopodiaceæ were as great as in the fossil, and in some an average amount of the tissues agree with and fully illustrate the stems of Lepidodendron. In regard to the application of these structures to recent cryptogams, it was certain that an adherence to vegetative organs would set aside the natural classification based on the reproductive organs. And, indeed, the views advocated by Prof. Williamson would separate plants so closely related as the Hymenophylleæ and the Polypodiæ. It was important that in the fossil, as well as in the recent vascular cryptogams, the most satisfactory materials for determining their systematic position were obtained from their organs of reproduction.

Dr. M'Nab said:—I am very sorry I cannot agree with Prof. Williamson in his interpretation of the structure of these stems. Botanists are all agreed in this, that Lepidodendra and their allies are closely related to the lycopods. Now we know that the lycopods, like the ferns, have closed fibro-vascular bundles; bundles which can only grow for a certain time, and then all the cambium being converted into permanent tissue, growth must cease. It seems to me that the key to these structures is to be met with in Lycopodium Chamæcyparinus, in which we have a cylinder of wood-cells surrounding the central cylinder of united fibro-vascular bundles. This cylinder of wood-cells represents, and is a mere modification of the cellular tissue met with in the ordinary stems of lycopods. In this way it follows that the central portion is not a pith, but consists of the central group of fibro-vascular bundles. It also follows that the wood cylinder in these stems is not the homologue of the wood cylinder of an ordinary exogen. The classification of these plants proposed by Prof. Williamson seems also to me to be quite untenable.

Prof. Thiselton Dyer thought it was satisfactory that the papers on fossil botany were at last brought to the section where they could be properly discussed. It was most important not to separate the study of recent from that of fossil forms. If this had always been remembered, a great deal of wasted money and labour might have been saved in the publication of imperfectly understood material. Prof. M'Nab's description of the homologies of the stems in Lycopodium and Lepidodendron was the one accepted by all botanists who had looked into the matter. Prof. Williamson's classification was botanically untenable; it traversed every canon of classification. It separated the Equisetaceæ from the Ferns, and placed them with Lycopodiaceæ, with which they had nothing in common. The two types of stem which existed in the recent higher cryptogams existed equally in the extinct forms.

Prof. Williamson, in reply, said he did not attack a classification based on the organs of fructification, but that based on growth, and reiterated his belief that we had here a series of cryptogamic plants with an exogenous growth of their stems.

SUB-SECTION.—ANATOMY AND PHYSIOLOGY

Professor Humphry read a paper *On the Caudal and Abdominal Muscles of the Cryptobranch.* He gave a general account of these muscles, and drew the following inferences:—1. That the abdominal muscles are an extension and expansion of the caudal muscles. 2. That the several abdominal muscles are derived from one simple muscular sheet, which is segmented into planes by difference in direction of the muscular fibres at different depths. 3. That the fibres of the external and internal oblique muscles are continued into those of the rectus, a gradual alteration from an oblique to a straight direction being observed in the fibres as they approach the middle line. 4. That the ilium and the ribs are the result of ossification in the course of the intermuscular septa and chiefly in those parts of their thickness which correspond with the plane of the internal oblique muscle.

SUB-SECTION.—ANTHROPOLOGY

Lieut.-Col. Forbes Leslie read a paper *On ancient Hieroglyphic Sculptures.* All the hieroglyphics on Scotch rocks and monoliths can be assigned to two distinct types, the earliest of which consisted for the most part of circular cups or cavities worked in the stone, and also of circles, or parts of circles, variously combined. The second type, which seems to have superseded the first, did not entirely reject its figures, and, from the territory in which it is alone found, may be termed Pictish. The earlier form is found widely distributed on monoliths in Scotland, while the later form is much more restricted. The hieroglyphs were symbols of religious ideas.

In the next paper, by Dr. Conwell, *On an Inscribed Stone at Newhaggard, in the County of Meath*, curious hieroglyphic characters of an unknown age and inscrutable meaning were exhibited to the meeting.

Dr. Beddoe then contributed a paper *On the Inhabitants of the Merse.* There were, he said, two well-marked types, the one consisting of a rather long and narrow oval head, almost Swedish or Frisian in form, light eyes and hair, and a tall, long-limbed figure; the other had a broader head, fuller temples, hair brown or light, and a robust frame. In stature and bulk the men of the Merse are hardly surpassed in Great Britain. Their large size may be inscribed to inheritance from the original Teutonic settlers of the district, and partly to the agency of a harsh and uncongenial climate, and a coarse, but plentiful diet of oatmeal, peasemeal, and milk. It is very probable, however, that the use of bread and tea instead of meal and milk, would cause a physical degeneration in the future.

Then followed a paper by Mr. J. W. Jackson, *On the Atlantean Race of Western Europe*, and *A Description of Paleolithic Implements*, by Mr. J. W. Flower. And in the absence of the authors of some of the papers Mr. W. Boyd Dawkins gave an account of the origin of the domestic animals of Europe. None of them date so far back as the Quaternary age. The sheep, goat, the small short-horned ox (*Bos longifrons*) the domestic *Urus*, the domestic horse, the dog, the tamed wild boar, and the turf-hog, to which all the European swine can be traced, appeared in Europe at the same time in the Neolithic age. He argued that they were probably derived from the East, and imported by a pastoral people from the central plateau of Asia. The evidence afforded on the point by the southern forms of vegetation found along with this group of animals in the Swiss lakes adds considerable weight to this view. In Britain, down to the time of the English invasion, there was no evidence of any larger breed than the small short-horned *Bos longifrons;* the larger breed of the *Urus* type were probably imported by the English, and is represented at the present day in its purity by the white-bodied, red-eared Chillingham ox. In the course of the discussion Dr. Sclater fully agreed with the views of the speaker as to the eastern origin of our domestic animals, since the East is the only region in which the wild ancestors of the domestic breeds are now found.

The President then read a paper *On Human and Animal Bones and Flints from a Cave at Oban, Argyleshire*. The cave contained the remains of man associated with flint-flakes and the bones of the red and roe deer, fox, otter, and possibly reindeer. The human teeth were unground, and contrasted strongly in their preservation with those of modern civilised races; the leg-bones also presented features which possibly may be platycnemic. The date of the cave is uncertain, but the association of flint implements with the human and animal bones pointed to a considerable antiquity.

W. Boyd Dawkins made some remarks on the Classification of the Palæolithic Age by means of the Mammalia. The eminent French naturalist, M. Lartet, acting on the *a priori* consideration, has attempted to divide up the palæolithic age into four distinct periods. "L'age du grand ours des cavernes, l'age l'elephant et du rhinocéros, l'age du renne, et l'age de l'aurochs." He said the very simplicity of the system had made it popular. A cave bear is found in a bed of gravel of a cave, and you put it down to the period of the great bear; you find an aurochs, and forthwith assign it to the latest age. There are, however, two fatal objections to this mode of classification. In the first place, nobody could expect to find the whole Quaternary fauna buried in one spot. One animal could not fail to be better represented in one locality than another, and therefore the contents of the caves and river deposits must have been different. The den of a hyæna could hardly be expected to afford precisely the same animals as a cave which had been filled with bones by the action of water. It therefore follows that the very diversity which M. Lartet insists upon as representing different periods of time, must necessarily have been the result of different animals occupying the same area at the same time. In the second place, M. Lartet has not advanced a shadow of proof as to which of these animals was the first to arrive in Europe. From the fact that the Glacial period was colder than the Quaternary, it is probable that the Arctic Mammalia, the mammoth, woolly rhinoceros, and the reindeer arrived here before the advent of the cave bear. It is undoubtedly true that they died out one by one, and it is very probable that they came in also gradually. The fossil remains from the English caves and river-deposits, as, for instance, those of Kent's Hole or Bedford, prove only that the animals inhabited Britain at the same time, and do not in the least degree warrant any speculation as to which animal came here first. Nor does it apply to France or Belgium, for in the Reindeer caves of both these countries the four animals in question occur together—the Mammoth with the Reindeer and the Aurochs with the Urus. In Belgium, indeed, the reindeer was probably living in the Neolithic bronze and iron ages, since it lived in the Hercynian forest in the days of Julius Cæsar.

SECTION E.

At the opening of this Section on Monday morning two very interesting papers were read by Mr. C. R. Markham, *On the Recent North Polar Expeditions*, one was by Dr. Copeland, on the Second German Arctic Expedition, and the other by Capt. Ward, R.N., on the American Arctic Expedition. Both papers contained details of great interest, some of which have, however, already been published in Petermann's *Mittheilungen*, and elsewhere; and it is impossible in a short space to give even an abstract of them. They gave rise to interesting discussions.

The proceedings of this Section closed on Tuesday, August 8, when Mr. A. Buchan read a paper *On the Rainfall of the Northern Hemisphere in July contrasted with that for January*. The paper was illustrated by chart showing the distribution of rain in inches over the greater portion of the northern hemisphere in July. Mr. Buchan described the principles which guided him in drawing lines representing the rainfall of the globe—namely, to reject all places which, being in the immediate vicinity of hills or rising grounds, did not represent the average rainfall of the district; secondly, he drew lines of rainfall for each month separately. The months of July and January were selected, because in these months the greatest effect of heat and cold on the earth's atmosphere and its movements occurred. In July the line of the rainfall passed through the south of Spain, the north of Africa, through Syria, and thence westwards into the desert of Cobi, thus forming the northern boundary line of the rainless region of this part of the globe in July. The map further showed that the greatest amount of rainfall occurred in the centre of the continent of Asia and Europe, taking them both as one continent; and that the line of greatest rainfall passed through the centre of Europe and towards the centre of Asia to some distance north of the Caspian. In India, the line of the rainfall passed a little to the west of the Ganges, east of which the lines representing inches could not be shown; and the whole of this region was therefore marked by a deep red to show the rainfall was enormous; and the rainfall was also very excessive in Further India, and in the east of Asia generally. In America the line of the rainfall included California and the neighbouring regions. Very heavy rainfall occurred in the lake district of the north-western sides which sloped eastward—that is, those to the east of the mountains; but the heaviest rainfall occurred in the sides bordering on the Gulf of Mexico and the whole of the eastern slope of Central America. In the map contrasting the rainfall of July with that of January, there were two sets of lines—blue and red, the red showing those regions at which the rainfall of July exceeded that of January, and the blue those regions where the rainfall was less than that of January. Mr. Buchan showed that where there were prevailing winds blowing into warmer latitudes the rainfall was not defective, even though those winds came from the ocean, and illustrated his remarks by the summer rainfall of the south of Europe and the north of Africa, and by that of California. The greatest excess of the rainfall in July was in those regions to which the prevailing winds arrived after having traversed a vast extent of ocean, India and Central America. Illustrating this connection, on the western slopes of the British Isles the rainfall in July was less than that of January, but on the eastern slopes it was greater. In July, when the prevailing winds blew from the Atlantic eastwards into the centre of the great continent, the rainfall of the hills of this immense tract was greatly in excess in July of what it was in January. Mr. Buchan also pointed out the importance of inquiry in reference to the great movement of the atmosphere, especially the vapour which was condensed into rain, and which must come from some neighbouring surface. The important bearing of the subject on physical geography and climate, and the distribution of vegetable and animal life on the globe, was also pointed out.

On the conclusion of the paper, Colonel Yule remarked that Mr. Buchan had not gone beyond six inches in his calculations, but he wished to state that in the place where his earliest service began—in the district of Assam—there fell, in the month of August 1841, 30 inches of rain on six days continuously, or 180 inches in all, while the whole rainfall of Edinburgh for a year was about 26 inches. During that same month of August the rainfall was 264 inches, or 22 feet. He thanked Mr. Buchan heartily for his paper, and hoped that his maps and observations would be published before long in a shape in which they could all have access to them.

The only remaining paper of more than pure geographical interest was by Captain L. Brine, R.N., *On the Ruined Cities of Central America*. It stated that it was not until the year 1870—more than than 200 years after the Spanish conquest—that the existence of ruined cities and temples lying hidden in the jungles and forests of Central America was revealed to the knowledge of the Spanish Government. A small party of Spaniards, travelling in the State of Chiapas, happened to diverge from the usual track leading from the southern limit of the Gulf of Mexico to the Mexican Cordilleras, and accidentally discovered in the dense forest remains of stone buildings—palaces and temples, with other evidences of a past and forgotten civilisation of a very high order. These ruins were those of Palenque. Some years subsequently to this discovery, the King of Spain ordered an official survey to be made, and this survey was made in 1787 under the direction of Captain del Rio. Later official surveys were also made in 1806 and 1807; but these, with the usual secresy of the Spanish conquerors, were not generally made public, and thus it happened that only as recently as the year 1822, at the revolution of Mexico, did the existence of these ruins first become known in Europe. Since then other hidden cities or temples had been discovered—Copan, in the State of Honduras; Ocosingo, on the frontiers of Guatemala; and several in Yucatan, of which Uxmal and Chichen Itza are the most famous. It was very remarkable that all these ruins, evidently the work of one particular and highly-civilised race of Indians, should only be found in a very limited area. None exist in South America, and none in that part of the continent commonly distinguished as North America—they all lie within the tropics, between the 14th and 22nd parallels of north latitude, and were chiefly adjacent to the Mexican and Honduras Gulfs, or in the plains on the west of the Cordilleras of Central America. On the eastern or Pacific slopes and plateaux, within the same parallels, are also remains of ancient fortifications and sacrificial altars, but these are of a less elaborate type, and are allied to the Aztecan structures of Mexico. The paper went on to give an interesting account of a journey undertaken by the writer across the continent, in the spring of last year, from the Pacific, through Guatemala to the Atlantic, to enable him to examine in detail the mixed populations and conditions of the lands between the Cordilleras and the Pacific, the central plateaux, with their aboriginal Indian races and ruins, the region—almost entirely unknown—inhabited by those unbaptised Indians called the Candones, near which lie the ruins of Ocosingo and Paleque, and finally concluding the journey by traversing Yucatan, visiting the strange ruins with which the country abounds, and emerging on the northern coast of the peninsula at Sisal.

SCIENTIFIC SERIALS

THE *Journal of Anatomy and Physiology.* Conducted by G. M. Humphry, M.D., F.R.S., Professor of Anatomy in the University of Cambridge; and William Turner, M.D., Professor of Anatomy in the University of Edinburgh. No. VIII. May, 1871 (Macmillan and Co.).—This number is quite up to the standard of its predecessors, but the papers it contains are so numerous that we can do little more than indicate the subjects of most of them. Mr. Perrin heads the list with a couple of papers on muscular variations observed in the dissecting room of King's College, London, during two winter sessions; and Mr. Wagstaffe, demonstrator at St. Thomas's, Mr. Bradley, of the Manchester Medical School, and Mr. Cameron contribute similar papers, and thus illustrate one great use of the journal, for without it such observations would probably go unrecorded. —Mr. W. A. Hollis gives an account of the so-called salivary glands of the cockroach, and seems to show satisfactorily that they are really part of the tracheal system of the insect, and not glandular at all.—Dr. Wickham Legge contributes some observations on the physiological action of hydrochlorate of cotarnamic acid, a derivative of narcotine obtained by the late Dr. Matthiessen; the most interesting points about the new poison are the length of time (often several days) which elapses before its effects show themselves if it be administered by the mouth, and the great diminution of blood pressure and the paralysis of the cardiac branches of the vagus which it produces.—Mr. Garrod, of St. John's College, gives an account of a very simple cardio-sphygmograph which appears likely to prove useful, and also a description of the telson of Schyllus arctus, in which he endeavours to show that it is not a mere azygos appendage as it is usually supposed, but is a true body segment, possessing appendages of its own.—Dr. Wilson Paton has a paper on the influence of certain drugs, of diet, and of mental work, on the urine; one of his most important results being that neither the infusion, alcoholic extract of alkaloids of broom tops, have any effect in increasing the quantity of any of the constituents of the urine, at least in health, although they are so commonly regarded and prescribed as diuretics.—Prof. Cleland gives an account of a case occurring in his practice which showed that the trapezius plays an important part in keeping the bones of the shoulder joint in contact; he also describes a case of epispadias.—Prof. Rutherford describes a modification of Stirling's section machine, which is especially fitted for getting microscopic sections of frozen tissues, and also gives some experiments on the excitability of the trunk of a spinal nerve which go to negative Pflüger's "avalanche" theory.—Dr. Kennedy contributes an account of a young Aïno cranium; and Prof. Turner concludes the original articles of the number with papers on the "Two-headed ribs of whales and man" and on the "Transverse processes" of the seventh cervical vertebra in Balænoptera Sibbaldii. The review of the recently published works bearing on the natural selection theory is peculiarly full and interesting, and the reports on the progress of anatomy and physiology during the preceding three months, which conclude the number, are drawn up with their usual completeness.

Symon's Meteorological Magazine has now reached its fifth yearly volume, and it maintains its character of being a useful monthly medium for the interchange of meteorological jottings, which are not of sufficient importance to form papers for scientific societies. It contains, in addition to reviews and abstracts or reprints of papers published elsewhere, some valuable notices of special investigations carried on by private observers, such as a discussion on solar radiation temperatures, conducted by the Rev. F. W. Stow and Mr. Nunes. The tornado of October 19, and, of course, the aurora of October 24 and 25, find a place in its pages. The standing portion of the magazine, however, consists of monthly rainfall returns and notes on weather from about fifty stations, and thus forms a sort of supplement to the annual volume, "British Rainfall," brought out by the same author.

Journal of the Chemical Society.—The last number of this journal contains the "abstracts of chemical papers" which have been already noticed in our columns, and two papers read before the Society, the first being "The Action of Heat on Silver Nitrite," by Dr. Divers. The author finds that when silver nitrite is submitted to the action of heat it is decomposed, the products of the action consisting principally of silver nitrite, metallic silver, and oxide of nitrogen, but that the relative proportions of these vary according to the conditions of the experiment. When the nitrite is heated in an open dish, the result may be represented by the equation $3NO_2Ag = N_2O_3 + Ag_2 + NO_3Ag$, but if it is heated in a vessel nearly closed, so that the gaseous products may be kept in contact with the undecomposed nitrite, the loss of weight is less, and the amount of nitrite formed is greater, the hot silver nitrite apparently reducing the higher oxides of nitrogen to nitric oxide. When the nitrite is freely exposed to a moist atmosphere, and heated, it tends to yield only metallic silver and nitrogen peroxide. Mr. Gill, in "Laboratory Notes on the Examination of Glucose containing Sugars," after remarking on the effect produced by the use of an excess of lead subacetate in decolouring sugar solutions for optical examination, the action of inverted sugar on polarised light being greatly altered by the presence of this reagent, proposes the use of a strong solution of sulphur dioxide as a satisfactory method for removing the lead.

IN the *Journal of Botany* for August the most interesting article is a "Flora of Hyde Park and Kensington Gardens," by the Hon. J. L. Warren. This apparently unpromising field for botanising yielded to a careful search no fewer than 190 species of indigenous flowering plants, some half-dozen of them by no means common plants, and the list might probably be considerably extended. A hundred years hence this list will be of considerable interest to the botanist of the future. The other original articles in this number are of a more technical character.

SOCIETIES AND ACADEMIES

BRISTOL

Observing Astronomical Society.—Observations to July 31.—*Solar Phenomena.*—Mr. T. W. Backhouse, of Sunderland, observed a large spot in the sun's south hemisphere from the 12th to the 22nd of July. He obtained the following measures of its dimensions:—

Date.		Penumbra. Length. Miles.	Umbra. Length. Miles.	Umbra. Breadth. Miles.
July 12	9.12 a.m.	—	20,000	about 10,000
July 15	9.15 a.m.	36,000	17,000	—
July 18	7.45 a.m.	37,000	22,500	14,500
July 20	7.55 a.m.	41,000	27,500	18,000
July 22	9.15 a.m.	—	22,500	7,500

"It was comparatively small on July 9. The umbra was one of the largest I have ever seen."

Comets I. and II., 1871.—Mr. John Birmingham, of Tuam, reports that he "had several observations of Comet I., from April 22 to May 8, but under very unfavourable circumstances, caused by the state of the atmosphere and strong twilight and moonlight. Still notwithstanding its faintness a nucleus was easily detected, and the comet seemed in general to present a granulated appearance. On April 22 it was not visible in the finder, but bore magnifying up to 126 very well. There was a slight elongation in the normal direction of a tail. By the best measurements that I was able to apply, the comet seemed always slightly in advance of the position computed by Pechüle. On July 17, at 12^h 15^m, Dublin mean time, I first found Comet II., the cloudy weather having rendered a previous search ineffectual. This comet was of extreme faintness, and without the sharpest attention it might easily pass unnoticed across the field. When first observed it was in contact with a small star, not identified, from which it gradually detached itself, and its position seemed to agree well with Pechüle's calculation. It was best seen with 56 and 99, and with the latter, after intent gazing, the momentary flickerings of minute points in its misty form could be caught at instants of good definition. This so strongly suggested the appearance of a nearly resolvable cluster that I was not satisfied with the comet's identity until I perceived its motion. Previous to this observation I had not read the description of the object by Herr Tempel, the discoverer, but subsequently I was pleased to see his allusion to its appearance as if 'sprinkled' with little stars towards the middle. If the light of the comet is sufficient, I shall not be surprised to hear of its giving indications of a continuous spectrum in addition to the usual bright lines." Mr. Charles Hill, of Bristol, also observed Comet II. on July 18, and found that it was an exceedingly faint object. It was scarcely perceptible in his 8½ in. equatorially mounted reflector.

Venus.—Mr. Henry Ormesher has succeeded in detecting the dark markings on several recent occasions. On April 22 they were rather pale, but the terminator was clear and well defined. On May 10 they were well seen, and appeared to him to be very similar to the dusky markings on the surface of Mars. On May 21 and 29 he also saw the markings. Mr. H. W. Hollis examined the planet on July 17, at 6^h 30^m, with his 6 in. O.G. power 150. "The rounding off of the southern cusp was evident at a glance, and the prolongation of the northern one more remarkable than I have ever seen it before. A dusky ill-defined spot, of uncertain shape, was visible. On the 18th, at 5h 15m, I suspected the presence of this spot again somewhat nearer the terminator, but of this I cannot speak positively." Mr. John Birmingham, of Tuam, writes: "I have been carefully observing Venus at every opportunity without detecting any definite markings besides the well-known peculiar forms exhibited by the cusps, which appear to me brighter than other parts of the planet."

Saturn.—Mr. H. W. Hollis reports as follows:—"On July 17, at 10^h 20^m, I inspected Saturn on the meridian, and notwithstanding his low altitude, found the shadow of the ball upon the rings clearly visible. I could trace Ball's division all round in moments in fine definition. But what especially interested me was that, under a power of 250, the eastern opening between the ball and the inner ring was unmistakeably wider than the western one. Of this I am certain. The air was too unsteady to admit of any operations with the micrometer."

PARIS

Academy of Sciences, August 14.—M. Faye in the chair. M. Dumoncel sent a note on the Influence of Electrodes in the Generation of Electricity. It is well known already by every working electrician that a cool surface may be enlarged with advantage for a certain distance and surface of zinc.—M. Demosquay sent a paper, which showed that many Communist Nationals were wounded when intoxicated. The result of it was an immense mortality amongst them, which could not be prevented by the most assiduous care. The temperature of the patients was remarkably low, which is always indicative of great danger.—M. Arson, chief engineer of the Parisian Gas Company, has conducted with great care for many years experiments with the view of correcting the compass from every variation produced by the iron contained in ships. These experiments were worked out in the great La Villette gas works, where the company keeps about twenty large gas-meters. A commission appointed for the purpose will in course of time publish an elaborate report. M. Lependry, engineer of the canalisation in the same company, has commenced to study all accidents analogous to the extraordinary gas-lighting by thunderbolts, described in M. W. de Fonvielle's memoir.—M. Resal, an engineer in the mining service, sent a note showing that connecting chains as they are used by railway carriage constructors are not strong enough.—M. Durand Claye, an engineer in the Ponts et Chaussées, sent a paper strongly advocating a radical change in the way of dealing with the sewage of Paris. The learned engineer shows, by conclusive arguments, that it is absolutely necessary to deal with these refuse waters according to the British system, as worked for years in Edinburgh, &c., &c. It is not the first time that learned members of our scientific administration have tried to naturalise that excellent method. But every real progress was stopped by the prevalent system of Imperial red tape and corruption. It is to be hoped that the French Republic will not lose time in putting an end to the disgusting waste of manure now permitted to poison a noble stream. M. Durand Claye proposed to irrigate the celebrated Gennevilliers peninsula, whose extent is only 5,000 acres.—M. Leverrier read a report on observation of the August meteors, of which a summary was published in the *Times* of August 17. He read also a letter from M. Coggia stating that his bolide was not an imaginary one. M. Elie de Beaumont expressed an opinion that possibly that extraordinary bolide was not of planetary origin, but merely some fire formed in our superior atmosphere, possibly by the agency of electricity. M. Henry Sainte-Claire Deville read a memoir written by MM. Nagi and Hautefluelle, two teachers in the normal school, on a peculiar fact of chemistry relating to a combination of chlorine of silicium, which appears to be destroyed from 700° to 1,000° C., and to be formed again from 1,000° C. to 1,500° C.—M. Charles Sainte-Claire Deville read a short note on a stroke of lightning which exploded within his meteorological observatory, two hours only before an academical sitting had taken place. The natural electricity was attracted by a leaden tube, in which an isolated metallic wire belonging to the telegraphic system of the observatory had been inserted. The leaden tube had performed the part of a condenser, and the spark was created on the spot of the explosion as the primary wire was in connection with the earth.

BOOKS RECEIVED

ENGLISH.—Bird Life, Part 1: A. E. Brehon (Van Voorst).

FOREIGN.—(Through Williams and Norgate).—Geschichte der Glycosurie von Hippokrates bis zum amfange des Neunzehnten jahrhunderts: Dr. Max Solomon.—Ueber die Helligkeitsverhältnisse der Jupiterstrabanten: Dr. R. Engelmann.—L'Homme pendant les Ages de la Pierre: M. E. Dupont.

PAMPHLETS RECEIVED

ENGLISH.—British Railway Reform: J. H. Watson.—Western Chronicle of Science.—Cassell's Book of Birds, Part XXII.—On the Spirit Circle: Emma Hardinge.—Transactions of the Boys' Literary Society, Sidcot School, 1870-71.—Sidcot School Board Chronicle.

AMERICAN AND COLONIAL.—What are they doing at Vanar?—Fourth Annual Report of the Trustees of the Peabody Museum.—Transactions of the Entomological Society of New South Wales, Vol. ii., Part 2.

FOREIGN.—Bulletin de la Société de Géographie for May, June, and July, 1871.—L'Institut, No. 1,921.—Allegemeine für Deutschland, No. 33.—La Tour du Monde, No. 565.—La Rêvue Scientifique, No. 9.—Rendiconti, Vol. iv., No. 15.

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NOTICE

We beg leave to state that we decline to return rejected communications, and to this rule we can make no exception.

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