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CONTENTS.

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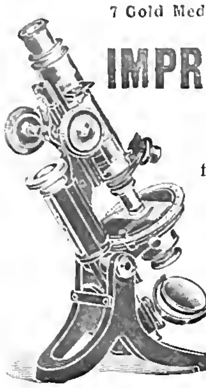

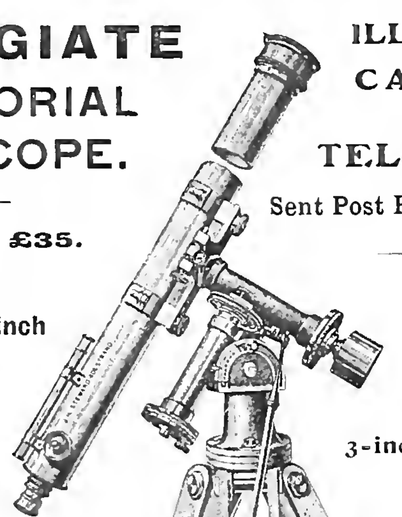

CONTENTS.

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CONTENTS.—See page V.

An Extraordinary Reptile.

By R. LYDEKKER.

THANKS to the authorities of the United States National Museum at Washington, the British public will shortly have the opportunity of seeing, in the Natural History Museum at South Kensington, a restored model of the skeleton of what may well be termed the most extraordinary representative of that wonderful group of extinct land reptiles, the Dinosauria. It is not that the Triceratops (as the creature was appropriately named by the late Professor O. C. Marsh, of Yale College) is remarkable on account of its vast bodily size, for in this respect it is not in the running with the giant Diplodocus, whose skeleton was set up a few years ago in the reptile gallery of the museum. Neither does it lay claim to admiration and astonishment on account of walking on its hind legs with its head raised sixteen feet high in the air like its cousin the Iguanodon. On the contrary, Triceratops, so far as bodily size and gait are concerned, has no claim to special distinction, its total length falling just short of a score of feet, while it walked on all fours very much in the fashion of an unusually long-limbed crocodile.

What, however, it lacks in these respects, the three-horned dinosaur, as it may be designated in the vernacular, more than makes up for in the extraordinary conformation and huge size of its skull. It enjoys, in fact, the distinction of having, both absolutely and relatively, the largest head of any known land animal either living or extinct, and to find a parallel in this respect we must look to the members of the whale tribe, in some of which the relative size of the head is, however, still greater.

The horned dinosaurs, of which those commonly designated Ceratops and Triceratops are the best known, were described by Professor Marsh in a series of papers published in the *American Journal of Science* between 1888 and 1894, inclusive. Their remains occur in the upper Cretaceous beds along the eastern flanks of the Rocky Mountains for a distance of about eight hundred miles, but are more abundant than elsewhere in Wyoming, and more especially Converse County, where the original of the skeleton forming the subject of the present article was discovered. As an indication of the abundance of these remains in the district in question, it may be mentioned that some years ago a single investigator collected bones referable to no less than forty distinct individuals. The Ceratops beds, as they are called, are of fresh-water, or brackish, origin, but rest in some places on marine strata. As they occur some distance below the topmost Cretaceous, their age may be approximately correlated with the highest beds of our chalks, so that the horned dinosaurs lived at a much later epoch than the majority of the giant herbivorous dinosaurs, which flourished during the Oölitic and Wealden epochs. By some palæontologists it has been considered probable that the horned dinosaurs of North America were represented by allied types in the upper Cretaceous of Continental Europe, but by others the correctness of this identification is disputed, and the group is regarded as peculiar to America.

The skeleton, of which the model sent to this country is a replica, forms one of the most striking objects in the court devoted to vertebrate palæontology in the museum at Washington, and is the first of its kind that has hitherto been mounted. When discovered, it was far from complete, and it accordingly became necessary to restore the missing bones. So far as possible these missing parts were supplied by selecting bones from other skeletons of the same approximate size, but when this proved impracticable, as was the case in a few instances, the bones required were modelled in plaster. The skeleton is, therefore, confessedly in some degree a "fake," although the restoration is believed to be practically true to nature. It need scarcely be added that, except on sentimental grounds, the model is in every way as good as the original, although there are doubtless persons who, when they learn this, will exclaim: "Oh, but it isn't real," and will thereupon cease to take any further interest in the specimen.

As mounted, the skeleton measures 19 feet 8 inches from the front of the curious, toothless beak to the tip of the tail; while at the loins it stands 8 feet 2 inches. In addition to the skull, which is 6 feet long, or nearly one-third the total length, the most noteworthy features of the skeleton are its great relative height at the loins, the extremely short and deep body (shaped more like that of a mammal than that of a crocodile), the tall and massive limbs, and the curious turtle-like flexure of the fore-feet. Unfortunately, it was found impossible to determine the exact proportions of the front horn in this particular species, so that it was deemed necessary to omit in the restoration this very characteristic feature, upon which the generic name Triceratops is in part based.

In addition to its great absolute and relative size, the skull is specially characterised by the presence of three horns, one in front and two behind; the hind pair being strikingly like the horn-cores of a gigantic ox. Indeed, so ox-like are these horns that a pair was actually described as indicating a Cretaceous bison. Equally peculiar is the presence of a cutting beak, formed by a separate bone in each jaw. More striking still is the presence of a great bony curtain or frill (like the flange of a fireman's helmet) overhanging the neck, and thus rendering the relative length of the skull greater in respect to the rest of the skeleton than it really is. Both the horns and the curtain are considered by Professor Marsh to have been covered in life with a thick layer of horn.

Despite the enormous size of the skull, which forms a long triangle in shape, the brain was of the small size of dinosaurs in general. Whether this implies slow and sluggish habits is not easy to decide. The powerful armature of the skull is, however, suggestive of activity both in attack and defence, it being difficult to imagine that such structures were not developed for special purposes.

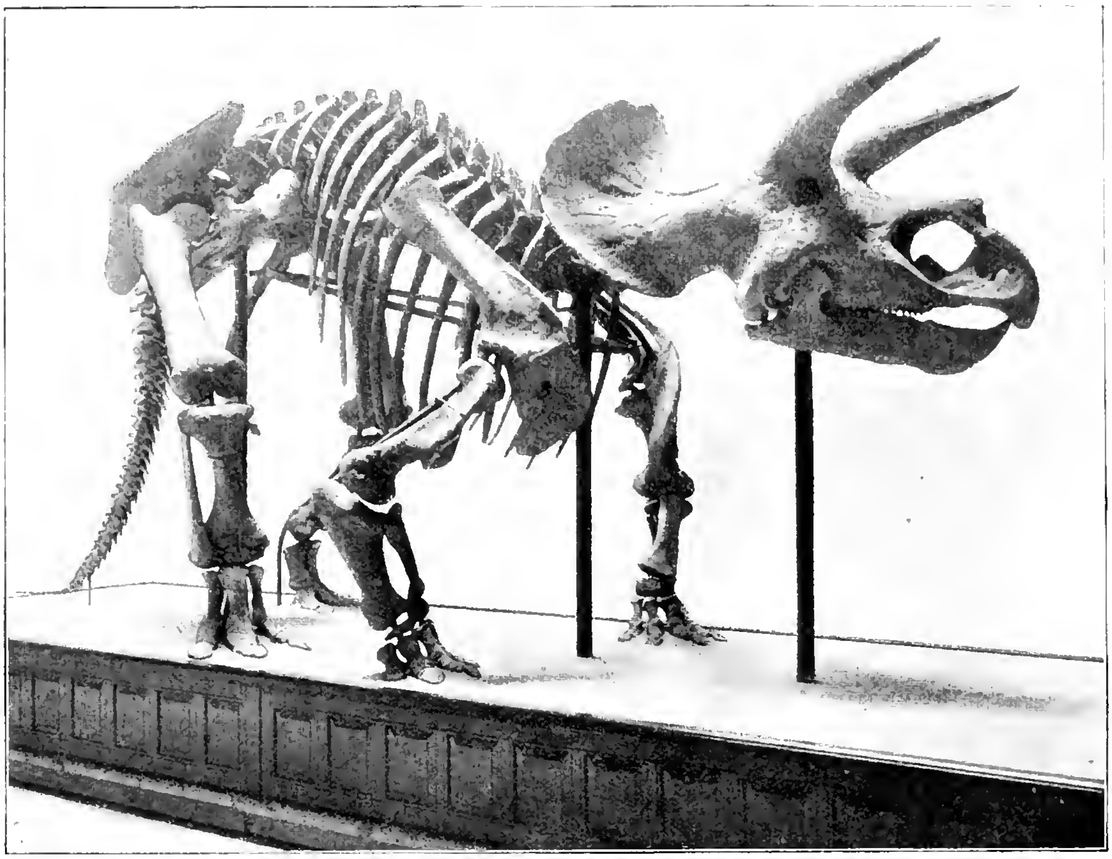
That Triceratops was an herbivorous reptile is evident from the structure of its teeth, which differ, however, from those of more ordinary dinosaurs in being implanted in the jaws by means of two distinct roots, thereby foreshadowing the mammalian type, although, of course, there is no direct relationship between this group of reptiles and mammals. By Professor Marsh the food of Triceratops is considered to have been formed by soft, succulent vegetation

Although no attempt has been made to reproduce it in the restoration of the skeleton, it was believed by Professor Marsh that during life the body was protected to a certain degree by bony armour. This idea is based on the fact that various spines, bosses, and plates of bone have been found in association with the remains of these dinosaurs. To assign these fragments of armour (presuming, of course, that they really belong to the Triceratops) to their proper position on the body has not at present been found practicable, although it was suggested by Professor Marsh that some were probably situated on the back behind the bony curtain of the skull, while smaller ones may have defended the throat. In a restoration of the creature attempted by an American artist the spines are altogether omitted.

That the heavy armature of the head in the Triceratops and its allies was developed for purposes of attack and defence seems, as already mentioned, almost a certainty. Presuming this to be the case, it has, however, yet to be definitely demonstrated whether it was for the purpose of aiding these reptiles in encounters with individuals of their own species, or to protect them from the attacks of contemporary carnivorous dinosaurs, such as the Dryptosaurus (or Laelaps), the Cretaceous representative of the well-known Megalosaurus of the Oölites. Professor F. A. Lucas, who has paid much attention to the restoration of extinct animals, is in favour of the former alternative, as is evident from the following passage :—

"So long as Triceratops faced an adversary, he must have been practically invulnerable, but, as he was the largest animal of his time, it is probable that his combats were mainly with those of his own kind, and the subject of dispute some fair female upon whom rival suitors had cast covetous eyes. What a sight it would have been to have seen two of these big brutes in mortal combat as they charged upon each other with all the impetus to be derived from ten tons of infuriate flesh! We may picture to ourselves horn clashing upon horn, or glancing from each bony shield until some skilful stroke or unlucky slip placed one combatant at the mercy of his adversary . . . .

"A pair of Triceratops horns in the National Museum (at Washington) bears witness to such encounters, for one is broken midway between tip and base; and that it was broken during life is evident from the fact that the stump is healed and rounded over, while the size of the horns shows that their owner reached a ripe old age."



Skeleton of the Horned Dinosaur (*Triceratops prorsus*), from C. W. Gilmore, *Proc. U S. Nat. Museum*, 1905.

In connection with the concluding part of the last sentence, it should be mentioned that reptiles, like fishes, but unlike birds and mammals, continue to grow throughout their entire span of life, so that unusually large bodily size is, at all events as a rule, an indication of advanced age. As regards general appearance, Triceratops may, perhaps, be best described as a reptilian rhinoceros, with the proviso that the tail was much larger and thicker than in that group of animals, and passed insensibly into the body, as in reptiles generally, while the number and arrangement of the horns were different.

To imagine what colour the creature may have been in life is, of course, mainly, if not entirely, a matter of pure conjecture. From the prevalence of slaty hues in giant living mammals of the present day, such as elephants, rhinoceroses, and hippopotamuses, Professor Lucas is, however, inclined to believe that similar tints may have obtained among the giant reptiles of former days. "So," he writes, "while a green and yellow Triceratops would undoubtedly have been a conspicuous feature in the Cretaceous landscape, from what we know of existing animals, it seems best to curb our fancy, and, so far as large dinosaurs are concerned, employ the colours of a Rembrandt rather than those of a sign-painter."

As already mentioned, the head of the Triceratops is so vast in proportion to the rest of the animal that it might seem a difficult problem in mechanics to explain how it was adequately supported in life. The solution of the problem, according to the researches of the American palæontologists, is apparently to be found in the great posterior fringe of the skull, which served not only as a means of defence, but acted as a counterpoise to the enormous weight of the fore-part of the skull, and likewise afforded ample space for the attachment of the mass of muscles and ligaments necessary to support and move the enormous head. As a matter of fact, the centre of gravity of the skull has been found to be situated behind the eyes, so that the head was well balanced on the anterior neck-vertebræ. It may be added that, as in whales, several of the vertebræ of the neck were more or less completely welded together so as to afford additional support and stability for the attachment of the muscles. Of course, this implies restriction of mobility in the neck, but as this was already brought about by the existence of the overhanging frill itself, no additional detriment was involved.

The Observation of Meteors and Meteoric Showers.

By W. F. DENNING.

THERE is so much to be said with regard to this subject that it can hardly be comprised within the limits of a short paper. If photography could now effectually take the place of visual observation we might look for more accurate results, but, unfortunately, we still have to depend mainly upon rough eye estimates of position.

It will be important to determine whether the Bootids, Aquarids (May and July), Leonids, Geminids, and some other rich streams, exhibit a shifting or fixed radiant. The Perseids and Lyrids have centres becoming displaced from night to night, while the Orionids form a stationary radiant.

Fresh evidence should be gleaned as to the apparently long duration of a great number of minor systems and the unchangeable situation of their radiant points. Are the latter identical in position during their prolonged activity?

The principal periodical displays should be observed from year to year, and the date, hour, and visible strength of their maxima carefully noted.

Do the Andromedids form an annual display similarly with the Perseids, Leonids, &c.?

Fireballs should be precisely and fully recorded whenever they are seen, both as to their paths amongst the stars and the durations of their flights. These brilliant objects are usually directed from radiants in the western half of the sky, and move slowly in orbits overtaking the earth. As they often appear at times when regular meteoric observers are not watching the heavens, astronomers generally should combine to record and communicate the necessary data for the computation of their real paths in the air.

I have often thought it would be a good plan to form a society specially devoted to the observation and discussion of fireballs. The society need simply consist of gentlemen who would undertake to record and report such large meteors as they see either casually or during regular observation. These objects are sometimes not fully recorded, and many are not publicly notified at all. Thus numbers of them escape suitable investigation every year in England alone. If observers made it a practice of supplying prompt, ample, and accurate information of such conspicuous meteors as they witnessed, the materials would soon form a substantial gain to meteoric astronomy.

For the detection of the ordinary shower-radiants of shooting stars individual observers are recommended to pursue long watches habitually. The great majority of meteoric showers are so feeble that they will escape recognition unless the search for them is very keen and persevering. A single observer is capable of doing a great deal of useful work, but must, necessarily, do it in a very thorough manner, or the data secured is sure to be meagre. But an experienced and naturally-talented man will certainly derive more exact and trustworthy results than any combination of individuals. One amongst the latter may be very inaccurate, and the incorporation of his results will spoil the whole collection. In a cloudy climate like England, however, an observer working single-handed cannot achieve much, but it is astonishing how many materials can be gathered by a person who watches during the whole night and avails himself of every opportunity presented.

It is particularly with regard to fireballs that I trust some effort will soon be made to secure more numerous observations. The necessity for this will be obvious when I mention that during the last three months of 1906 I received, or read published, descriptions of 45 large meteors seen in England. Yet only in three or four cases were duplicate observations forthcoming. If some organised plan were followed in collecting data concerning fireballs I feel certain that instead of some half-a-dozen of their real paths being computed annually we should soon be in a position to increase the number to 30 or 40, and this would represent a very important addition to this interesting branch of science.

Planetary Chart for 1907.

MESSRS. CARL ZEISS send a sheet containing particulars of the planetary positions prepared from the specification of R. H. Bow, of Edinburgh. Two charts are presented, one showing the declinations at any given date, the other right ascensions. Having found the R.A. and Decl. for any date from these two curves, the place of the planet is then plotted on the zodiacal star chart at the top of the sheet. The device gives a considerable amount of useful information in a small space, and will doubtless be convenient to many who have not tables handy.

Lord Kelvin on Earthquakes.

THERE have been for some time back more than the normal number and variety of terrestrial disturbances. We have had the violent earthquakes at San Francisco, Chili, Kingston, and Sumatra striking terror and desolation. And we recently had one of the most brilliant displays of aurora borealis that have been witnessed for years. At the same time there was a preponderance of large spots on the sun.

Lord Kelvin, at a meeting of the Royal Society of Edinburgh, the other day, gave his candid, learnedly scientific, but not dogmatic opinion of the causes of earthquakes. To do this he had to go back to the formation of the earth. He returns to the atomic theory derived from the Greeks of old, and popularised in verse by the Latin poet, Lucretius.

According to this theory, the primitive condition of things was atomic. At first these atoms were at rest, distributed uniformly in respect of average density through a sphere of a thousand times the size of the earth. Lucretius held that the atoms had in them the inherent power of motion in parallel lines, but his theory fell through when the parallel motion was transformed into jostling and solidifying. But Lord Kelvin considers that each atom would have a velocity to the centre, until some came so near one another that mutual molecular forces brought about combinations. At that stage the density would be considerably less than one-tenth of the density of water.

When the density became so great that the atoms jostled against each other, concrete matter began to be formed. There would be an immense crowd of atoms becoming denser round the centre, and jostling one another with increasing force, until the pressure became eased by a reactionary rebound outwards, followed by several rapid alternate augmentations and diminutions of the density, until ultimately molar steadiness was nearly reached. This resulted in a vast fluid mass at a very high temperature, which gradually became lower by radiation in waves of ether in all directions outward.

There would then ensue a raising of the central temperature by the increased pressure in that region, caused by the shrinkage of the boundary and work done due to contraction. When the temperature of the central region reached its maximum and began to diminish, the whole mass would go on cooling in the still liquid state, till, at the surface it became frozen solid. This denser material resting on the liquid within would, through time, have serious changes on account of the equilibrium being unstable, and large portions of the crust would break away and sink in the liquid. Through time this process, irregularly continued, would go on, until the interior, still liquid, became blocked with masses of solid rock of all shapes and sizes. This he considers to be something like the state of the crust and interior of the earth at the present moment. Volcanoes and earthquakes were produced by the settling down of the denser solid material, and the squeezing outwards of the lighter still molten rock.

Volcanoes might be expected to continue so long as there was any molten rock in the interior, though he is of opinion that solid matter constitutes much the greater part of the whole mass of the earth. And, even after all the molten rock has been squeezed out in the forms of volcanoes, and has formed solid lava, there would still be a shrinkage of the hot, solid interior, which would leave cavities beneath the cool surface of the earth. Earthquakes would then occur on an increasing scale of magnitude, as volcanoes decreased. This would go on until the very central region was cooled—till the whole earth became solid. All this, of course, would depend upon there being no violent collision of the earth with another globe, when "the elements would melt with fervent heat."

According to Lord Kelvin's theory, there can be earthquakes without lava, only subsidation. The crust of the earth is cool and hard, with an interior increasing in temperature. Slow though it be, there is an escape of heat. The interior must be shrinking more than the crust. The hard outer crust would gradually be dragged inward and vast cavities would be made. The solid earth being undermined in some places seemed to be an explanation of earthquakes. However, after an earthquake on a large scale there would be a lowering of level, or an absolute engulfing, as was the case with the small island off the north-west coast of Sumatra. Great sinkings of the earth are noticed after these terrible phenomena, and, by the violent action, while some part subsided, another part was tilted up. After the Indian earthquake of 1897 there were very decided changes of level, some parts rising up and others sinking down. In a recent earthquake in Japan half a valley was thrown down 20 feet.

Accordingly, Lord Kelvin concluded that earthquakes were due to the earth having become undermined, and parts of the solid crust falling into the underground cavities, thus somewhat lowering the surface level.

J. G. Mc. P.

Obstruction to Greenwich Observatory.

THE committee appointed to inquire into the working of the County Council generating station at Greenwich has recently presented its report. They recommend: (*a*) The questions of vibration and obstruction by chimneys to be reviewed after two years' work with the second part of the installation. (*b*) The second part of the generating plant to be equipped with turbine machinery of a perfectly balanced type. (*c*) When the second portion is available, the reciprocating engines are not to be used after 10 p.m., and shall be restricted in use after 8.30 p.m. (*d*) The two chimneys now being built not to be higher than 204 feet above O.D. (*e*) The gases discharged not to be materially hotter than 250° F. (*f*) No further extension of the station beyond the 20,000 kilowatts at present contemplated.

THE monthly meeting of the Royal Meteorological Society was held on Wednesday evening, the 20th ult., at the Institution of Civil Engineers, Great George Street, Westminster, Dr. H. R. Mill, President, in the chair. Mr. Edward Mawley presented his report on the phenological observations made during 1906 by observers in various parts of the British Isles. The most noteworthy features of the weather of the phenological year ending November, 1906, as affecting vegetation, were the dry period lasting from the beginning of June until the end of September and the great heat and dryness of the air during the last few days in August and the first few days in September. Wild plants came into flower in advance of their usual dates until about the middle of April, after which time they were, as a rule, to about the same extent late. Such early spring immigrants as the swallow, cuckoo, and nightingale reached these islands somewhat behind their average dates. The only deficient farm crop, taking the country as a whole, was that of hay, all the others being more or less over average. The yield of apples was about average in all but the North of England and in Scotland, where there was a very scanty crop. Pears and plums were everywhere very deficient, whereas all the small fruits yielded moderately well. As regards the farm crops, the past year proved even a more bountiful one than that of 1905.

Features of the Earth and Moon.
Craterlets and Canals.

(*Continued from page 30.*)

WE give some further illustrations from Professor W. H. Pickering's "Lunar and Hawaiian Physical Features Compared," which is included among the Memoirs of the American Academy.

The floors of the craters on the moon are, Professor Pickering observes, of three kinds. Either they are furnished with a central peak, like Tycho, or they contain one or more smaller craters, not central; or, again, they are without conspicuous detail — in which case it appears probable that the original floor was melted by a second dark lava flood from below. Analogues to the first two classes are to be found in Hawaii, though the Hawaiian craters are comparatively so small that the central cone inside them is rare. Our first figure represents a portion of the middle crater of Mokuaweoweo. Somewhat nearer them the centre is shown an active cinder cone composed apparently of a medium-sized crater and two or three smaller ones upon its rim.

Fig. 1.—Mokuaweowen Mauna Loa.

Reproduced, with [illegible] illustrations from Professor W. H. Pickering's "Lunar and Hawaiian Physical Features Compared."

The crater called Kilauea Iki, shown in Fig. 2, also reproduces the craterlet characteristic. The walls of Kilauea Iki are very steep, but can be descended with care. The floor is level, one-quarter of a mile in diameter and 750 feet below the rim. Numerous small craterlets are scattered irregularly over this floor; and the most complete of them is shown in the illustration. Its height was 15 feet, and the diameter of the rim, which was composed of lava of a ropy appearance,

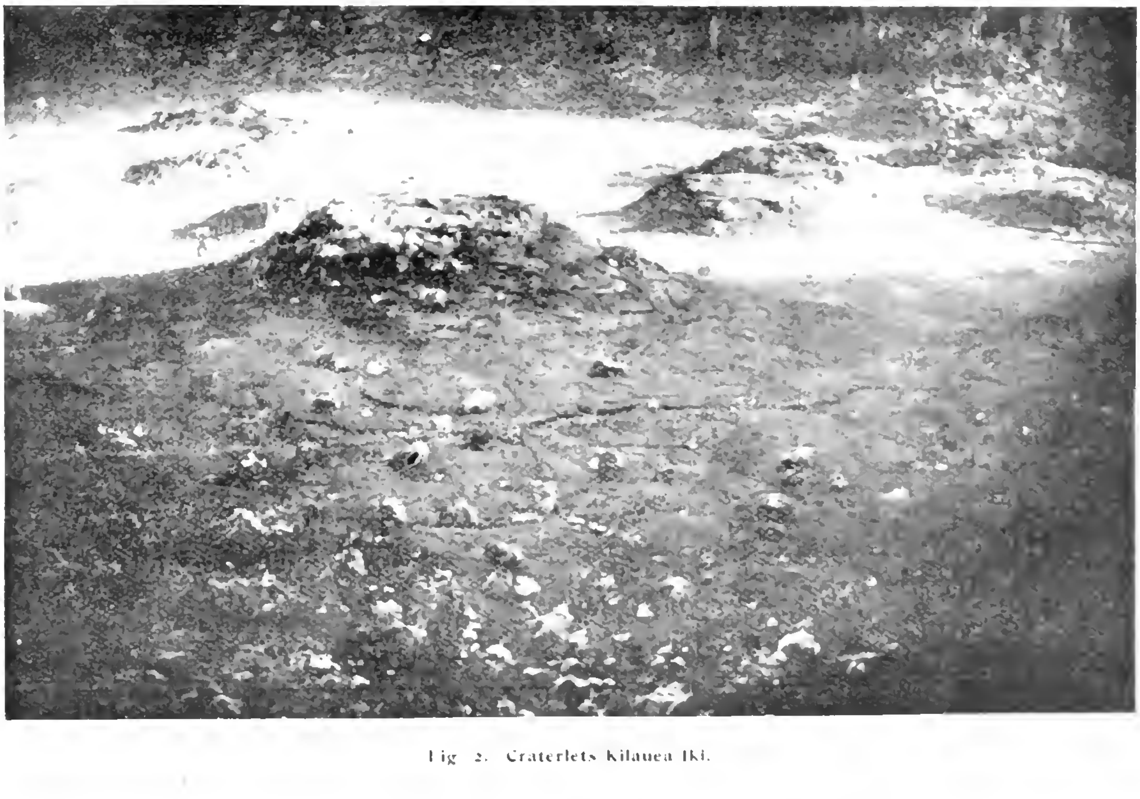


Fig. 2. Craterlets Kilauea Iki.

was 25 feet. A stream of lava had poured from the summit, but had not got far beyond the rim. There may have been as many as 50 rudimentary craterlets scattered over the floor, in all stages of growth, from a hardly-noticeable elevation to the complete craterlet shown in the figure. . . . "If the volcanic forces beneath these craterlets," observes Professor Pickering, "had been more intense, it is probable that the issuing lava would have completely destroyed them, forming a series of crater pits, into which the lava would have subsequently retreated. In the south-eastern portion two such pits were found, perhaps 30 feet in diameter, down which the lava had poured, but had solidified without filling them up.

Fig. 3.—Pinnacles Mare Imbrium.

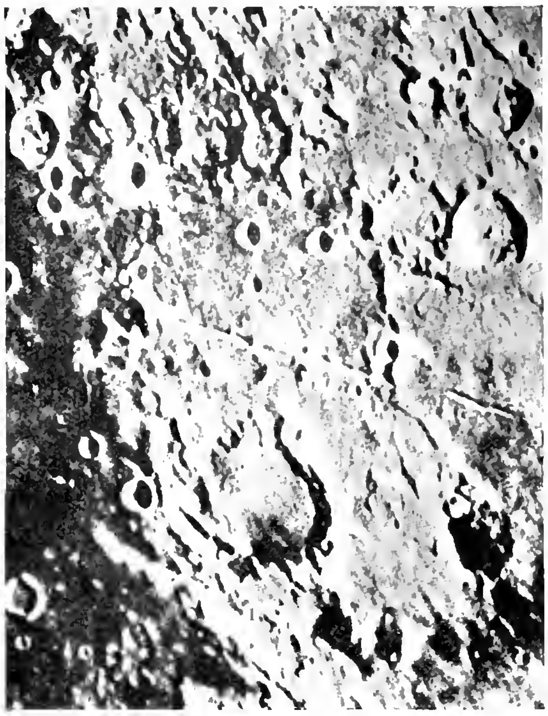


Fig. 4.—Ariadaeus Rills.

After the craters, among the most important features of the lava floors, are the elevated formations—the spiracles, pinnacles, and ridges. When the gases work their way up to the surface they escape by little blow-holes. In so doing they often carry small quantities of lava along with them. This lava quickly hardens on reaching the surface, and builds up around the aperture a tube, which Professor Pickering calls a spiracle. Sometimes it is closed at the

Fig. 5.—Crack, Kilauea.

top by the last escaping lava, and sometimes it is left open. These spiracles are found of all sizes, from one measuring three or four inches in diameter, up to another measuring 100 feet.

Fig. 6.—Theophilus.

On the surface of the moon are two kinds of rills, some of which are probably elongated craters or grooved valleys, and rills proper. The rills proper are extremely numerous on the moon, and about a thousand are known and identified. The Ariadæus rill (shown in Fig. 4) is the widest and most conspicuous of them. It measures three miles in breadth by a little over half a mile in depth. Like all true rills, its course is approximately straight or made up of curves of long radius. Evidently, like terrestrial dikes or mineral veins it has been partially filled up from below. Other narrower rills apparently of great depth are found on the moon. The general view that they are simply cracks in the lunar surface is accepted by Professor Pickering as correct. They occur most frequently in formations of the secondary period; that is, in the dark surfaces; or, if found in the primary formations, it is where the surface has apparently been softened, and partially flattened out by the application of heat, as in the present instance. Rills are frequently found on the edge of the lunar lava seas. A large crack is found in Kilauea in precisely this position. It is from six to eight feet wide, and from 20 to 30 feet deep near the bridge. It is about a mile in length. A crack 5 to 20 feet in breadth, and 40 to 200 feet in depth, and 10 miles in length is located south-west of the crater, and a similar one lies parallel to it. The cracks themselves have been partially filled up, but one said to be 1,500 feet in depth, is situated not far from the sixth crater near Kelanea.

Professor Pickering devotes some attention to the question of water and vegetation on the moon. "It is," he says, "a favourite argument of those who deny that water ever existed on the moon, to say that if such were the case signs of erosion would be found on its surface. In the case of the earth, where vast bodies of water are present, these signs are very pronounced in the eroded valleys of mountain regions and the alluvial plains of the more open country. When we search the coarser detail on the moon no such signs are found. . . . But, if the moon ever possessed any water at all, it must have been in comparatively small quantities, and we should accordingly look among its finer detail for any evidence of its former existence. Fig. 6 represents Theophilus, a crater 64 miles in diameter. The central peaks rise 5,000 to 6,000 feet above the crater floor and are indented by numerous deep valleys, four being clearly shown in the photograph. It is believed that these valleys are due to erosion, and are analogous to those shown in Fig. 7, which represents a mountain ridge behind Honolulu. The pre-

Fig. 7.—Erosion Valleys in Hawaii.

cipitation cannot have come from a general atmospheric circulation, but more likely from steam expelled from the

Fig. 8.—Terrestrial Valley or Canal near Kilauea.

openings of the spiracles in the central peaks themselves.

The lunar day is $29\frac{1}{2}$ terrestrial days in length, and, from the standpoint of climate, might almost be called a lunar year, for the temperature rises from some 250 degrees below freezing to a height as great as that experienced on the earth's equator, in the course of 14 or 15 days of sunshine. It has been observed that some spots on the moon grow darker in this period, and Professor Pickering attributes the darkening to the springing up of vegetation. In the crater of Erastosthenes, which is about 40 miles in diameter, he has perceived two dark spots on the crater floor, and has noted that these spots change, disappear, or increase, as the long lunar day progresses from sunrise to sunset. There are two snow-white central peaks in the crater, and the dark spots (of vegetation?) are joined by lines, which, to Professor Pickering's mind, resemble the canals of Mars. In studying Erastosthenes in 1904 Professor Pickering found its interior seamed with numerous fine cracks. Watching some of these cracks soon after the sun rose on them he was able to see them broaden out and change gradually into canals. It is his belief that the cracks gave out water vapour, which fertilised the vegetation along their sides and in their neighbourhood, and that it was the growth of this vegetation which produced the appearance of a canal. A further inference is that the canals on Mars, which become more clearly visible at some periods of the year, owing to the melting of the Martian Polar ice cap and the flooding of the waterways, are similar cracks on the surface of Mars. Cracks of the kind occur on the moon. The largest of them is that known as Sirsalis, which is 400 miles in length. It is possible also that they exist on the earth, though they are not readily discernible. It has sometimes been supposed that terrestrial volcanoes lie along subterranean cracks that do not reach the surface. The volcanoes of the great chain of the Andes lie along a straight "crack" reaching from Southern Peru to Terra del Fuego, 2,500 miles in length. The volcanoes of the Aleutian Islands lie along a curved crack equally long. Since other shorter lines of volcanoes are very numerous on the earth, and since countless others existed in former times, the cracks on the earth's crust must be exceedingly numerous. Every mineral dike and vein, indeed, bears witness to this fact. There is no reason why terrestrial cracks should not be as numerous as those on the moon. In the case of the earth they have usually been closed, sometimes by liquid matter from below and sometimes by surface denudations. There is one

Fig. 9.—Sinus Iridum. A Crater Ring on the Moon.

crack, however, which comes to the surface in various places in Eastern Asia and Western Africa, and stretching from the Dead Sea to Lake Nyassa, reaches the enormous length of 3,500 miles. That is about the same length as the longest of the Martian canals.

Halley's Comet.

By F. W. HENKEL, B.A., F.R.A.S.
(Late Director of Markree Observatory.)

THE shortly expected return of this well-known object, which was the first of these bodies known to move in closed paths round the Sun, and the remarkable phenomena attending its last appearance (in 1835 and 1836) render Halley's Comet a peculiar object of interest at the present time.

Newton, in the third section of the Principia, first showed that a body moving under the influence of a force varying inversely as the square of the distance from the centre of force, will describe one or other of the curves known as the "conic sections," *i.e.*, either an ellipse (or circle, as a special case), a parabola, or a hyperbola. These three curves may all be obtained by cutting a cone in different ways by a plane, but perhaps they may be more intelligibly defined to the non-mathematical reader as obtained by throwing the shadow of a circular disc upon a plane, such as the surface of a table. If, however, the disc is held parallel to the table, we shall get a circle; if it is held edgeways to the light, the shadow will be a straight line. If now we raise our disc so that its highest point is on a level with the source of light, we shall get a curve known as a parabola, which will be oval at one end, but the two sides will open out. If now we hold our disc still higher, we shall get another curve still, whose two sides will separate even further from one another. This curve is known as the hyperbola.

Whilst the planets move in ellipses, so little differing from circles that if represented on paper the deviation is not perceptible, on the other hand, most comets are found to move in orbits so nearly parabolic that only in a few cases are they known to be otherwise. A great comet which appeared in 1680, and approached very close to the Sun, was the first whose path was calculated as a parabola, though there is some reason to believe that it was not truly so, but an enormously elongated ellipse.

In 1682 a comet was observed by Newton, Halley, and others, and on examining the circumstances of its motion, Edmund Halley computed its orbit on the supposition that this was a parabola. Comparing his results with observations of previous comets, for which purpose it was necessary for him to compute their orbits from the necessarily imperfect observations of earlier times, he found that in 1531 and 1607 comets had appeared which followed so nearly the same path as this one that he ventured to assert its identity with them, and to predict its return in a period of about 75 years. It was afterwards ascertained that comets had been seen in 1066, 1378, and 1456 whose paths were the same as that of the comet of 1682, and it is now known that all these were apparitions of one and the same body. In 1066 its appearance was figured on the Bayeux tapestry, and it was regarded (after the event) as an omen of the Norman Conquest. In 1456 the comet is said to have been of extraordinary splendour, its tail 60 degrees long, and it is stated that a papal bull was fulminated against the Turks and the comet, and it was ordained that the bells of all churches should be rung at mid-day. Although Halley had predicted its reappearance, he did not live to observe this himself, dying in 1742, at the age of 83, after having been Astronomer Royal for 23 years. He pointed out that the comet must have passed very near the planet Jupiter in the interval between 1607 and 1682, and its velocity increased, thereby resulting in a shortening of its period of revolution. Thus he concluded that, whilst the interval between 1607 and 1682 was only 75 years, the following revolution would probably take a longer time; but the then state of Mathematics did not enable him to make the necessary calculations to determine this with accuracy. Were the Sun and comet alone existing in space, the latter's path would be an exact ellipse, and the period of its revolution always the same. This is, however, not the case. Besides the Sun there are also the planets, and these, by the law of gravitation, attract, and are attracted by, one another, and other bodies. Their masses, however, being very small, in comparison with that of the Sun, the general nature of the paths pursued by planets and comets is not changed by this action; but deviations nevertheless arise, which are the more perceptible as their masses are greater and their approaches more close.

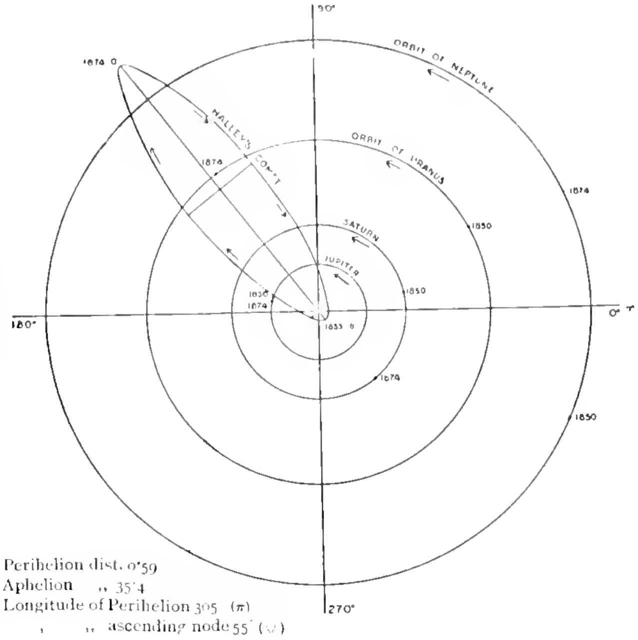
Thus Jupiter, the giant planet of our system, whose mass is about $\frac{1}{1000}$ that of the Sun, has at times a greater effect on comets when near to him than the Sun itself. Lexell's comet of 1770 must have been at one time fifty-eight times less distant from Jupiter than from the Sun, and so the planet's attraction ($3\frac{1}{3}$ that of the Sun) must have been three times greater.

The celebrated Clairaut, who so greatly advanced the science of astronomy by his work on the Moon, as well as by his researches in pure Mathematics, undertook the great labour of calculating the effect of the action of the planets upon Halley's Comet for a period of about 150 years, and in a memoir presented to the *Académie des Sciences*, at Paris, he predicted the date of perihelion as the 18th April, 1759, subject to an uncertainty of about a month. As the result of his calculations he estimated that the period of revolution of the comet was increased by 100 days on account of the action of Saturn, and 518 days by Jupiter. It was first seen by Palitsch, a Saxon peasant, about the end of 1758, and came to perihelion on March 12, 1759, just a month earlier than the time assigned by Clairaut. Before its next return the orbit was calculated by no less than four mathematicians, Damoiseau, Pontécoulant, Rosenberger, and Lehmann, and they all agreed in giving a day in the month of November, 1835, as the time of its perihelion passage. It was first seen at Rome early in August of that year, and was visible up to the 10th November in the Northern Hemisphere.

After this, passing its perihelion on that day, it was seen at the Cape and at Melbourne up to the early part of May, 1836, when it finally disappeared from view. Very careful observations and elaborate drawings of its appearance were made by Sir John Herschel, who was then in South Africa. At first it presented the appearance of an almost round nebula, having a bright nucleus not quite at its centre. By the beginning of October, 1835, a small tail appeared, and this reached a length of about 20° by the middle of the month. After this the tail diminished, so that before the time of perihelion (November 16) it had again disappeared. On the 2nd of October, the day when the tail was first seen, an emission of light was seen coming from the nucleus, on the side presented towards the Sun. This emission ceased for a time and then recommenced on the 8th of that month. At this time one observer perceived what he called a "second tail," in a direction opposite to the original tail, thus presented towards the Sun. The shape and brightness of the emanations continually varied from the 5th to the 22nd of October. At one time two or three emanations were seen to issue in different directions, these having forms sometimes like that of a gas flame coming from a flattened opening, at other times only slightly divergent, and again occasionally only one jet was seen. When more than one such jet or emanation was visible, the principal jet of light oscillated in direction to and fro on either side of the line directed towards the Sun, "like a compass needle thrown into vibration and oscillating about a mean position." Sir J. Herschel concluded, from his own observations and those of others, that the matter of the nucleus is largely converted into vapour by the Sun's heat, and escapes in jets and streams from the parts turned towards the Sun. This matter is, however, prevented from proceeding in this direction by some force directed from the Sun, much more powerful than gravitation (and repulsive). Being thus repelled from the Sun with considerable velocity, it must leave the nucleus altogether, and, consequently, at each approach the comet must lose a portion of its substance, for the feeble attractive power of the nucleus will prevent this matter being retained within the comet's sphere of attraction, and it will be too far away to be re-absorbed afterwards. Thus it is probable that at each apparition the comet will be less conspicuous. After passing its perihelion, the comet was not seen again till near the end of January, when it had no longer a tail, but was seen as a small, round disc, surrounded by a "coma" or nebulous envelope. As the comet gradually receded from the Sun this coma disappeared as though absorbed into the disc, and this latter increased greatly in size, so that during one week (from January 25 to February 1) it increased in volume 40 times. This increase of size continued, so that mainly from this cause it became invisible, its illumination becoming fainter and fainter as its size increased. The shape of the disc changed gradually from a nearly circular form to that of a paraboloid. The nucleus meanwhile remained nearly unchanged, but the ray or jet proceeding from it increased in length and brightness, its direction being along the axis of the paraboloid. "If," says Herschel, "the office of the jets was to feed the tail, the office of the ray would seem to have been to conduct back its successively condensing matter to the nucleus."

The comet's envelope and ray gradually faded, and as last seen it had the same form as in the previous August, viz., that of a small, round nebula, with a bright point near the centre. In all, it was visible from the 5th of August, 1835, to the 5th of May, 1836, a period of 9 months.

The period of revolution of this comet is given in Herschel's "Outlines of Astronomy," as 27,865.74 days, so that, since it passed its perihelion on the 15th of November, 1835, it should again return to this position on March 2, 1912; but on account of the considerable disturbing action of the planets Jupiter, Saturn, and Uranus, the actual date may differ considerably from this. So eccentric is the position of the Sun in its orbit, that whilst at perihelion the comet's distance from the Sun is about 0.586 of the earth's distance, or about 55 millions of miles, it recedes to a distance of 35.4 times that of our earth, or about 3,300 millions of miles, considerably greater than that of Neptune. Whilst the planets all move in orbits lying nearly in the same plane, the comet's orbit makes an angle of 17° with the Ecliptic (plane of the earth's orbit), and its motion therein is in a direction contrary to that of the planets (and of most of the other short period comets), or is retrograde. Whilst the planets move in a direction opposite to the hands of a clock, as seen from our northern latitudes, the comet of Halley moves in the "clockwise" direction (as shown in the accompanying diagram). This comet, as also five others, viz., Pons' Comet, seen in 1812 and 1884; Olbers' Comet, seen



in 1815 and 1887; De Vico's Comet of 1846; Brorsen's Comet of 1847, and Westphal's Comet of 1852, passes near Neptune's orbit at its aphelion, and these comets are sometimes known as Neptune's family of comets. If at any time a comet enters our system from an infinite distance, moving in a parabola under the Sun's attraction, it will have its motion either accelerated or retarded when it comes near any of the planets. The smallest increase of velocity will change the parabolic orbit into a hyperbolic one, the smallest decrease will convert it into an ellipse. In the latter case the comet will become a permanent member of our system. This it is possible is what has actually happened, and the converse case of a loss seems also to have occurred. A comet was discovered in 1770, and was shown by Lexell to move in an elliptic orbit, with a short period of about 5½ years. It was, however, never seen again, nor were any former records of its appearance to be found. Lexell, however, showed that in 1767, when at its aphelion, or furthest from the Sun, the comet must have been fifty-eight times nearer to the planet Jupiter than to the Sun, and that then the planet's attraction on it was three times that of the Sun; that in all probability it had been moving in a parabola, which orbit was converted into an ellipse by the planet's action. He further showed that since the aphelion was close to Jupiter's orbit and the comet's period 5½ years, that of Jupiter being 11 years, at the end of two revolutions of the comet and one of the planet, they would again be close together, 500 times less than their distance from the Sun, so that in all probability the comet's orbit would become again parabolic or hyperbolic. Thus he anticipated its eventual disappearance, and, in fact, it was never again seen. Laplace and Leverrier later showed, however, that Lexell's results were liable to considerable uncertainty.

Although, as we have stated, the motion of a comet is greatly affected by the proximity of a planet, the latter, on the other hand, seems quite unaffected.

Thus, the comet of Lexell approached so closely to the planet Jupiter that, had its mass been in any way considerable, both that planet and its satellites would have had their orbits completely changed, the comet's distance from Jupiter being, when nearest, less than that of the fourth satellite (the furthest of those discovered by Galileo in 1610). Nevertheless, not the smallest measurable derangement was observed, so that the mass of the comet must have been much less than that of any of these satellites. This seems to be a general rule, no perturbations due to a comet having been ever perceived for any planet. Yet the volume of some comets being at times greater than that of the Sun itself, the density of the materials composing them must be extremely low. This is also evident from other considerations. Small stars have been distinctly seen through the head of a comet, even through the nucleus, without perceptible diminution of brightness. In the case of one comet, known as Encké's, from the name of the discoverer, there is reason to believe that its period of revolution is diminishing gradually, and that it is slowly getting nearer to the Sun, as though acted upon by some resistance to its motion. This has been supposed to be due to the "luminiferous ether," but since this retardation seems to have become much less of late years than formerly, and so far no other comet seems to have its motion affected in a similar way, there is considerable doubt about this conclusion. By Kepler's third law, the periodic time of a body moving round the Sun is known from its distance from that body. (The squares of the periodic times are as the cubes of the mean distances.) Thus, a resisting medium, by diminishing the comet's velocity, gives the Sun more power to draw it towards itself, and so, lessening its distance, causes its period to become shorter. So unless the comet be dissipated by loss of material, it will some day fall into the Sun.

Many interesting problems are presented to us by these bodies (of which Halley's Comet is one of the most remarkable and interesting). The question as to the existence of a resisting medium, the nature of the repulsive force (supposed by some to be electrical, which is at times much greater than the gravitational attraction), the condition of the matter composing the comas and the tails, and the origin of these bodies, are all matters concerning which we know but little at present. Many recent writers have revived Clerk Maxwell's idea of "radiation pressure" with regard to the phenomena of comets' tails. Light being regarded as an electromagnetic phenomenon, its incidence on an absorbing substance causes a pressure on the latter. The late Professor Fitzgerald suggested this light pressure as the cause of comets' tails, and observed that each different gas would give rise to a separate tail, owing to the different size and density of its molecules. Since only a small part of the radiation falling on gases is absorbed by them, Arrhenius supposes that the matter repelled by the light pressure is not gaseous, but rather consists of fine particles, condensed from the gaseous emanations. In making some further investigations, Schwarzschild arrived at the conclusion that light pressure is sufficient to account for a repulsive force twenty times as great as gravitation on the cometary tails and appendages, but not for a greater amount of force. Since in some cases a repulsive force as much as 40 times that of the gravitative attraction has been observed, the light pressure theory is insufficient to account for these. Of other theories as to cometary appendages, we may mention that outlined by Mr. Boys, in his presidential address to Section A of the British Association, 1903. He suggests that radio-active substances in the nucleus may be the cause of these phenomena. If the Sun be electrically charged, the rays will be repelled from the nucleus so as to form a tail, and the different kinds of rays given by radio-active substances would give rise to tails of differing curvatures.

It has already been stated that though the mean period of Halley's Comet is nearly 77 years, yet, on account of planetary perturbations, the actual interval from one return to the following may differ very considerably from this. In 1862, Dr. Angström published a paper in which he deduced a mean period of 76.93 years from a discussion of all the observed perihelion passages, and stated that this period is affected by two large inequalities. Calculating from his empirical (*i.e.*, observational) formulæ, Mr. Crommelin has obtained the date 1913.08 for the next return to perihelion. The late Comte de Pontécoulant, however, in 1864, published the results of his calculations, giving the date of 1910, May, for the next return, a difference of nearly 2¾ years from Angström's result. Messrs. Cowell and Crommelin, of Greenwich, are at present engaged in independently computing the perturbations of this comet, following Pontécoulant's method, and the present writer has also done a little in this direction. Some obvious errors in the values given by Pontécoulant for the change of eccentricity have been detected, and the perihelion distance is nearly the same (0.59, the earth's distance from the sun being 1.00) as at the last return, whereas Pontécoulant made it considerably greater (0.68). However, they have arrived at the main result, that the time of return given by Pontécoulant (1910, May) is correct within a month, but it may be a few weeks earlier; consequently Angström's curve is altogether wrong for this return. Thus they consider his two inequalities to have a very doubtful existence, and that it is possible many of the earlier returns have been wrongly identified by Hind, whose results Dr. Angström used.

Practical Aerodynamics And the Theory of Aeroplanes.

II.

HEAD RESISTANCE TO A BODY MOVING THROUGH THE AIR.

By Major B. Baden-Powell.

Any body which is being rapidly driven through the air, whether it be the main body of the apparatus or the blades of the screws, wings, or other propelling appliances, is acted upon by three different forces (in addition to gravity), which tend to retard its speed. These are: First, the *head resistance*, caused by the inertia of the particles of air which have to be displaced in order to make way for the body. Second, the *negative pressure* or suction due to the partial vacuum which is formed behind the body, and the air which has been displaced taking time to flow back to fill the space which it originally occupied. Third, the *side pressure* or skin friction.

As Lord Kelvin has said, "In Nature every fluid has some degree of viscous resistance to change of shape," which also accounts for these opposing forces.

It will readily be understood that the pressure on a body being pushed against the air, or falling vertically through it, is exactly the same as if the body were held stationary and a steady current of air, such as wind, be driven against it.

In considering head resistance we will first take the case of a plane surface propelled perpendicularly to the line of advance. The problem to be decided is, what is the force opposing the progress of the plane as compared to the speed and area? This is a most important consideration, as it is on this that all our calculations must be based. When we come to investigate the pressure developed on inclined or curved surfaces, it will be seen that these are but a certain definite proportion of the pressure that would be imparted to a plane surface of similar area moving at right angles.

Supposing we find that to propel a given mass at a certain speed it becomes necessary to apply a steady push of one pound, it is evident that in order to increase that speed it will be necessary to apply more force.

Newton, by noting the time taken by spheres in falling from the dome of St. Paul's Cathedral, concluded that the resistance of the air on the body is proportional to the square of the velocity. Later experiments have shown this law to be approximately true. This is to be expected, since if we imagine a plane moving against the air at a given rate, if its speed be doubled it will strike the air twice as hard, but it will also pass over double the distance in the time, and will, therefore, strike twice as many particles of air, hence the pressure or force required will be four times as great.

There is, however, still some doubt as to whether this law applies when the body is travelling at comparatively high velocities. Experiments made on the resistance offered by the air to projectiles moving at speeds of 2,000 or 3,000 feet per second tend to prove that the resistance increases in a greater ratio than at rates below a hundred miles an hour (146 feet per second). But it is only the latter that we need now be concerned with.

To get at a proper working formula for computing the resistance of the air, we put $P = Kv^2$; that is, the pressure in pounds per square foot equals the square of the velocity in miles per hour multiplied by a certain constant K, which has not yet been very exactly determined.

A number of separate experiments have been made to solve this point, but the results have not been in perfect agreement. It may be desirable, considering how important the results are to the subject, briefly to recapitulate what has been done in this line, and the conclusions come to, since, as far as I know, no connected account of these has hitherto been published.

The resistance of the air was first carefully investigated by Robins* in 1742. His experiments were chiefly directed on the investigation of the resistance offered to bullets fired from a musket, which at that time was a matter almost entirely ignored. Later on he constructed a "whirling machine," consisting of a light arm rotated by means of a weight unwinding a cord wound round its support. On the end of the arm was mounted a sphere to represent a cannon ball.

Smeaton, who had been investigating the force obtainable by means of windmills, shortly afterwards published a table of wind pressures† which had been communicated to him by Rouse. This was compiled on the supposition that K = .005. The table, though produced in so uncertain a way, nevertheless was accepted as authoritative, and is often quoted intact to this day in books dealing with engineering and wind effects. Subsequent investigations, however, show that these deductions were somewhat misleading.

* "New Principles of Gunnery," by Benjamin Robins, F.R.S., new edition, to which is added "Subsequent Tracts" 1805.

† "Philosophical Transactions" for 1759, p. 165.

In 1809 Sir George Cayley* came to rather different conclusions as the result of his own experiments. The latter were conducted with an apparatus in which a surface of one square foot was mounted upon an arm about five feet long and rotated by weights over a pulley. He found after "many carefully repeated experiments, that a velocity of 11.538 feet per second generated a resistance of 4 ounces, and that a velocity of 17.16 feet per second gave 8 ounces resistance," which would give a value of .004 and .0034 respectively for the symbol K.

Dr. Hutton† continued the experiments of Robins, using the same or a precisely similar machine (which is still preserved in the model room at the Royal Academy, Woolwich). His investigations were more extensive and precise, and will again be referred to.

In compiling a table of wind pressures his figures differed slightly from Smeaton's table, giving less force for a given velocity. In these K would work out at just about .004.

More recent investigations, which tend to prove a still lower value for K, must be deferred to another article.

⁂ In the last article (February KNOWLEDGE) the title of Mr. Wilde's paper "On Aerial Locomotion" was wrongly printed.

(To be continued.)

* *Nicholson's Journal*, November, 1809.

† "Mathematical Tracts," Vol. 3, by Dr. C. Hutton. 1812.

CORRESPONDENCE.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I have two thermometers in the same screen, one wet bulb, the other dry. Usually there are from 0° to 10° difference between them. This morning the wet bulb was the highest by about 2° or 3°.

I have noticed the same effect at other times, when the water in which the cotton is soaked was frozen. Why is it?

Also, is there usually a wave of high barometric pressure about January 25? I see, in 1904, that there was a record high barometer, or something like it, then.

Yours faithfully,

Hopesay Rectory, Aston-on-Clun, S.O. R. J. ROBERTS.

February 7, 1907.

[When the temperature is below freezing-point the wet bulb thermometer requires special attention, as the muslin and conducting thread become frozen and there is consequently no supply of water to the bulb. On the occasion referred to above the moisture on the muslin round the bulb was evidently just passing from the liquid to the solid state, and so was at the freezing-point temperature, viz., 32°. The mercury in the wet bulb thermometer would remain at 32° until the freezing process was complete. On many occasions—especially in rather damp weather and with the temperature of the air not much below the freezing point—the wet bulb thermometer will remain at 32° for a considerable time—often for hours—and so be much higher than the dry bulb. During frost the muslin should be wetted about an hour before the time of observation, so that a coating of ice may be formed round the bulb. With regard to barometric pressure, this is much more variable in winter than in summer, and so in one year it may be very high and in another year very low about the same date. Mr. Roberts mentions January 25, 1904, as the date when a high barometric pressure occurred. Against that may be placed January 26, 1884, when practically the lowest barometric pressure ever recorded in the British Isles was observed, viz., 27.332 ins. at Ochtertyre, near Crieff.—W. M.]

Physics and Biology.

By JOHN BUTLER BURKE, M.A. (Camb. and Dubl.).
Formerly Berkeley Fellow of Owens College, Manchester, &c.

THE study in recent years of life's origin has come more closely within those departments of science which deal with the invisible and ultra-microscope forms of matter than with the visible, which are so much more and so vastly complicated. It comes, as I have tried to indicate elsewhere, more within the realm of chemistry, or indeed more appropriately physics, than within that of botany or zoology. And it is, perhaps, as remotely connected with these, as these are with human physiology; nay, even (should we say?) with psychology. For the problem of life's origin is one that resolves itself, and is ultimately lost in the gradation of the infinitely small; a fact which concerns the physics far more than it does the biology of to-day.

View it as we may, it leads us, as I think, to infer the atomic constitution of vital substance—vital atoms, entities as separate and distinct, and perhaps immutable, as the atoms of the chemist, or (should we say?) the electrons of the physicist.

No prejudice or predilections, as to what does or does not come within the sphere of any particular science, should be allowed to stand in the way of developments on these lines; if there are reasons which indicate that the recognised limitations should be extended or removed.

Now in dealing with vital phenomena, from a physical point of view, one fact stares us in the face each time we approach the problem; and that is, the asymmetric structure of living matter; and the fact that such asymmetric structure has hitherto never been obtained, save through the agency of its vital processes.

This is a phenomenon not less than that of life, which baffles the physicist, as much as it does the biologist of to-day. And it is undoubtedly one which runs parallel and is concomitant with the phenomenon of life itself.

How did the asymmetric structure arise? Is its asymmetric property that which gives the unstable but directive quality to living matter? Is it, and is living matter with it, as persistent, as approximately stable, as the atoms themselves? How are physical principles in the phenomenon of *biotic* energy or potential life-activity to be explained?

The argument, from continuity alone, might lead us to expect that the electron is only a halting step in the great scale of being; and that, whether we should ever succeed in demonstrating it or not, it, too, in its turn will be found to be an aggregate of smaller units. So on *ad infinitum*. There is, however, no actual demonstration of this possible at present.

Now, my endeavour has been to show that biophores, the ultimate nuclei or vital units in their final state, are aggregates of smaller units. There is a stage through which, like spiral nebulæ, on a totally different scale, they must pass before being transformed or condensed into stable systems, like chemical atoms.

As all nebulæ are resolvable into these spiral forms, so the condensing aggregates of electrons not less than those of matter in its grosser states would have to assume the peculiar shapes or curves, which characterise their larger analogues.

We must not expect that we shall ever reach the smallest any more than the largest of things; for in the mathematical and physical there is nothing either great or small, but thinking makes it so.

The problem of life transcends physics because for many reasons it not merely depends upon the ultra-microscopic, but in turn upon the atomic, ultra-corpuscular, or ultra-electronic, *ad infinitum*.

The electron or corpuscle should be an aggregate, and not an indivisible, unit. On this basis the formation of such nebulæ and spiral atoms may be conceived. The actual corpuscles which form the planets of the atomic solar systems would seem to be in their turn but aggregates of smaller units.

My chief reasons for holding this view are as follows:—

Clerk Maxwell was careful to point out that the variety of phenomena of life could not be accounted for by the small number of atoms in the organic cell. The chemical atoms, indeed, of the same element may be regarded as resembling each other only in certain respects, as one individual resembles another. But if they are aggregates of smaller units, as I have tried to emphasise in "The Origin of Life," there would be opportunities for variations in atoms, which, as chemical units, are the same. The atoms of the same substance would, so to speak, have merely a family likeness, and there are strong reasons for supposing that the phenomena of life are thus dependent upon the ultra-atomic constitution of matter. A process analogous to natural selection would ensue.

Now the general physical properties of gross matter are explicable, as we know, on the supposition that there are small particles called *molecules*; the chemical properties on the supposition that there are smaller ones called *atoms*; the electrical properties on the assumption that there are still smaller ones called corpuscles or *electrons*; and the biological properties, I think, on the assumption that there are yet smaller ones—since, as we shall see, such phenomena demand it—of which biophores or biogen are nebular forms. If there are biophores with an asymmetric structure, that asymmetric structure and all its varied properties can be explained on the supposition only that the electrons are aggregates of smaller units; an assumption which other phenomena demand. There is nothing unphilosophic in this assumption. And if the atomic theory is to hold in its application to biological, as well as to purely chemical and physical phenomena, the facts of the case demand it. We cannot frame the nebula analogy for electronic systems without postulating that the electrons or corpuscles are aggregates of smaller things. The corpuscle may be compared to a planet; the nuclear positive ion to a sun; but if these systems have been formed by condensation, they must be the condensation of still smaller things.

Germ-plasm, that is, the biophoridæ, would thus consist of a nebula of uncondensed matter, of corpuscles or electrons in the state of formation, as planets and solar systems are evolved from atoms. This is not an absurdity, as may at first sight be imagined, but merely an extension, and a logical extension, as I venture to think, of the theory that atoms are such miniature planetary systems.

The atoms and electrons may be regarded as the condensed products of the primordial substance, which I have called *biogen*.

So eminent a man of science as Professor Schuster has written in the following terms in discussing this theory of biogen in its relation to the origin of life*:—

"The discoveries of the last few years have in one respect inverted our previous ideas of the problem of

* *Manchester Guardian*, April 27, 1906.

creation. That there was only one substance, and that all matter was ultimately derived from that substance has, I believe, been always a tacitly accepted axiom of scientific thought. But we look upon the more complicated structures as having been gradually built up from the simpler ones. Hydrogen being the body which has the lightest atoms, and other bodies having atomic weights which are approximately multiples of that of hydrogen, the thought was natural that hydrogen was, if not the ultimate atom, yet the body which formed the bricks out of which other so-called elements were built up. At last, however, we are able to watch the actual formation of one element out of another, but instead of the more complex bodies being formed out of the simpler one, the reverse is the case, and one of the lightest elements, helium, is evolved from one of the heaviest elements, radium.

"Where we can follow the process of evolution, it is therefore the complex body, which, through instability, yields the simpler one. Scientific men love to generalise, and it is therefore natural that they should quickly have inverted their former ideas and have begun to look at the most complicated structures as the one which was formed the first.' If this idea is driven to its extreme—though not necessarily its logical—limits, we should be led to the conclusion that living organism is the primordial element, and that inanimate matter is only the result of the decay of living matter. This I gather to be Mr. Burke's view. He compares, indeed, the derivation of ordinary matter from the original bio-element with the evolution of the solar system, out of the historic, though now somewhat discredited nebula. It is undoubtedly a new and an original view, and one that must be taken seriously."

I owe to Professor Schuster a deep debt of gratitude for thus emphasising what many of my other friends could not be made to understand. Many investigators are as absorbed in their own special work as they are indifferent to its relation with anything else. I say this in all good faith, appreciating as I do the high value an investigator's opinion in his own special, but narrow, line of work may have. But the great discouragement which it can mete out to any scheme which does not fit in with that which he himself may happen to be engaged in, is not always stimulating or satisfactory. New ideas, no doubt, require to be familiarised. If they do not at first seem to be quite orthodox—as new ideas seldom are—or if they are not altogether on similar lines with those in which others have been working, the promulgator thereof may expect to have many bricks, like books and candlesticks of old, flung at his wearied and bewildered head.

Quite apart, then, from the question as to whether the views I have ventured to put forward are orthodox or heterodox, let us consider them in their relation to the great problem which not merely biology, but physics now presents, the asymmetric structure of living matter and the concomitant or inseparable connection between living matter and asymmetric structure. For as living matter has never been produced from dead matter, as familiarly understood, so polarising matter has never been obtained except through the intervention of that which is living or has lived.

As we say, if the atomic and electronic systems have been formed by a process of condensation of a primordial substance, the transitory stages of spiral nebulæ is to be expected. But it may take many thousand years to pass through this transitory stage; even as the astronomical nebulæ on the larger scale take many million millions of years to be condensed into a solar system.

In such circumstances, then, the atomic nebulæ may, for all intents and purposes, be regarded as entities as much so as the individual atoms; unstable as these may really be. Their spiral nature, however, would in certain circumstances rotate the plane of polarisation of light; as, for instance, when the atoms are all right-handed or left-handed.

Now such spiral atoms, if they may be so called, will in the course of time be converted into more stable atomic systems, becoming radio-active, and ultimately inert. The latter being the lightest elements.

It is a curious circumstance that the principal constituents of protoplasm are carbon, nitrogen, oxygen and hydrogen, the lightest of each group. And that silicon, phosphorus, sulphur, chlorine, etc., the second lightest of the respective groups, come next, but in far lesser proportions.

This point is most suggestive, indeed. And the formation of cellular protoplasm from such atomic systems is rendered probable enough when we consider the development of mimic or artificial cells in protoplasm by the action of radium salts upon it. Mr. Rudge's experiments were made with gelatine, which does not contain albumin or protoplasm. They do not in any way touch the point in the argument.

The complexity even in the nucleus itself would be very great indeed, so much so that to account for its great varieties and variations presents a difficulty far exceeding anything that our imagination enables us to picture to ourselves.

This is the inference which analogy, extrapolation, and experimental results may lead us to draw. I have said elsewhere that "We may regard the ultimate vital substance which seems to play so mysterious a part in the phenomena of Nature as corresponding to a state of matter which should be described as neither molecular nor atomic, but of matter in the process of becoming—a state of electronic, or really of biogenetic, aggregation, from which matter in the course of time has been evolved, the hiatus, the borderland or critical state, between disintegrated and integrated electricity.

"Biogen may be regarded as the immediate state between free electricity and condensed electricity, which we call matter—the hiatus between electricity as we know it and matter as we know it. It may be looked upon as the nuclear substance—in its ultimate form, as the material in which the energy and potentialities of the cell are stored, and from which they afterwards emanate. It possesses those properties which enable it in suitable environments to produce cells like the artificial ones we have demonstrated. But it possesses also the power of exciting vigorous metabolism, and of developing into more divers forms.

"This nuclear substance, consisting of biogen or the ill-defined bioelements, is what I regard as the basis of the manifold properties of living things we see around us."

This view of the phenomena of life shows us that it is merely one phase in the never-ending series of gradations.

(To be continued.)

MANY are the causes to which the disturbances of digestion during summer months are attributed, and they range from the dust of the streets to the milk supply. Dr. Baldorini, of Rome, adds another to the disturbing causes—the vessels in which ice-cream is usually made. The linings of these receptacles consist of an alloy of tin and lead. The ingredients of ice-cream dissolve this, and a certain amount of the lining of the vessel finds its way into the cream. A very small amount of lead, can, as the late Mr. Geoghegan said of strychnine, cause the human subject to betray symptoms of grave personal inconvenience.

Photography: Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Variations in Exposure Shutters.

Attention has recently been emphatically drawn to the fact, well enough known to many of us, that a large proportion of the exposure shutters now available, not only do not give exposures of the duration marked on them, but that they too often give variable exposures under what are supposed to be the same conditions. A shutter may be adjusted with the utmost precision by the maker, but if there is much friction in its various parts, a little change in the nature of the surfaces of those parts, or a little dust or grit, will make a very considerable difference in the duration of the exposure and render the maker's adjustment useless. I do not refer only to those shutters that can never possibly give the exposures marked upon them, but also to those that are honestly made and honestly marked.

It is obvious that this variation, due to alterations in the rubbing surfaces and to the presence of extraneous matter upon them, is likely to increase as the surfaces are more changeable and more extensive. Other circumstances being equal, a focal plane shutter with its large blind is more likely to suffer than a lens shutter with its smaller blind, and this, again, than a diaphragm shutter with its small rubbing surfaces of smooth metal. On the other hand, a little grit, that would be fatal to the performance of a metal shutter with its unyielding surfaces, might be carried along on a sheet of fabric without making any sensible difference to its rate of movement. The best protection that is possible for such apparatus cannot keep dust out nor prevent material, whether fabric or metal, from being affected by friction, and presumably the softer substance will suffer most.

To minimise irregularities it follows that the moving parts should be small, that they should be hard (that is, of metal), and that the rubbing surfaces must be reduced to the very smallest dimensions. Twenty-two years ago I published a description of a shutter that consists of a disc supported on a central pin, with a sector-shaped in it that, when the disc revolves in its own plane in front of the lens, gives the required exposure. The opening in the disc is adjustable by a sector-shaped shutter to vary the exposure. Shortly after, I had made by a watchmaker a shutter on exactly the same lines, but the disc was done away with except a sufficient part of it to cover the lens. There were really two sectors made of very thin brass that could be put one over the other for the maximum exposure or fanned out for a shorter exposure. I believe no shutter could give more constant results than this, for the only friction is on the small central pin, and I cannot conceive it possible to further reduce the friction. The rotating part can be removed in a moment and cleaned if necessary, but in this country it never needs it. That is the shutter that I should take to countries where dust and sand are so troublesome. It worked perfectly for many years, and is still as good as new, for it has nothing to wear out. The drawback to it is the limited range of exposure that any such device can give, unless, of course, the opening is reduced to less than the lens aperture, when what some call the "exposure" would be reduced, though the time necessary for the "exposure" to be given would remain much about the same. With a large disc, or its equivalent in sectors, an extensive range is possible, but for portable apparatus it must be small, and, therefore, its range must be undesirably limited.

The Photometry of Coloured Lights.

The paper on this subject, by Mr. J. S. Dow, that was communicated to the Physical Society of London last May, has just been published in the *Proceedings* of that Society. He shows what grave differences are obtained when comparing a red and green light by merely altering the size of the illuminated surfaces in a Joly photometer, as well as by the use of other types of instruments. It is well known that the sensitiveness of the retina to different colours is not equally proportioned in its various parts, but the value of Mr. Dow's paper consists in the fact that he has estimated the discrepancies that this leads to in actual work with the current forms of instruments. The subject is of fundamental importance to all who are interested in the estimation of the comparative luminosities of coloured surfaces, as well as to those who deal with what are more commonly understood as coloured lights, and even the lights from various sources that are generally regarded as colourless or white are sufficiently different in their tints to give measurable and sometimes notable variations.

Fishes'-eye Views.

The appearance of things in general to animals that inhabit water has an interest other than that which concerns those who find enjoyment in catching them. We know how rarely it is that water is still enough and clear enough to allow us to see objects much below its surface. In looking from under the water surface the objects in the second medium (the air) are generally better illuminated than those in the water, and this must be a considerable advantage, but the ripples interfere greatly with the definition of objects outside, causing such confusion and apparent movement of them that they may not be distinguishable. A bright or well-polished object would generally be more conspicuous if on shore than in the water when seen from the other medium, because in the former case it would be more brilliantly illuminated. In the February number of *The Photographic Monthly* there is a short and interesting article on this subject by Mr. J. Allan Stewart, M.A., illustrated by two photographs actually taken from under water, using a pin-hole instead of a lens to avoid the difficulties of focussing, etc. This is a curious subject well worth further study, and Mr. Stewart's is a valuable contribution to it, perhaps chiefly because he shows a suitable and simple experimental method for the purpose.

Colour Photography.

The *British Journal of Photography* has begun this year to issue an eight-page supplement devoted to "Colour Photography" with the first number of the journal for each month. One valuable feature of it is an illustrated summary in chronological order of British patents granted for this and allied subjects, beginning with Louis Ducos du Hauron's specification of three colour photography, dated 1876. I hope that in due time foreign patents will be dealt with as well.

There has recently been established "The Society of Colour Photographers," of which Mr. Henry J. Comley, of Surrey House, Stroud, Glos., is the Honorary Secretary and Treasurer, for the purpose of the interchange of experiences and specimens of work. Collections of specimens are already being circulated among the members. There must be a very great number of persons interested in the copying of colour because the applications of such work are innumerable, and it is a matter for hearty congratulation that they can now claim a society and a journal devoted exclusively to this subject.

NOTES

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Silicon in the Chromosphere.

IN a paper recently communicated to the Royal Astronomical Society, Professor A. Fowler discusses the evidence he has collected for the identification of two strong red lines of silicon with well-marked chromospheric lines. Careful determinations of their wave-lengths from a photographic spectrum of high dispersion give the values 6347.51 and 6371.57. The more retrangible line is the stronger in the proportion of 10 to 6, while their intensities in the chromosphere are 25 and 15 respectively. There may have been some suspicion of duplicate origin with a line of iron recorded by Kayser and Runge at λ 6371.60, but if there is such an iron line it is certainly not an enhanced line. From other considerations of the behaviour of the line it appears most satisfactory to attribute it chiefly to silicon. In sun-spot spectra these two lines are almost obliterated, and this feature is in accordance with the general behaviour of chromospheric lines. These two silicon lines show the general characteristics of enhanced lines in that they appear close to the positive pole of the arc.—(*Monthly Notices*, 77, p. 157, December, 1906.)

The Sun's Spotted Area during 1905.

In reviewing the measures of sun-spots for the year 1905 from photographs taken at Greenwich, Dehra Dun, Kodaikanal and Mauritius, the Astronomer-Royal states that there was a marked increase over the area for 1904, both the umbræ and the whole spots showing an increase of over 144 per cent., the actual area of 1191 being greater than that of 1883. Three periods of exceptional activity were noticeable, comprising January to March, July and October to November. The faculæ, as usual, maintained a more steady rate of advance than the spots, the total for the whole year only showing an increase of 48 per cent. over that for 1904. The two hemispheres showed different activities in the ratio of 63 to 37, for the north and south respectively. As the mean distance from the Equator of all spots barely exceeded 13°, this is suggestive that 1905 was the actual year of maximum of the present cycle. Also every latitude from the Equator up to 32° was represented, this being an arrangement usually characteristic of the year of maximum activity. The most striking feature of the year was the great number of abnormally large spot groups, notably that of January 29 to February 11, 1905.

Rotation of Giacobini's Comet C. (1905).

In the case of Swift's Comet 1892 I., Professor W. H. Pickering brought forward evidence to show that its tail exhibited a rotation about its axis in a period of about four days (*Harvard Annals* 32, p. 271). After discussing recently the beautiful photographs of Giacobini's comet of 1905 obtained by Professor E. E. Barnard, Pickering finds that they are divisible into two main classes, in one of which the tail is narrow, and in the other broad, giving the impression of a sword alternately presenting to us its edge and its flat side. In this case the rotation was somewhat slow, and as the comet was only visible for a short time, the photographic evidence only exists through a range of fifteen days. The intervals between the two presentations is about nine days, so that the period of rotation would be eighteen days. Professor Pickering makes the appeal that all future comets should be photographed as frequently as possible, so that any changes may be more accurately determined.

Perturbations of Halley's Comet.

In view of the general interest taken in the approaching apparition of Halley's periodical comet, Messrs. Cowell and Crommelin have undertaken the computation of the perturbations. Wishing to obtain a preliminary survey as to the correctness of Pontécoulant's perihelion date, they have made a computation of the Jupiter perturbations, dividing the comet's orbit into eighty portions, and following Pontécoulant's method closely. The two main results of this inquiry are: (1) May, 1910, is the correct date within a month for the next perihelion passage. Their actual date is a fortnight earlier than Pontécoulant's, but no stress is laid on this difference. (2) Pontécoulant's value of the eccentricity for 1910 is notably in error, the perihelion distance being practically the same as at the last return (0.59), whereas he increased it to (0.68). This change is of importance, as it would considerably affect the geocentric path of the comet at the next return, and would considerably modify the point at which the meteors accompanying the comet would intersect the earth's orbit.

Exploration of the Upper Air.

Extraordinary heights have been attained by registering balloons in connection with the work undertaken at various stations for the International Committee for researches in the upper air. On July 6, 1905, a rubber balloon sent up from the Meteorologische Zentralstation at München (Munich) attained a height of 23,000 metres (14.292 miles). The balloon was 1½ metres diameter, inflated with hydrogen. It landed at Deggendorf, having travelled a distance of 131 kilometres W.N.W., the period of flight being 97 minutes.

BOTANICAL.

By G. MASSEE.

The Water Hyacinth.

THIS beautiful aquatic plant, known botanically as *Eichornea speciosa*, is at the present moment a source of great anxiety to the members of the Legislative Assembly of New South Wales, owing to its rapid extension in the creeks, lagoons, and more sluggish rivers of that country, thus impeding navigation. When growing in shallow streams or lagoons, it tends to suck up the water, and converts limpid streams into bogs. The plant is a native of tropical South America, and, being very showy, is much cultivated. Its spread in New South Wales is traced to a few plants having been thrown into Swan River by a local resident, who cultivated it as a decorative plant. The water hyacinth is an aquatic, and usually floats freely without being attached to the soil; when growing in shallow water or swamps the roots grow into the mud. If the mud becomes dry, the plant perishes. The leaves are roundish and arranged in a dense rosette one or two feet high; the lower portion of the leaf-stalks are much swollen and filled with air, and serve as buoys insuring the stability of the plant, and preventing its being overturned by wind or waves. The roots form a dense tuft one or two feet long. The flowers are produced in profusion, of a lilac colour, and arranged in clusters like those of the hyacinth, hence the popular name. The plant is reproduced abundantly by stolons or shoots from the parent stem; these stolons, when about six or nine inches long, form a rosette of leaves at the tip, which soon forms a plant as large as the one from which it originated, and in turn produces stolons; by such means dense groups of plants of different generations remain organically united, and as the stolons are very strong, rowing boats and barges find it impossible to make headway, and steamers fare but little better, as the plants become entangled in the blades of the propeller. During floods large masses of the weed are detached and carried down stream as floating or half-submerged islands, which prove dangerous to bridges, jetties, &c. No satisfactory means of destroying the plant have as yet been devised. Some years ago certain rivers in Florida were completely choked up with this plant, which had been accidentally introduced. Specimens of the plant are at present growing in the Lily House, Kew Gardens.

A Brazilian Linen Plant.

The American Consul-General at Rio de Janeiro has recently sent an account to Washington of a plant which he considers likely to exercise an important influence upon the textile world in the near future. It has been described as *Canhamo braziliensis*, and is a common weed in Brazil, reaching a height of 12 to 18 feet within 12 months. When carefully cultivated it matures within three months, and three crops can be produced in a year. The fibre has all the necessary qualities required for high-class use; strength, fineness, flexibility, and adaptability for bleaching, dyeing, &c. Every part of the plant can be utilised for some industrial purpose, more especially for the manufacture of writing paper. The cultivation was commenced with the assistance of the State Government, and is now said to have emerged from the experimental stage successfully, and its influence will be felt at once, the products of the plantations having been contracted for by British interests at a highly remunerative rate. The production has been patented in the United States. The plant belongs to the Mallow family Malvaceae, and although recently described as a new species, proves to be the same as the plant previously known as *Hibiscus radiatus*, Cav.

Mycorhiza and the Fixation of Free Nitrogen.

Möller has demonstrated (*Ber. Deutsch. Bot. Gesell.*) that the dichotomously-branching mycorhiza present on the roots of certain coniferous trees, *Picea excelsa* and *Pinus montana*, is of no use in fixing free nitrogen for the tree. This is opposed to the view previously held by Muller.

The Eared Elm of Hampstead.

This famous old tree, which has just been removed, was situated on the Spaniards' Road side of Heath House, and has long been an object of interest to visitors, on account of a very large protuberance projecting from the trunk a short distance from the ground. The protuberance resembled, in general form, a human ear, and an account of its origin and structure, was recently given by Sir Samuel Wilks to the members of the Hampstead Scientific Society. Microscopic examination showed the substance of the protuberance to consist of wood, the result of an outgrowth of "callus," which trees produce to heal wounds. In the present case probably a large branch was broken off, leaving a long wound deep in the centre of the tree and shelving off to the surface. This was the reason for the growth being one-sided, and for a large projecting boss of wood being formed as its foundation.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Chrysalis Oil.

THE continual rise in the price of oils and fats has made it profitable to recover the oil contained in waste material, such as leather cuttings and wool waste, for manufacture into lubricants or soap, and experiments have been made to determine the value of other hitherto neglected sources of fat. Among the most recent of these may be mentioned Dr. Lewkowitsch's investigation of the nature of the oil to be obtained from the chrysalis of the silkworm. The oil, after extraction by means of a suitable solvent, was dark brown in colour and had an odour recalling that of fish oils. It could be clarified by filtration through fuller's earth, but on standing for some time, threw down a flocculent deposit. Its specific gravity at 40° C. was 0.9105, or practically the same as that of cod liver oil, which it also resembled in certain other physical and chemical characteristics. The proportion of oil yielded by the chrysalides was about 27 per cent., and although the dark colour would prevent its being used for the best soaps it could probably be advantageously employed in the manufacture of those of a lower grade.

Neon in Mineral Waters.

Argon and helium are almost invariably present in the rare gases in natural mineral springs, and the researches of M. Moureu show that neon is also a frequent constituent. The method he has employed is that used by Sir James Dewar, which is based upon the power possessed by cocoanut charcoal of absorbing the rare gases with the exception of helium and neon, the spectra of both of which can then be identified in the residual mixture. By this means M. Moureu has found traces of neon in the gases from twenty-two mineral springs, and has also been able to identify helium in the gases from two springs in which it had not previously been detected.

Alcohol from Peat.

A few years ago the problem of obtaining fermentable sugar on a commercial scale from sawdust was successfully solved, and experiments on similar lines with peat as the raw material have recently given promising results. It is well known that when starch is treated with a dilute acid it is converted into sugars and dextrins which can be more or less completely fermented by yeast, and a similar change can be effected, though less completely and with more difficulty by the action of acid upon cellulose, which forms a chief constituent of both sawdust and peat. The first attempts to manufacture alcohol from peat were made in 1875 by Herr Zetterlund, who seems to have obtained fairly successful results, but little more seems to have been done in this direction until 1905, when Herr Reynaud prepared a solution of sugar by heating peat with dilute sulphuric acid, and fermented this liquid by means of a yeast specially cultivated for the purpose. These experiments were continued on a manufacturing scale during the early part of last year at Aalborg, and some thousands of gallons of spirit were manufactured. Unfortunately, the liquid, after fermentation, did not contain more than 1 per cent. of alcohol, and it is questionable whether the concentration of so weak a "wash" would pay. A somewhat richer yield of alcohol, however, seems to have been obtained in the experiments independently carried out last year by Herr Frestadius and Baron Fock, at Stratskosten. Ordinary peat containing about 62 per cent. of water was boiled for 15 minutes with dilute sulphuric acid in a closed copper vessel under a pressure of three atmospheres, after which the mass was expressed under moderate pressure, and the filtrate neutralised with chalk and separated from the resulting gypsum. It was then fermented in large tuns with a special yeast and a portion of the alcoholic product distilled. The distillate contained 5½ per cent. of alcohol corresponding to a total calculated yield of 75½ litres of absolute alcohol from 225 kilos. of peat. A systematic study of the effect of varying the conditions as to the amount and concentration of the acid, the time of treatment and the pressure, will probably lead to a process which shall produce a stronger saccharine solution, and, consequently, a "wash" richer in alcohol. Assuming that this can be done, or that the cost of concentrating so weak a spirit is not too great, a new industry might be started in Ireland, where the bogs would furnish an unlimited supply of the raw material.

The Toxic Action of Rare Earths.

The rare-earth metals thorium, cerium, lanthanum, and zirconium are best known through their use in the manufacture of mantles for incandescent gas burners. The chemical and physical characteristics of their salts have frequently been studied, but hitherto little has been known about their physiological action. M. Hebert has, therefore, made a series of experiments to discover the effect of the sulphates of the four metals upon animal and plant life, and upon various enzymes. He finds that guinea-pigs and frogs are affected but little, if at all, by small doses of these salts, but that fish are killed by being placed in water containing one part in 5,000. The toxic effect upon fish varies with the nature of the metal, zirconium being the most poisonous and lanthanum the least. Plants are less sensitive than fish. They are not affected until the concentration of the solution reaches three parts in 1,000, and do not die for several days in solutions containing as much as five parts in 1,000. In the case of lower organisms, such as mould fungi and yeasts, and of enzymes, such as diastase and emulsin, the toxic effect of the sulphates of zirconium and thorium is comparable with that of mercuric chloride, whereas the sulphates of cerium and lanthanum appear to have no effect even in relatively large amounts. There does not appear to be any relationship between the toxicity and the atomic weights of the rare-earth metals (viz., thorium, 232.5; cerium, 140; lanthanum, 138; and zirconium, 90.7), for the poisonous action of the highest and lowest members of the series is the most marked.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

The Geological Society of London.

THE prosperous and flourishing condition of the Geological Society of London is a matter of considerable public interest. From the report of the Council for 1906 we find that the year closed with a total Fellowship of 1,252. The Society will celebrate the centenary of its founding in September next. This will be an interesting function, and it is hoped that many delegates from kindred institutions at home and abroad will attend. Mr. H. B. Woodward's History of the Society has now been completed, and the author is engaged in passing it through the press. The Wollaston Medal, the blue-ribbon of the geological world, has been awarded to Professor W. J. Sollas, F.R.S., the Murchison Medal has been awarded to Mr. Alfred Harker, F.R.S., and the Lyell Medal to Dr. J. F. Whiteaves, a sum of money accompanying the awards in the last two cases. No awards are made this year from the Barlow-Jameson Fund, the Prestwich Trust Fund, and the Daniel-Pigeon Fund. The Council have exercised their powers very laudably in the allotment of the various funds, and it is believed there is greater determination now to find out workers in the provinces who have merited well of the science, and whose efforts sometimes languish for want of encouragement. It is hoped that the claims of the amateur geologist will receive full consideration, both in the matter of awards, and in the recommendations of the Council for seats on its own body.

The Victoria Falls.

The geology of the Zambesi Basin around the Batoka Gorge (Rhodesia) was the subject of an interesting paper read by Mr. G. W. Lamplugh, F.R.S., on January 23, at Burlington House. The author described in a most interesting and effective manner the portion of the river Zambesi as it flows through the great gorge, which forms the exit of the river after plunging down the Victoria Falls. Above the Falls the river has many channels, more or less shallow, and has here apparently reached the last stage of old age. The flow above is of a tranquil nature, and in times of drought great islands appear in the stream. Were it not for the fact that, just when it was approaching that stage when further excavation was almost impossible, and its waters were likely to spread over a wide area of basin, it found a weakness in its bed in the shape of transverse-fractured joint or series of joints, its rejuvenescence would not have been accomplished. Finding, however, this fracture filled up with easily-excavated material, it proceeded to denude it, with the result that after the lapse of long periods of time, the whole river now falls into the chasm. The exit of the river is not the full width of the chasm; in fact, the exit is comparatively narrow, and as this was presumably eroded where the process was easily done, it adds additional probability to the theory that the chasm of the fall was what may be called a rubble-filled fracture, easily disintegrated along its whole width. The width of the issuing stream as compared with the width of the falls is a phenomenon which may be satisfactorily thus accounted for. Mr. Lamplugh's vivid description of the geology of the neighbourhood was admirable in every way, and it was well illustrated by a well-chosen set of slides. But the subject is a great one, and he was careful to show in what direction future explorers may prosecute their researches.

Earthquake Origins.

It is unsafe to deny that volcanos and earthquakes have at times a real connection, although it may be that sometimes the one or the other may be alone noticeable. Earthquakes may and do undoubtedly arise from explosions in volcanos, but many arise from other causes. The sudden formation of a fissure far underground, or the extension of a fault already in existence, may result in an earthquake, or even the collapse of the roofs of caves in a limestone district may give rise to one. The results of numerous investigations have shown that some of the most appalling catastrophes have their origin at a very slight depth, as compared with the earth's radius. Even the Charleston earthquake of 1886 had its origin but about 12 miles below the surface, and probably the seat of origin in no case exceeds 20 miles. The outermost crust only seems to contain the yielding material; beyond it all is too compact to produce movement. The rent in the rocks which is thought to have caused the Charleston earthquake made its effects felt from Boston to Cuba, and from Eastern Iowa to the Bermudas. The vibrations of a shock may be compared to the vibrations caused in air during the production of sound, such as when a sudden shout is made. Each particle of the earth vibrates rapidly, the swing of each particle probably, as a rule, not exceeding a tenth of an inch, but the movement is there, and the shock of this light movement of millions of particles, and their sudden arrestment and retrograde movement, are sufficient to cause the appalling results of a great quake. Frequently after an earthquake land is found to have been raised, as, for instance, in 1822, when the coast of Chile was suddenly raised three or four feet. At other times there is a sudden depression, as in 1812, when a region of 75 miles by 30 miles, resulted in the production of swamps and shallow lakes in New Madrid, Mo. These phenomena must be regarded not as the effects of an earthquake, but rather as the visible effects of the disturbance to which the earthquake is due. Not necessarily, then, an earthquake is caused by a connection with an outburst of volcanic energy, but as any shock to the crust must result in a quake of some sort, so volcanic explosions may give rise to local earthquakes, although these may not be felt many miles away from the volcano. On the other hand, the deeper that volcanic explosion may occur, to the greater distance will the shocks be felt, and we cannot safely say from negative evidence alone, that volcanic action is not at work beneath our feet, resulting in quakings of the earth.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Ailsa Craig.

CONSIDERABLE alarm has been created among bird lovers by the news that Ailsa Craig has been let by its owner, for a term of thirty years, for quarrying purposes on an extensive scale. It is felt that this may have disastrous results in the bird colonies established there, partly on account of the blasting operations necessary for the dislodgment of the granite, and partly by the raids which will probably be made on the breeding birds by workmen and others. That such fears are not unfounded may be gathered from the fact that at the last meeting of the British Ornithologists' Club the matter was seriously discussed; and, on the proposition of the Hon. Walter Rothschild, it was at last decided to appoint a deputation of the Club to approach the Marquis of Ailsa, with a view to secure his interest in the matter, in the hope that he may be induced to take all possible precautions to secure the birds from molestation.

The Eggs of the Solitary Sandpiper.

At the meeting of the British Ornithologists' Club held on January 16, Major F. W. Proctor exhibited three sets of eggs of the Solitary Sandpiper (*Totanus solitarius*) procured in Northern Alberta, N.-W. Canada, in June, 1903. These eggs excited considerable interest, inasmuch as they are the first that have ever been brought to Europe. But, in addition to their rarity, these eggs were remarkable on account of the light which they shed on the peculiar nesting habits of this bird. Thus, the first clutch contained five eggs taken from an old nest of the American Robin (*Turdus migratorius*). The second was incomplete, two eggs only being found, and these in a nest of Brewer's Blackbird (*Scolecophagus cyanocephalus*) placed in a tamaric tree five feet from the ground. The third was represented by three eggs also taken from a nest of the American Robin about 15 feet from the ground. The normal clutch appears to contain four eggs, which are laid in the deserted nests of other birds, and at some distance from the ground.

Destruction of the Kite in Wales.

We regret to have to draw the attention of our readers to the fact that a Common Kite has recently been killed near Brecon. In a letter to the *Field* (February 9), Mr. Cambridge Phillips relates that he saw this bird in the flesh in the shop of a local gunmaker. It is to be hoped that steps will be taken to secure the conviction of the vandal who killed this bird, who should further be made to forfeit the specimen.

Bitterns in Suffolk.

The Rev. Julian Tuck, in the *Zoologist* for February, records the fact that two Bitterns have recently been shot in Suffolk—one at Bardwell and one, a female, at Thorndon, near Eye. It seems a pity that these birds cannot be left alone, for they might yet be induced to breed here if given the opportunity.

Sabine's Snipe in Ireland.

Three samples of the melanic variety of the Common Snipe, known as Sabine's Snipe, were killed in Ireland during December, according to the *Zoologist* for February one near Ballina, Co. Mayo, on December 10, one in Co. Leitrim, December 15, and one in Co. Clare, December 20. The two latter appear to have been extremely good specimens of this curious variety, lacking the characteristic stripes down the head and back.

Snow Goose in Ireland.

Mr. Robert Warren, in the *Zoologist* for February, gives some interesting particulars of a flock of Snow Geese seen by Captain Kirkwood on Bartragh Island, Killala Bay, on December 30. This flock appears to have been composed of fourteen birds, four of which were adults, as shown by the white plumage and black-tipped primaries. It is suggested that these represented two broods accompanied by the old birds.

Snowy Owl in Ireland.

Captain Kirkwood also reported having seen a Snowy Owl on a hillock among the sand-hills in Bartragh, also on December 30.

These birds appear to have been driven before the great snowstorm and three days' terrific northerly gale which accompanied it.

PHYSICAL.

By Alfred W. Porter, B.Sc.

Electrons and Radiation.

Attempts have been made (*e.g.*, by Nagaoka) to explain the existence of banded spectra and of series in line spectra in terms of the theory that the atom is built up of negative and positive charges of electricity. The electrons in such a theory are conceived as rotating, like planets, round a positive nucleus, which corresponds to the central sun.

G. A. Schott, in the *Philosophical Magazine*, investigates the possibility of such a system being the source of bands and series, and he comes, firstly, to the conclusion that a single ring cannot be made to account for them, and hence such a single ring cannot serve as the model of an atom. However, light can be thrown on the conditions which a true model must satisfy, by a study of such a system. Schott concludes from his investigations that radiation of sufficient intensity and possessing the same range of wave-length as the observed lines in spectra, can consist of a number of waves too small to account for the lines even of one series if emitted by a single ring. Hence, he considers it useless to consider further the exact character of the system which will give rise to series of the same type as those of Balmer, Rydberg, or Kayser and Runge.

Acoustical Properties of Halls.

M. Marage has been studying several halls in Paris in regard to their acoustical properties. The result of the experiments is to confirm Sabine's theory. In any room an auditor hears three kinds of vibrations: (1) The primary wave, which comes direct from the source; (2) diffuse waves, sent back by the various surfaces in the room; (3) waves reflected regularly by particular surfaces, which give rise to distinct echoes. In order that a speaker may be distinctly heard there must be no echo, and the diffuse sound must last for a sufficiently short time to strengthen the sound which gave rise to it, without encroaching on the next. The duration of the diffuse sound can be expressed by the equation $t = K/(a + b)$ where K is proportional to the volume of the hall, and a and b refer to the empty room and the spectators, respectively. As sources of sound, M. Marage has employed a vowel-siren, furnished with buccal resonators, in order to imitate the human voice as closely as possible.

As an example of his results, we may cite that in the Salle du Trocadéro, he finds that when empty, the duration of resonance is about 2 seconds; when containing 4,500 auditors, it is reduced to 1½ seconds. In this hall, in order to be heard well, it is necessary to speak slowly, stopping between each phrase. To keep down the disturbance from resonance, one should not employ more energy in speaking than in the Physical Theatre at the Sorbonne, which seats only 250, and which has a remarkably short period of resonance (.6 second).

The Joule-Thomson Effect.

Reference has previously been made in these columns to the temperatures at which the heating (or cooling) of a gas in being forced through a porous plug (or throttle) may be expected to become zero. The only direct experimental determination of this inversion point had been made by Olszewski in the case of hydrogen, and then for one initial pressure only. Examination of the necessary consequences of van der Waals' and other characteristic equations of gases had led us to believe that a different inversion point would be found in general for every initial pressure. This published expectation has induced Olszewski to make direct determinations in the cases of air and nitrogen, with the result that the expectation is found to be fully justified. For example, in the case of nitrogen for variations of the pressure on the high pressure side of the throttle from about 160 atmos. to 30 atmos., the temperature at which no heating or cooling took place varied continuously from 248° C. to 163° C. For higher temperatures than the inversion one the gas became hotter in escaping, just as hydrogen does at ordinary temperatures; for lower temperatures it cooled. The importance of this arises in part from the fact that a gas must be cooled by other means below the inversion temperature before it can possibly begin to cool in any of the modern liquefying machines. Besides this reason, however, there is the other important one, that additional light is hereby thrown upon the exact behaviour of gases, and we may hope that an extension of such experiments will ultimately lead to a more exact knowledge of the relations between the pressure, volume, and temperature of a gas, a relation which is expressed by the characteristic equation.

ZOOLOGICAL.

By R. Lydekker.

The Bonte-Quagga.

One of the larger South African mammals now verging on extinction, if, indeed, it has not already ceased to exist, is the typical race of Burchell's zebra, the bonte-quagga (or "pied quagga") of the Boers, and the *Equus burchelli typicus* of zoologists. This race apparently inhabited the plains to the north of the Vaal River, now forming British Bechuanaland. It is characterised by the complete absence of barring on the legs and of stripes on the lower part of the hind-quarters; while between the dark brown body-stripes were faint "shadow-stripes" on the still paler ground-colour. The original specimen in the British Museum, brought home by the great African traveller, Dr. Burchell, was, unfortunately, destroyed at a time when but little attention was paid to the priceless value of "types," and there is now no example of this race of the species in the national collection. According, however, to a paper published by Mr. R. I. Pocock in the *Annals and Magazine of Natural History* for 1897, there is, however, one specimen in the museum at Tring, and a second in the Bristol Museum, both of which come very close to the typical form, although neither is exactly similar, and each differs slightly from the other. In these circumstances it is interesting to learn that a specimen exists in the American Museum of Natural History, which has recently been described and figured by Mr. M. W. Lyon in the *Bulletin* of that institution. The specimen, which was purchased from Messrs

Barnum and Bailey's travelling menagerie in the year 1855, agrees very closely with the one figured by Mr. Pocock.

Peculiar British Mammals.

At one time it was considered that there were no mammals peculiar to the British Isles. The refinements of modern zoological methods are, however, gradually demonstrating that the British representatives of various species are, as might be expected, distinguishable from the Continental forms, and are, therefore, entitled to rank as separate races, although it must be confessed that, in some cases at any rate, their distinctive features are but slight. Some time ago, for instance, Prof. Einar Lonnberg, of Upsala, pointed out that Scotch red deer are distinguishable from the typical Swedish *Cervus elaphus*, and he accordingly proposed that they should be regarded as representing a race apart, under the name of *C. elaphus scoticus*. More recently Dr. E. Satunin, of Tiflis, has called attention to the fact that the British badger has a wider skull than the Continental animal; and on this ground he has raised it to the rank of a special local race, with the title *Meles taxus britannica*.

Parasite and Host.

Sea-cucumbers (holothurians) are infested with certain small transparent fishes, which take up their abode in the body-cavity of their host and live in luxury on the food brought within reach without any active exertion on their own part. Recently an American naturalist has had an opportunity of observing the manner in which the uninvited effects an entrance into his lodgings. The fish, it seems, when it encounters a holothurian, feels its way with its head along the creature's side till it comes to the vent, into which it inserts the tip of its slender tail, and then gradually forces its way into the roomy interior.

Three Interesting Mammals.

The rare bush-dog (*Speothos venaticus*), of Guiana and Brazil, has long been the only known representative of its genus. A second species (*S. riveti*) has, however, recently turned up in the Andes of Ecuador, and is remarkable for possessing a soft, woolly coat like that of an opossum, thereby differing altogether from any other known member of the dog family.

Another mammal which has hitherto been generally regarded as the sole representative of its genus is the Chinese water-deer, *Hydropotes* (or *Hydrelaphus*) *inermis*, characterised, in common with the musk-deer, by the absence of antlers in the bucks, whose upper jaw is, however, armed with long, sabre-like tusks. This animal inhabits the reed-beds of the Yang-tse valley. Recently Dr. Max Hilzheimer, of Strassburg, has described what he regards as a second species, under the name of *H. kreyenbergi*, from the neighbourhood of Hankow. It is chiefly, if not entirely, distinguished by the characters of the skull.

In the columns of the *Field* the present writer has contributed a note on certain North American moose-heads characterised by having the bald patch on the flabby muzzle T-shaped in place of triangular. He might have added that a Canadian specimen presented recently to the British Museum by Mr. Frank Hutt shows the same peculiarity. The two specimens in which the feature is best displayed were reported to come from British Columbia, but this is now denied. The attention of sportsmen may be directed to the interest connected with this feature.

The papers read at the meeting of the Zoological Society on January 15 are mentioned in our last issue.

New Catalogues.

WE have received catalogues from Chas. Baker, of 244, High Holborn, of second-hand instruments of all descriptions, including microscopes, objectives, accessories, telescopes, physical and photographic apparatus, all excellently arranged; from John Wheldon and Co., 38, Great Queen Street, being the second and third parts of their excellent botanical catalogues, containing books on economic and geographical botany respectively; from E. George and Sons, 151, Whitechapel Road, List No. 44, covering books on Natural History and kindred subjects; and from Wm. Bryce, 54 and 54A, Lothian Street, Edinburgh, containing books on chemistry, electricity, technology, &c.

REVIEWS OF BOOKS.

ASTRONOMY.

A Century's Progress in Astronomy, by Hector Macpherson, Junr.; pp. xi. and 246 (Edinburgh: Blackwood, 1906; 6s. net). To a certain extent this work resembles a simplified edition of Miss Clerke's well-known work, to which the author acknowledges his obligation, an obligation which it will be difficult for any similar compiler for some time to come to avoid. He follows her in choosing Herschel as his starting point, which, though an obvious thing to do, makes the "century" rather long. The volume contains a fairly complete sketch of modern progress in most branches of astronomy, though geodetic work, for instance, is practically ignored. We do not like the persistent italicising of names, which is a feature of the book: nearly every man referred to, however unimportant, being provided with what are presumably intended to be full and correct Christian names. The italics only serve to emphasize the fairly obvious fact that the names are not invariably full or correct. We may instance the names of Gauss, Hough, and *Charles* Easton as having caught the eye in this connection, and, to show the indiscriminate use of the italicised names, we note they are given (incompletely, as it happens) for one man whose sole claim to mention in the book appears to be a neat phrase in an obituary notice of somebody else. The author, as regards living astronomers, is open to a suspicion of personal bias in respect, possibly, of those of whom he has more intimate knowledge. We question whether Mr. Gore will fully appreciate the remark that his calculations "represent our highest scientific conception of the universe," on the palpably inadequate ground that he has written down some purely hypothetical figures which transcend the author's powers of imagination. There is a certain monotony in the constantly appearing description, "the celebrated Esquimaux astronomer," or some similar phrase. Such a description is either superfluous, or conveys nothing beyond the bare fact of nationality, and, besides, possesses the same disadvantage as the indiscriminate use of "swear words" in certain circles, which render the user powerless to express himself in a real crisis. Superficial defects, which, after all, are largely a matter of taste, being put on one side, the book strikes us as containing an array of facts marshalled in an orderly and readable manner, various theories carefully weighed, and conclusions in general not too rash. The errors of authorities are bound to be repeated to a certain extent. It is of no great importance, so long as it does good work, to know who actually made the Crossley reflector, but, as a matter of fact, it was *not* Common, but Calver, from whom Common purchased it. Of misprints, beyond those noted by the author himself, the only obvious one we noticed is Pusiex for Puiseux.

BIOGRAPHY.

Sir William Flower, by R. Lydekker (London: J. M. Dent and Co.; 1906; price 3s. 6d. (English Men of Science Series).—The task of the biographer is a notoriously difficult one, and this is especially true when the writer undertakes to summarise the life of one to whom he was bound by the ties of friendship and common pursuits. The judicial balance is hard to keep in such a case. It may be true enough that no man is a hero to his own valet; but in the matter of friendship, sentiment and sympathy are apt to swing to the opposite extreme. Mr. Lydekker, however, in his life of Sir William Flower, has displayed a fine restraint, and, as a consequence, we have a dignified portrait of one who, in his time, played many parts, and always with distinction. This versatility is well brought out in Mr. Lydekker's introductory chapter, where Flower's career is briefly traced. Beginning, naturally enough, with his boyhood, we are taken on to his student days, and thence to that critical time when, as an army surgeon, he faced the horrors of war, in the Crimea. "The hardships and privations which caused the strength of his regiment to be reduced by nearly one-half within the short period of four months could not but tell severely on the constitution of the young surgeon, which was never very robust; and from some of the effects of these he suffered throughout his life." On his return to England he joined the staff of the Middlesex Hospital, as assistant surgeon, and to his other duties added the curatorship of the Hospital Museum, an appointment destined to bear important fruit. Within a year or two after this we find him curator of the museum of the Royal College of Surgeons, and here he remained until he succeeded the late Sir Richard Owen as Director of the British Museum of Natural History. His influence here made itself felt throughout the museums of the world; no one has done so much, probably, for the development of museums. Under his rule, the dreary array of stuffed and pickled specimens gave place to a judicious selection of examples, each of which had a definite lesson to teach, while the methods of displaying these were revolutionary in their novelty; the aim being to represent the natural surroundings of the creatures exhibited in so far as this was possible. And in the case of our British birds, this was done with marvellous fidelity to Nature. But Sir William Flower not only displayed a profound genius in the matter of the management of museums; he also earned distinction as a comparative anatomist and zoologist. His achievements in these several directions are passed in review, and appraised by Mr. Lydekker with a judgment and skill that is rarely exercised. It is not surprising to find that the trend of modern work and thought is to discount many of Flower's conclusions, but there is one matter at least to which we are pleased to note Mr. Lydekker draws special attention, and, further, on which he ranges himself on the side of Sir William. And this concerns the vexed question of nomenclature. A certain school, at the present day, have adopted an attitude in this matter that at times seems to reach the limit of sanity. The enthusiasts who are guilty of these acts of indiscretion have set up a kind of Gilbertian travesty of the Law of the Medes and Persians, and have enacted that in the matter of names for species and genera priority is to be followed blindly. Further, should a name make its first appearance mangled by the compositor, that misspelling is to be retained. Though most of us are agreed that trinomials have come to stay, what it to be said for such names as "Thouarsitreron dupetit-thouarsi dupetit-thouarsi," or "Pternistes leucoscepus muhamed-ben-abdullah,"? to say nothing of such names as "Caryocatactes caryocatactes caryocatactes!" And the same is true of the "laws" which have lately been enunciated with regard to the observance of priority in generic names. At these things Flower looked askance, and sooner or later rebellion will put an end to the present intolerable state to which zoology is being dragged. Though Sir William Flower left his mark upon the zoology of his time, yet his work "is characterised," says his biographer, "in the main by its conscientious carefulness and exactness, rather than by brilliancy of thought, conception, or style . . . . but there is no epoch-making discovery or comprehensive generalisation which can be associated with his name." Finally, he remarks, "Sir William was, undoubtedly a man of high and noble character, endeared to all with whom he was brought into intimate relations by his unfailing courtesy and charm of manner." This book is a book to read; not only is it a most delightfully written book, a model of what a biography should be, but there will be found within its pages an extremely valuable sketch of the growth of our present knowledge of the comparative anatomy of the higher vertebrates, a growth which Sir William Flower did much to assist.

W. P. P.

BOTANICAL.

Plant Life; Studies in Garden and School; by Horace F. Jones (Methuen and Co.; 3s. 6d.).—This book is plotted on modern lines, the primary object being to lead young students to look upon plants as something possessed of life, and to ascertain for themselves, by means of appropriate experiments and observations, the why and wherefore of the various structural and physiological peculiarities presented by plants. This idea is excellently carried out, the student being led from simple to complex experiments by easy grades. The method is sound. Instead of having to listen to a dissertation, as of old, which the student vainly endeavours to understand and to remember, the time is occupied in performing certain experiments which, being at the same time something tangible and interesting, it is difficult to forget. To a person knowing nothing of a subject, it is wisest to use universally adopted terms at once. The author speaks of "water-paths," presumably meaning wood bundles; his newly invented term will probably never occur in any other book, and the student will at some time have to unlearn a wrong term and learn the right one. It is stated that the examination of the "water-paths" will at once determine as to whether the plant under examination is a Monocotyledon or a Dicotyledon. This remark proves that the author's morphological studies did not extend to our common water-lilies. Notwithstanding minor slips, we have no hesitation in recommending the book to those desirous of learning how plants live, move, and protect themselves.

CHEMICAL.

Elementary Science of Common Life (Chemistry). by W. T. Boone, B.A., B.Sc.; pp. v. and 249 (London: W. B. Clive; 2s.).—No better guide than this little book could be found by a student preparing for the Board of Education examination in the above subject. It is clearly written and well arranged, and each step is illustrated by simple experiments, most of which can be carried out without the help of the teacher. In fact, the learner is taught how to prove the truth of each statement, and to take nothing for granted. Many points frequently omitted in elementary books on chemistry are here dealt with in a way that must hold the attention. In the section on air pressure, for instance, the student is shown how to construct his own barometer, to make a chart of the daily readings, and to interpret the meaning of the figures. Diagrams and illustrations are supplied wherever necessary, and, in short, we can thoroughly recommend the book to anyone wishing to begin the study of chemistry.

A Smaller Chemical Analysis, by G. S. Newth, F.I.C.; pp. v. and 147 (London: Longmans, Green, and Co.; 2s.).—The name of Mr. Newth is deservedly so well known in connection with the teaching of chemistry that we know beforehand that any book on the subject written by him will stand the test of practical work. This is certainly true of this book, which is practically a condensation of the qualitative section of the author's *Manual of Chemical Analysis.* The directions are so clear and sufficient, though without loss of conciseness, that they can easily be followed by a student working by himself. The scope of the book is essentially the qualitative analysis of simple salts, though the last chapter gives a description of a few of the more simple volumetric methods of quantitative analysis.

PHOTOGRAPHY.

Lantern Slide Making and Exhibiting, by John A. Hodges, F.R.P.S. (London: Marshall, Brookes, and Chalkley, Ltd.; price 6d. net.).—This small volume of 57 pages of reading matter, and a few illustrations is No. 4 of the *Focus* Photographic Manuals. The beginner will find it a reliable and useful guide, and will probably regret that the author has not given him still more of his experiences.

MISCELLANEOUS.

The February number of the *Museum Gazette* contains, like its predecessors, a large amount of varied and miscellaneous information on natural history and other subjects. Some of the phenomena of frost and the woods in winter form the subjects of articles specially suited to the season. In the notes for a lecture on swine we are told that the babirusa occurs in Borneo, while the information concerning bush-pigs and wart-hogs is distinctly original. Zoologists, in a later paragraph, will be surprised to learn that "the mastodon has grinders resembling those of the African elephants," while a great African sportsman and traveller will scarcely recognise his own name under the travesty of Major Morrell Cotton.

MICROSCOPY

Conducted by F. Shillington Scales, B.A., F.R.M.S.

Royal Microscopical Society.

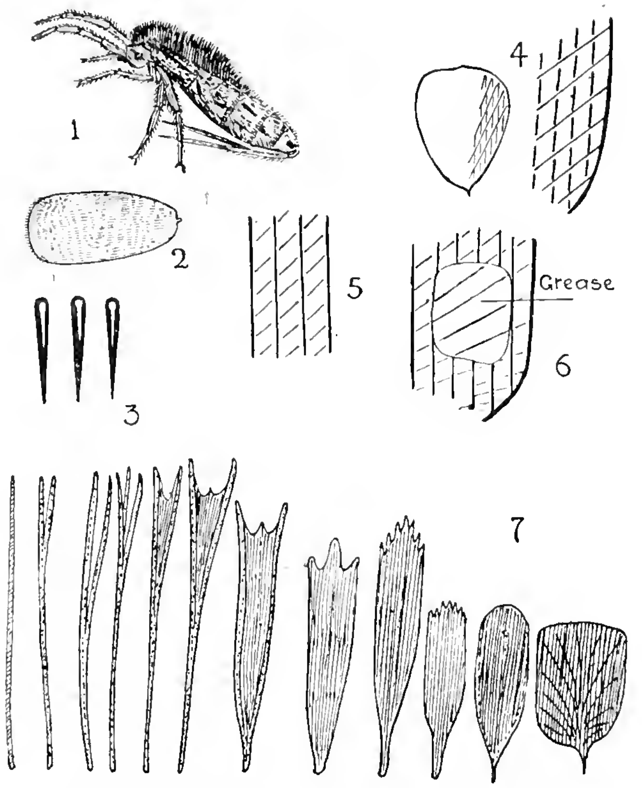
January 17, 1907.—Annual meeting, Dr. Dukinfield H. Scott, F.R.S., President, in the chair. Mr. Rousselet exhibited under microscopes a collection of mounted specimens of fresh-water polyzoa, which included nearly all the known species, several being very rare, and others not yet found in this country. Among the specimens were *Arachnidia Ray-Lankester*, from Lake Tanganyika, Statoblasts of *Lophopodella Thomasi*, from Rhodesia, *Pectinatella gelatinosa*, from Japan, and from Havel, near Berlin, and *Victorella favida*. Some excellent stereo-micrographs, sent over by Mr. Dollman, of Adelaide, were exhibited by the Secretary. The Annual Report and Balance-Sheet were read and adopted. The following officers were elected for the ensuing year:—President, The Right Hon. Lord Avebury; Vice-Presidents, Conrad Beck, A. N. Disney, Dr. J. W. H. Eyre, and Dr. D. H. Scott; Treasurer, Wynne E. Baxter; Secretaries, Rev. Dr. W. H. Dallinger and Dr. R. G. Hebb; Librarian, P. E. Radley; Curator, C. F. Rousselet. The President delivered his annual address, the subject being "The Flowering Plants of the Mesozoic Age in the Light of Recent Discoveries." The address, which was illustrated by about 50 lantern slides, was the last of a series on recent discoveries in fossil botany.

Quekett Microscopical Club.

January 18.—Mr. F. B. Rosseter, F.R.M.S., communicated a paper, which was taken as read, on two avian tapeworms, *Hymenolepis nitida* and *H. nitidulans*. Mr. A. E. Hilton read a paper "On the Nature of Living Organisms." He thought that a complete answer to the question as to what a living organism really was would not be possible for a long time to come. Science tells us that a living organism is an "automatic chemical machine." That all living things have a similar foundation has been well known for the last forty years. This foundation, a substance at first called protoplasm, but now more correctly known as plasm, is defined as colourless, and of a jelly-like consistency, about one-half water by volume or weight. In its entirety, it is a colloid, is elastic and highly mobile, but at the same time is tenacious, and not easily diffusable, is not soluble in an excess of water, but without a proper proportion of water in its composition the free action of its vital machinery is impossible. The idea that the honeycomb, granular, or thread-like structures observed are really the characteristics of pure plasm is no longer tenable. The appearances may be those of plasm products. The subject was then dealt with at considerable length from the "new chemistry" point of view, and stress was particularly laid on the strongly catalytic property of plasm. The lecturer concluded with a review of the known qualities and properties of the "automatic chemical machinery," and considerable discussion followed.

The Markings of Butterfly Scales.

The Podura Scale (*Lepidocyrtis curvicollis*) has long been a favourite test with microscopists for moderately high-power lenses, such as a quarter or a sixth of an inch, and much time has been spent in resolving the markings into "exclamation marks" of the utmost tenuity, and with a white inner "exclamation mark" in each dark mark. As a matter of fact, the test is by no means a reliable one, as the "resolution" is largely a matter of careful adjustment of both light and diaphragm; but the slide is found in most microscopists' cabinets, and there has been a good deal of discussion as to the exact nature of the markings referred to.



Dr. Alfred C. Stokes, of New Jersey, U.S.A., contributes to the December issue of the Royal Microscopical Society's Journal an interesting note on the markings of the wing scales of a certain butterfly, remarking that in 1895, Mr. Alfred Letherby, F.R.M.S., published a paper in the Journal, entitled "Notes on the Podura Scale," in which he stated that "this scale is formed of two membranes, one a delicate hyaline membrane, from which the stalk extends, and one a denser (optically) brownish membrane, superimposed upon the other. The latter is perforated all over, in the form known as 'exclamation marks,'" and that he presented photographs to substantiate his contention. From what Dr. Stokes has himself observed on the scales of another insect, he judges Mr. Letherby's statement to be correct. Dr. Stokes had in his collection a slide of the wing-scales of an unknown butterfly, which on examination were shown to be formed of three membranes, of which the upper and the lower bear longitudinal ribs, between which both membranes are distinctly, even conspicuously, perforated by minute apertures, arranged in rows more or less horizontal. Some of the scales in the preparation had the two margins accidently turned upward, so that both membranes could be readily examined. Others, accidentally torn, showed the postage stamp fracture with equal distinctness. The longitudinal ribs appeared to be externally directed folds or elevations of both membranes. Those on one surface passed around the stem-bearing end of the scale, and were continuous with the corresponding ribs on the other. The perforations ceased at a considerable distance from the posterior, or stem end, so that in that region the membranes showed no markings except these ribs, and, in certain instances, several oblique folds or wrinkles. The third membrane was intermediate between the two perforated surfaces, and was structureless. It appeared to be connected with the upper and lower membranes at the front, and at the two lateral margins of the scale. Dr. Stokes adds that its function seemed to be to stiffen and to support the two perforated membranes, which are so exceedingly delicate, and so susceptible to injury, that the process of mounting them in balsam had in many instances stripped them from the structureless basement membrane, leaving it bare and conspicuous, with only a few perforated fragments scattered over its surface. By analogy, therefore, he endorses Mr. Letherby's earlier statement as to the perforations in the Podura scale.

Some years ago I published in *Science Gossip* (Vol. VII., new series, 1900-1, pp. 152-4) an interesting note on "Podura Scales," by Dr. G. H. Bryan, F.R.S., originally contributed to the Postal Microscopical Society, in which he suggested that the scales varied so much in fineness that there were probably two varieties of the insect. Dr. Bryan stated that Dr. J. W. Arnold had succeeded in detaching the "exclamation marks," by means of an electric spark! (*Science Gossip*, 1873, p. 40.) He observed further that, in *Lepisma saccharina*, there are two kinds of ribs, those running longitudinally, which are on the outer side, and those running radially, which are on the side next the body of the insect; and, by means of a grease-spot on the scale, Dr. Bryan was able to obliterate the longitudinal ribs, whilst the radial ribs remained quite distinct. Where only a little grease was present, also, or at the edge of a grease patch, he observed little air-bubbles to follow the grooves between the longitudinal striæ, thus showing the thickness of the latter. Mr. Beck, in his appendix to Lord Avebury's "Monograph of the Collembola and Thysanura," states, however, that the longitudinal markings are on the under side of the scale, whilst the outer side bears the radial markings, the crossing of the two producing a curious optical effect, so as to give the appearance of beads. This optical effect was still more strikingly shown in two scales of *Polyommatus argus*, which lay partly over each other, producing an appearance very similar to that of a coarse Podura scale (see Carpenter's "Microscope," 8th edition, pp. 975-980, and Figs. 724, 726, 728, and 729). In the same volume of *Science Gossip* (pp. 245-6) I published also a note by Mr. W. T. McGhie, in which he described some insect hairs and scales, which seemed to him to exhibit the probable evolution of the insect hair and scale, and stated that "in the nervures a crooked system of vessels is perceptible, and these may be traced right through to pedicles of the tufts of bristles at the wing's point, the function being, I believe, to supply the scales with the liquid which, according to Dr. Royston Pigott, is found between the upper and lower membranes of the scales. There is certainly, as can be clearly seen with a good objective of wide angle, an intricate system of capillaries feeding every pedicle in the membrane."

The drawing reproduced on page 70 (Fig. 1) shows the appearance of the insect *Lepidocyrtus curvicollis* itself, by which it will be seen how it gets its name of "spring tail." Fig. 2 is a drawing of a scale of the insect, showing the curious watered-silk appearance under low powers or inefficient lenses. Fig. 3 illustrates individual markings on the scale, highly magnified to show the light central stripe. Fig. 4 shows part of a scale of *Lepisma saccharina* with the radial markings uppermost, and Fig. 5 one with the longitudinal markings uppermost, whilst Fig. 6 shows the obliteration of the latter by a grease spot on that side. Fig. 7 illustrates Mr McGhie's suggestions as to the evolution of insect hairs and scales.

Collecting Algae.

In a French scientific journal, M. Gomont gives some instructions to travellers on methods of preparing algæ for an herbarium or for examination. He divides the algæ into two groups, those which are visible to the naked eye, and those which are microscopic in size, and advises the careful labelling of each specimen, with its locality, and the nature of its habitat, as a matter of routine. The whole plant should be gathered, including its base. Some may be hung on a line in the shade to dry, but more delicate specimens should be laid out on a piece of sized paper, covered with calico, and pressed between sheets of blotting paper, both calico and blotting paper being frequently changed to ensure speedy drying. When the specimens are dry, the calico is removed, and the sheets packed on each other; or the specimens can be floated in sea-water, and a piece of paper inserted underneath, when they can then be teased out and left on an inclined plane to drain. A solution containing 35 to 40 grammes of salt per litre of water will do if sea-water is not available. Salt may also be used as a preservative, the specimens, after draining, should be packed, in alternate layers of algæ and salt, in a stone jar, and the vessel sealed. This method is suitable for a short journey only.

For microscopic algæ, quick drying in the open air on a sheet of sized paper is best, without calico or pressure. Diatoms and desmids may be placed in a drop of water and allowed to dry naturally. The author discourages the use of liquids for preservation of algæ, except for portions of plants which are to be studied anatomically, for which he recommends 90 per cent. alcohol, to which he adds a certain quantity of glycerine or a solution of picric acid.

Mounting Mosses.

In the *Bryologist*, Mr. J. F. Collins gives some hints on the mounting of mosses for the herbarium. Instead of the usual method of pinning the envelopes or pockets to the sheet, he uses half-inch discs of paper, gummed on both sides, to attach the envelopes, a single wafer being sufficient to hold most envelopes firmly, and being readily detached by a paper-knife. To mount specimens direct upon the sheet, he uses commercial liquid glue, diluted with an equal quantity of vinegar or water, which is brushed in a thin layer upon a sheet of glass. The specimen is rapidly pressed upon this and transferred to its position on the herbarium sheet. Small specimens, mounted with a certain amount of soil attached, which gives trouble by crumbling away, are easily hardened by a few drops of diluted white shellac—one part of shellac to three parts of 95 per cent. alcohol.

[*Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.*]

The Face of the Sky for March.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.50 and sets at 5.37; on the 31st he rises at 5.42 and sets at 6.28. The Sun enters the sign of Aries at 7 p.m. on the 21st, when Spring commences.

The Solar disc has been fairly well marked with Sunspots of late. At the time of writing there are two conspicuous spots visible.

The position of the Sun's axis, equator, and heliographic longitude of the centre of the disc is shown in the following table:—

Date.	Axis inclined from N. point.	Centre of disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Mar 2 ..	21 49 W	7° 14′	67° 51′
" 7 ..	22° 59′W	7° 15′	1 58′
" 12 ..	23° 59′W	7 13′	296° 5′
" 17 ..	24 50′W	7° 7′	230° 11′
" 22 ..	25° 29′W	6 58′	164 16′
" 27 ..	25 59′W	6° 46′	98° 20′

The Zodiacal light should be looked for in the west for a few hours after sunset.

THE MOON:—

Date.		Phases.	H. M.
Mar. 7 ..	☾	Last Quarter	8 42 a.m.
" 14 ..	●	New Moon	6 5 a.m.
" 22 ..	☽	First Quarter	1 10 a.m.
" 29 ..	○	Full Moon	7 44 p.m.

OCCULTATIONS.—The following are the occultations of the brighter stars visible at Greenwich:—

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N point.	Reappearance. Mean Time.	Reappearance. Angle from N. point.	Moon's Age.
			p. m.		p. m.		d. h.
Mar. 20	*m* Tauri	5·1	9 24	123°	10 17	228	6 16
" 21	χ¹ Orionis ..	4·7	7 16	64	8 30	290	7 14
			a. m.		a. m.		
" 22	χ² Orionis ..	4·8	0 30	95°	1 25	268	7 19
			p. m.		p. m.		
" 30	80 Virginis ..	5·8	7 42	180	8 4	227	16 14

THE PLANETS.—Mercury (Mar. 1, R.A. $23^h\ 50^m$; Dec. N. 0° 31′; Mar. 31, R.A. $23^h\ 18^m$; Dec. S. 4° 4′) is an evening star in Pisces during the early part of the month. On the 2nd the planet is at greatest elongation of 18° 9′ E. from the Sun, when he sets at 7.26 p.m., or $1\frac{3}{4}$ hours after the Sun. Hence, about this date, he is favourably placed for observation immediately after sunset. The planet is in inferior conjunction with the Sun on the 18th.

Venus (Mar. 1, R.A. $19^h\ 42^m$; Dec. S. 19° 24′; Mar. 31, R.A. $22^h\ 2^m$; Dec. S. 12 22′) is a morning star in Capricornus, rising at 4.50 a.m. on the 1st and 4.30 a.m. on the 31st. The telescopic appearance of the planet is gibbous, ·7 of the disc being illuminated.

Mars (Mar. 1, R.A. $16^h\ 50^m$; Dec. S. 21° 56′; Mar. 31, R.A. $17^h\ 57^m$; Dec. S. 23 30′) is a morning star in Ophiuchus, rising at 2 a.m. on the 15th. The planet is getting within range of ordinary telescopes, the apparent diameter of the disc being 8″.

Jupiter (Mar. 1, R.A. $6^h\ 4^m$; Dec. N. 23° 29′; Mar. 31, R.A. $6^h\ 12^m$; Dec. N. 23° 31′) is describing a short direct path about 1° North of the star η Geminorum. The planet is very conspicuous, and is due South about 6.30 p.m. near the middle of the month. The equatorial diameter on the 15th is 39″, whilst the Polar diameter is 2″·5 smaller.

The following table gives the satellite phenomena observable before midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.
Mar				Mar				Mar			
1	I.	Oc. D.	6 44	9	I.	Sh. E.	9 24	23	I.	Tr. I.	9 38
	I.	Ec. D.	10 12		II.	Ec. R.	10 19		II.	Oc. D.	10 6
2	I.	Sh. E.	7 29		III.	Ec. R.	11 56		I.	Sh. I.	10 56
	II.	Ec. R.	7 44	15	IV.	Oc. R.	7 13		III.	Oc. D.	11 36
	III.	Ec. R.	7 51		I.	Oc. D.	10 31		I.	Tr. E.	11 55
7	IV.	Sh. I.	8 29	16	II.	Oc. D.	7 33	24	I.	Ec. R.	10 28
	II.	Tr. I.	10 20		III.	Oc. D.	7 38	25	II.	Sh. I.	7 30
	IV.	Sh. E.	11 9		I.	Tr. I.	7 44		II.	Tr. E.	7 42
	I.	Tr. I.	11 22		I.	Sh. I.	9 1		I.	Sh. E.	7 43
8	I.	Oc. D.	8 37		I.	Tr. E.	10 1		II.	Sh. E.	10 23
9	III.	Oc. R.	6 48		III.	Oc. R.	10 42	27	III.	Sh. E.	10 11
	I.	Sh. I.	7 6		I.	Sh. E.	11 19	30	I.	Tr. I.	11 33
	I.	Tr. E.	8 8	17	I.	Ec. R.	8 33	31	I.	Oc. D.	8 50
	III.	Ec. D.	8 53	18	II.	Sh. E.	7 45				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn (Mar. 1, R.A. $23^h\ 14^m$; Dec. S. 6° 57′; Mar. 31, R.A. $23^h\ 28^m$; Dec. S. 5° 33′) is in conjunction with the Sun on the 9th, and hence is unobservable.

Uranus (Mar. 15, R.A. $18^h\ 53^m$; Dec. S. 23° 13′) is a morning star in Sagittarius, rising about 3 a.m.

Neptune (Mar. 15, R.A. $6^h\ 43^m$; Dec. N. 22° 13′) is situated in Gemini about 3° South of the star ε Geminorum. The planet is difficult to identify among the numerous small stars appearing in the same field of view, but can be detected by his motion if observations are made some nights apart.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Near to	Characteristics.
	h. m.			
Mar. 1-4 ..	11 4	+ 4°	τ Leonis	Slow; bright.
" 14 ..	16 40	+54°	μ Draconis	Swift.
" 24 ..	10 44	+58	β Ursæ Maj.	Swift.

Minima of Algol occur on the 1st at 11.46 p.m., on the 4th at 8.34 p.m., and the 24th at 10.17 p.m.

DOUBLE STARS.—γ Leonis, X.h 14m, N. 20° 22′, mags. 2, 4; separation 3″·6.

The brighter component is of a bright orange tint, whilst the fainter is more yellow.

ι Leonis, XI.h 19m, N. 11° 5′, mags. $4\frac{1}{2}$, $7\frac{1}{2}$; separation 2″·4. This object requires a favourable night and a fairly high power on small telescopes.

α Canum Venat, (*Cor Coroli*), XII.h 52m, N. 38° 49′, mags. 2·5, 6·5, separation 20″; easy double, can be seen with moderately low powers, even in 2-in. telescopes.

CLUSTER.—M 44, the Præsepe in Cancer, visible to the naked eye as a nebulous patch, best seen and easily resolvable with a pair of opera or field glasses. Situated about midway and a little to the west of the line joining α and δ Cancri.

LONDON AND COUNTY BANKING COMPANY LIMITED.

Registered under "The Companies Acts." Established in 1836.

CAPITAL £8,000,000, in 100,000 Shares of £80 each.

REPORT adopted at the Half-Yearly Ordinary General Meeting, the 7th February, 1907.

CHARLES JOHN HEGAN, Esq., in the Chair.

The Directors, in submitting to the Shareholders the Balance-sheet for the half-year ending 31st December last, have to report that, after paying interest to Customers and all charges, making provision for bad and doubtful debts, and allowing £43,106 6s. 5d. for rebate on bills not due, the net profits amount to £325,006 1s. 10d. From this sum have been deducted £50,000 allocated to writing down the Bank's holdings in Corporation Stocks, £25,000 transferred to Premises Account, and £50,000 carried to Reserve Fund (raising it to £1,550,000), leaving £200,006 1s. 10d., which, with £97,365 2s. 10d. balance brought forward from last account, leaves available the sum of £297,371 4s. 8d.

The Directors have declared a Dividend for the half-year of 10 per cent., which will require £200,000, leaving the sum of £97,371 4s. 8d. to be carried to the Profit and Loss New Account. The present dividend added to that paid to 30th June will make 20 per cent. for the year 1906.

The Directors, with deep regret, announce the retirement from the Board of William Howard, Esq., who entered the service of the Bank in 1862, and who has been for the past ten years a most valuable member of their body.

The Directors retiring by rotation are William McKewan, Esq., Oswald Cecil Magniac, Esq., and Charles James Cater Scott, Esq., who, being eligible, offer themselves for re-election.

The Dividend, £2 per Share, free of Income Tax, will be payable at the Head Office, or at any of the Branches, on or after Monday, 18th February.

Dr. BALANCE-SHEET of the London and County Banking Company Limited, 31st December, 1906. Cr.

Dr.	£ s. d.	£ s. d.
To Capital subscribed £8,000,000 Paid up		2,000,000 0 0
Reserve Fund		1,550,000 0 0
Due by the Bank on Current, Deposit, and other Accounts, including provision for Contingencies		44,990,316 12 9
Liabilities on Acceptances, covered by Cash, or Securities or Bankers' Guarantees		2,722,692 2 10
Rebate on Bills not due carried to next Account		43,106 6 5
Net Profit for the Half-Year, after making provision for Bad and Doubtful Debts	325,006 1 10	
Transferred to Investment Accounts	50,000 0 0	
	275,006 1 10	
Transferred to Premises Account	25,000 0 0	
	250,006 1 10	
Carried to Reserve Fund	50,000 0 0	
	200,006 1 10	
Profit and Loss Balance brought from last Account	97,365 2 10	
		297,371 4 8
		£51,603,486 6 8

Cr.	£ s. d.	£ s. d.
By Cash at the Head Office and Branches, and with Bank of England	8,093,142 9 7	
Loans at Call and at Short Notice	3,301,623 2 2	
		11,394,765 11 9
Investments, viz.:—		
Consols registered and in Certificates (at 85), New 2½ per Cents., and National War Loan (£6,894,491 7s. 11d., of which £357,000 0s. 0d. Consols is lodged for Public Accounts); Canada 4 per Cent. Bonds, and Egyptian 3 per Cent. Bonds, Guaranteed by the British Government	6,654,438 16 1	
India Government Stock and India Government Guaranteed Railway Stocks and Debentures	898,984 16 10	
Metropolitan and other Corporation Stocks, Debenture Bonds, English Railway Debenture Stocks and Colonial Stocks	1,644,109 15 9	
Other Securities	19,586 17 9	
		9,217,120 6 5
Discounted Bills Current	7,628,467 3 0	
Advances to Customers at the Head Office and Branches	19,835,994 8 9	
		27,464,461 11 9
Liabilities of Customers for Drafts accepted by the Bank (as per Contra)		2,722,692 2 10
Bank Premises in London and Country, with Fixtures and Fittings	829,446 13 11	
Less amount transferred from Profit and Loss	25,000 0 0	
		804,446 13 11
		£51,603,486 6 8

PROFIT AND LOSS ACCOUNT.

Dr.	£ s. d.	£ s. d.
To Interest paid to Customers		231,273 2 1
Salaries and all other Expenses at Head Office and Branches, including Income Tax on Profits and Salaries, Auditors' and Directors' Remuneration		331,314 11 0
Transferred to Investment Accounts		50,000 0 0
Transferred to the Credit of Premises Account		25,000 0 0
Carried to Reserve Fund		50,000 0 0
Rebate on Bills not due, carried to New Account		43,106 6 5
Dividend 10 per cent. for the Half-Year	£200,000 0 0	
Balance carried forward	97,371 4 8	
		297,371 4 8
		£1,028,065 4 2

Cr.	£ s. d.
By Balance brought forward from last Account	97,365 2 10
Gross Profit for the Half-Year, after making Provision for Bad and Doubtful Debts, and including Rebate, £28,715 0s. 8d., brought from 30th June last	930,700 1 4
	£1,028,065 4 2

Examined and Audited by us,

(Signed) J. J. CATER, E. H. CUNARD, W. E. HUBBARD, } *Audit Committee of Directors.*

H. R. WYATT, *Head Office Manager.*
W. G. GRIBBLE, *Country Manager.*
T. J. CARPENTER, *Chief Accountant.*

LONDON AND COUNTY BANKING COMPANY LIMITED,
11th January, 1907.

In accordance with the provisions of the Companies Act, 1900, we certify that all our requirements as Auditors have been complied with, and we report that we have examined the Balance-sheet and Profit and Loss Account, dated the 31st December, 1906, have verified the Cash-Balance at the Bank of England, the Stocks there registered, and the other investments of the Bank. We have also examined the several Books and Vouchers and certified Returns showing the Cash-Balances, Bills and other Amounts set forth, the whole of which are correctly stated, and in our opinion the said Balance-sheet and Profit and Loss Account are properly drawn up, so as to exhibit a true and correct view of the Company's affairs as shown by the books of the Company.

(Signed) HY. GRANT, THOS. HORWOOD, STUART PLEYDELL-BOUVERIE, } *Auditors.*

LONDON AND COUNTY BANKING COMPANY LIMITED,
17th January, 1907.

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