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Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., and E. S. GREW, M.A.

VOL. IV. No. 2. [NEW SERIES. FEBRUARY, 1907. [Entered at Stationers' Hall.] SIXPENCE NET.

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Practical Aerodynamics
And the Theory of Aeroplanes.

By MAJOR B. BADEN-POWELL.

INTRODUCTION.

JUST now the subject of aërial navigation has been prominently brought before the public. A wide interest has been aroused, and people generally are beginning to see what a vast future there is open to a machine able to traverse, surely and safely, the realms of blue. Although I am one of those who always prefer fact to theory, and though most of the important inventions which have aided human progress have not sprung from the mathematician's brain, I quite realise that a certain amount of study of the principles underlying any such subject is most necessary to one who would add any important work towards the conquest of the atmosphere.

The air, then, and the effects of its pressure on bodies moving through it, demands our earnest attention.

Air may seem a light, subtle fluid. If we pass our hand through it we notice very little resistance to the motion, and we may wonder how it is possible to utilise this very yielding medium to support the heavy weight of a human body or metal machinery against the force of gravity. From a mechanical point of view it is just the same whether a body be pushed against the air, or the air blows against a stationary body. Yet we all know what air, when in motion at a great speed, may effect. We know that if the wind be blowing with the force of a gale—perhaps 60 or 80 miles an hour—it is capable of exerting a very great pressure, especially on suitably disposed surfaces. We know well enough that when out on a windy day, an umbrella held even with its convex side to the wind, is sometimes most difficult to hold, and that directly it is turned so as to present a concave surface it is immediately blown inside out, or if made strong enough to resist this action, would pull with such force as to be almost impossible to hold. This enables one to realise what may be effected by making an apparatus to travel very rapidly through the air.

It seems probable that an ordinary umbrella (suitably strengthened) held so as to let a very strong wind strike underneath it, would pull so hard as to be almost capable of lifting a man off his legs, momentarily, at least. This fact hardly seems extraordinary, yet if we imagine a flying apparatus only as big as an umbrella progressing at 40 or 50 miles an hour through the air, it would surprise most of us to think that it was capable of raising a man.

This enables one to realise that if only we can get the *power*, properly applied, a very small apparatus may be sufficient for our purpose—and, if a very large aeroplane be used, what great lifting power is to be derived from it.

This subject, though likely, as already intimated, to become one of very great importance, yet is one that has received but comparatively little attention among scientific experimentalists.

Langley, in the introduction to his book, "Experiments in Aerodynamics," published in 1891, says: "In this untrodden field of research . . . I think it safe to say that we are still, at the time this is written, in a relatively less advanced condition than the study of steam was before the time of Newcomen."

No complete treatise on the subject exists. All the information that is available has to be extracted from works dealing with aëronautics (mostly historical), hydrostatics, and pneumatics, and from the various technical papers which have been compiled on certain definite branches and on results of particular series of experiments. The following is a general review of the whole subject gathered from these sources. It does not pretend to be complete or exhaustive, but it is hoped that it may be of assistance to those anxious to get an idea of the science, and who are unable to wade through the various sources of information enumerated.

I propose treating of the subject in the following order. It will be necessary first to briefly refer to the theory of the balloon, and ascent by reaction of a fluid, and then to get on to the main subject of aeroplanes and apparatus working on kindred principles.

This latter subject must again be subdivided into air pressures acting perpendicularly on a plane surface, air pressures on inclined plane surfaces, the effect on the back of such planes, and pressures on curved surfaces moving through the air.

Finally, to consider the combined effects on various shaped bodies in practice, the flight of birds, and the theoretical action of aërial screw propellers.

In considering the different methods possible for the attainment of artificial flight—which is practically synonymous with means of overcoming the force of gravity—there are three principles to be taken into account:—

(1) *Displacement.*—By displacing a bulk of air by a body of less total weight than that air. Under this head would be included hot-air balloons, gas balloons, and the theoretical, if impracticable, vacuum balloon.

(2) *Downward Reaction.*—By the reaction of a fluid driven forcibly downwards. Such is the principle of the rocket.

(3) *Sub-Pressure.*—Deriving support from the pressure of the air on the under surface of a body driven through it. This would include not only what is understood by the term "Aëroplane," but also revolving aeroplanes or lifting screws, and wings and paddles striking the air downwards. Under this heading, too, must come the wind-borne soaring birds and thistledown.

As regards the first of these methods we need but briefly go into it, since the subject of ballooning is rather beyond our present scope.

If a given volume of air be displaced and the space filled by a vessel inflated with some substance lighter than air, such as hydrogen, coal gas, steam, or air rendered less dense by being heated, then, if the containing vessel is not too heavy the whole will rise in the air. This is in obedience to well known laws. The heavier particles of air will slip under the lighter body and buoy it up, just as water when poured into a basin would slip under and buoy up a cork lying in the basin.

That air has definite weight can easily be proved by carefully weighing a bottle which has been exhausted of air, and weighing it again when air is admitted to it. In this way air is found to weigh .075 lb. per cubic foot, or 1,000 cubic feet will weigh 75 lbs.

Hydrogen gas can be weighed in the same manner, and is found to be .005 lb. per cubic foot, or 5 lbs. for 1,000 cubic feet. Coal gas varies, but may average about 35 to 40 lbs. per 1,000 cubic feet. Steam, which has actually been applied to ballooning, varies according to its temperature. As regards heated air, what is known as Charles's law shows that a given volume, under constant pressure, increases with temperature .00367 times its bulk per degree Centigrade, or .002 ($\frac{1}{500}$) per degree Fahrenheit. If, then, the air in a balloon can be raised by 100° F., one-fifth of its weight will be expelled; that is, each cubic foot will then weigh $\frac{4}{5}$ of .075, or .06 lb., or 1,000 cubic feet will weigh 60 lbs. instead of 75.

These principles are often overlooked by unscientific inventors, who suggest adding a *small* balloon to aid in lifting their apparatus, or who anticipate a hope of finding a gas lighter than hydrogen.

One F. Lana, in 1670, was probably the first to suggest the idea of a machine on this principle, but his suggestion was to exhaust the air from large copper globes, ignoring the practical fact that the pressure of the atmosphere would crush in any such vessel as soon as a very small quantity of air had been extracted from it.

The second method, though interesting as a speculative suggestion, seems hardly likely to prove of practical utility, for a man-carrying machine.

Rockets are well known. They are practically useful for many special purposes, but are extremely wasteful of fuel, and, therefore, short-lived. Steam jets striking downwards have been suggested.

Mr. H. Wilde, F.R.S., conducted a number of experiments at one time* in order to ascertain what force could be practically applied with this idea. He tried high pressure steam and compressed air through orifices of many various forms, also explosions of gas mixed with air and ignited by electric sparks He, however, sums up the whole matter by saying: "The results of all these experiments on the discharge of elastic fluids, made with a view to the possibilities of aërial locomotion, were purely negative, and proved decisively that the solution of the problem was not to be found in that direction." It occurs to me, though I have not actually tried the experiment, that liquid air might be used in this connection. A vessel of liquid air in ordinary atmospheric circumstances is practically equivalent to a vessel of water placed in the middle of a furnace. The liquid air in the one case and the water in the other are boiling hard and rapidly evaporating into air or steam respectively. So that by employing this method we practically have a steam boiler exposed to a comparatively very high temperature (that is the difference between that of the liquid and that of the surrounding atmosphere), yet without any fuel or apparatus for burning fuel. A great pressure may thus be obtained with but little weight, and it could, therefore, be made to ascend. It is true that this action may be very wasteful and would not last long. Still, as an experiment, it might be interesting to see a vessel rise in the air by this novel means.

It may be added that though a continuous stream issuing from a jet may, theoretically, be wasteful of power, it would probably not be difficult to make the jet intermittent, or, by progressing rapidly in a horizontal direction, to cause it to act continually on fresh air.

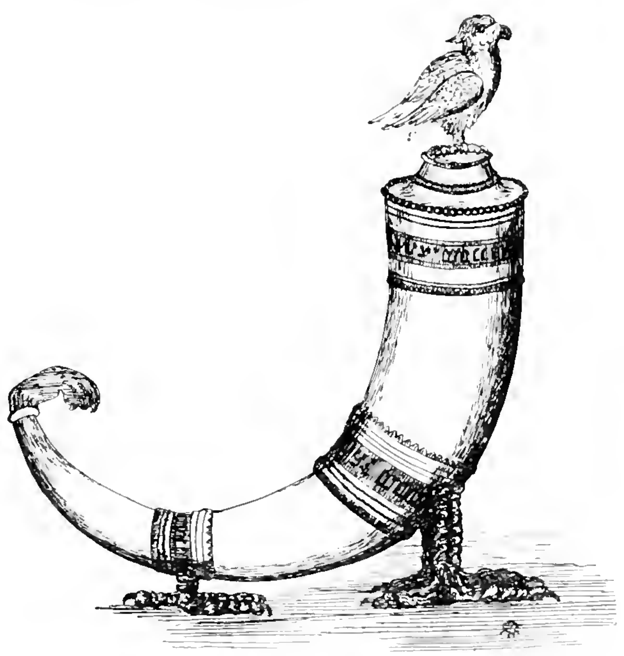
The third principle, which promises the most practical results, and is a much larger subject, we must leave for a future article.

(*To be continued.*)

* "On Animal Locomotion," by Henry Wilde, F.R.S. Vol. xliv. No. II of the "Memoirs of the Manchester Literary and Philosophical Society." 1900.

Queen's College Horn.

In the Buttery of Queen's College, Oxford, is preserved one of the city's greatest curiosities. It is an old drinking cup presented to the College by Philippa, Consort to Edward III., more than five hundred years ago, from whom it took its name. In shape it resembles a horn; it is made of polished horn, brown in colour, and richly decorated in silver-gilt. It is one foot eight inches high, and the outer curve from the



Sketched by Henry H. Crapper, Queen's College Lodge.

Horn in the Buttery, Queen's College, Oxford.

extreme points is forty-one inches. It will hold two quarts.

On the lid is a silver eagle of curious workmanship, and the whole is supported by eagles' claws.

An eagle was the crest of the founder of the College, Robert de Eglesfeld, Confessor to Queen Philippa. This cup is still used on "Gaudy" day, and is handed round after dinner. The contents consist of "Chancellor," a strong beer brewed by the College—sherry and brandy flavoured with pine-apple.

Features of the Earth and Moon.

Volcanic Formations.

SOME fascinating speculations on the formation of the Earth's crust emerge from the publication among the Memoirs of the American Academy of Professor W. H. Pickering's "Lunar and Hawaiian Physical Features." The physical features of the island of Hawaii which Professor Pickering has photographed and investigated are its huge craters and lava plains and lakes; and he has noted a similarity in their formation and contours with the very much larger craters of the Moon. The Earth and the Moon being supposed to have a common origin, and to have once been part of the same mass, it would appear not unreasonable to expect that their exterior features would bear some resemblance. But as Professor Pickering observes "the lunar surface presents such a strong contrast to the more thickly populated portions of the Earth that little resemblance between them can be traced. Even those of our volcanic regions which have been most extensively studied show little analogy to the Moon."

The only Earth craters which bear a colourable resemblance to those of the Moon are the craters of Hawaii, with which Professor Pickering in the work before us compares them; and from a consideration of the Hawaiian craters his theory of the reason for the difference between lunar and terrestrial formations, is chiefly drawn. The enormous discrepancy in size between the craters of the Moon and those of the Earth is sometimes attributed to the fact that the force of gravitation at the surface of the Moon is but one-sixth as great as it is on the Earth. But this theory will not do; although if the lunar craters had been due to explosions of steam, as the Earth's explosive volcanoes are, one may grant that matter expelled from a crater vent could be thrown very much farther or very much wider than is the case on this planet. But, says Professor Pickering, we are really

Fig. 2.—Kies and Mercator.

trying to compare objects formed under entirely different conditions. "The larger craters on the Moon came into existence when the thin solid crust covering the molten interior was, owing to the solidification and contraction of the crust, much too small to contain the liquid material. The craters were therefore formed by the lava bursting through the crust, and so relieving the pressure." In other words they were overflow eruptions.

Fig. 1. Interior of Haleakala.

Then, at a second period in the Moon's history, another form of crater, or rather another form of volcanic eruption, came into play. The crust of the Moon had thickened; and the interior regions, by cooling, shrank away from the solid shell, as a drying walnut does. The solid shell, being insufficiently supported, caved in here and there, permitting the great fissure eruptions which produced those great tracts which we call the lunar seas. These extensive outflows of lava dissolved the original

Fig. 3. Bullialdus.

solid shell whenever they came into contact, obliterating its features. The same obliteration of smaller craters (on a much reduced scale) can be perceived in Hawaii. In all probability the same thing, Professor Pickering suggests, took place on our own Earth on a larger scale instead of on a small one. The inner core of the Earth shrank still more from the cooling and hardening outer crust; the resulting cataclysms were still greater and more destructive; and through great fissures there were enormous outflows of lava and molten rock, now recognised as "archaic rocks," which completely dissolved and destroyed the gigantic blister craters which once studded our globe.

The volcanoes of Southern Europe, which are those most completely studied, have little in common with those of the Moon. In the case of the volcano of Vesuvius, for example, a high truncated cone has been built up by mild eruptions of steam and cinders, sometimes alternating with lava. At long intervals violent explosions occur, which sometimes blow away a large portion of the summit. Such an explosion occurred when Pompeii was overwhelmed, and it was repeated on a minor scale last year. The most violent explosion of the kind of which we have any record was that which occurred not at Vesuvius but at Krakatoa in 1883. Nothing whatever of that kind is perceptible among the discoverable craters of the Moon. In volcanoes of the engulfment type, as opposed to the explosive type, comparatively little steam is evolved; often there is no exterior cone, and the craters enlarge quietly by the cracking off, and falling in of their walls. This species of crater is to be found in Hawaii, though the Hawaiian structures are on a comparatively small scale, the largest of them being one-hundredth the diameter of a lunar crater.

On the great seas or *maria* of the Moon, secondary engulfment craters were formed; and of these Bessel, which is about twelve miles in diameter, is a large and well-known example. There are no great craters of that size on the Earth to compare with it; all the Earth's largest craters being of the explosive type.* At Hawaii, with the exception of the three great craters of Haleakala, Mokuaweoweo, and Kilauea, few of the crater pits exceed half-a-mile in diameter; but it is possible to compare these with those of the Moon, in spite of the discrepancy of size. On the Earth at present, the cooling process as witnessed at Hawaii always intervenes before great size is attained. Formerly, the lava was hotter when it issued from the interior; moreover, the

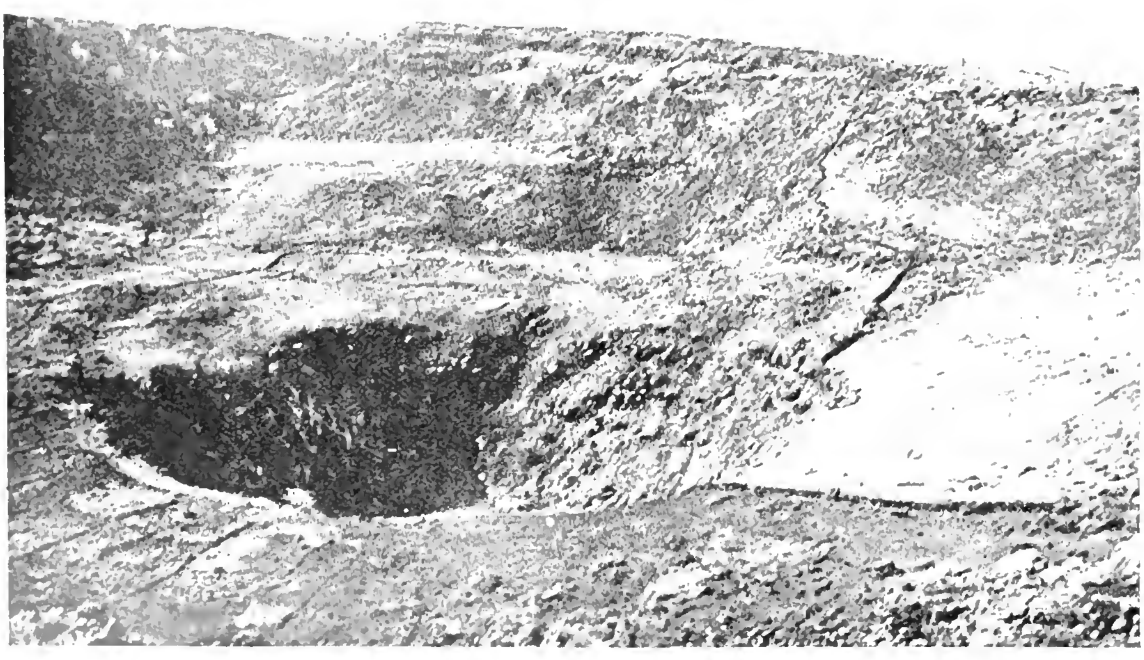


Fig. 4.—Kauhaku, Molokai.

* The three greatest craters on the Earth, about fifteen miles in diameter, occur in Kamchatka, in Japan, and in the Philippines. All are of the explosive type.

solid crust resting on the liquid mass was thinner, so that the channel communicating with the three reservoirs of molten lava was shorter and wider, thus offering a freer passage to the liquid flow.

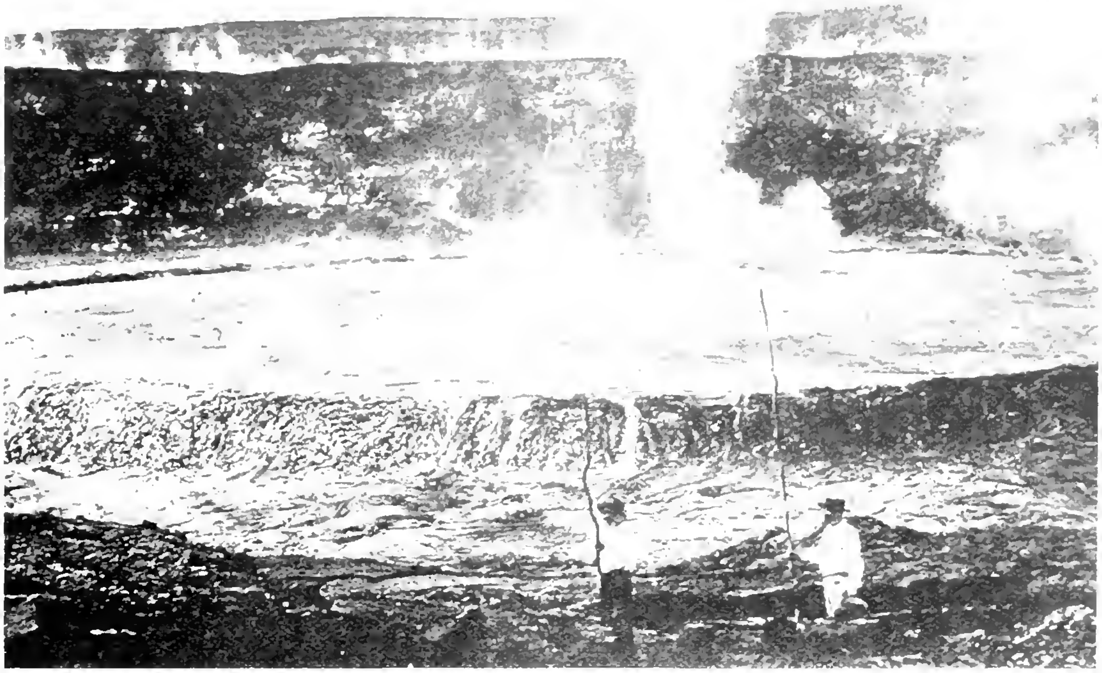


Fig. 5.—Lava Lake in Kilauea.

Professor Pickering divides terrestrial craters into three classes, according to the materials of which they are composed.

(i.) Tufa cones of hardened volcanic mud.
(ii.) Cinder cones.
(iii.) Lava craters.

It is this third class where steam or water is less involved in the process of eruption which most resembles what we find on the Moon.

This class may be again divided into four sub-classes according to the shape of the craters—namely, (*a*) lava cones, (*b*) lava pits, (*c*) lava rings, and (*d*) lava bowls. Taking the first of them (*a*), the lava cones, these often emit vast volumes of lava which may extend for miles in broad streams.

The second sub-class (*b*), the lava pits, are by far the most numerous group and are widely distributed through the Hawaiian Islands. They have no outer slopes whatever, consisting simply of a pit sunk in the ground. Their inner walls are sometimes vertical, sometimes inclined, and descending with a steep slope to a flat floor.

The lava rings (*c*) are the rarest type in Hawaii, and resemble the larger craters found on the Moon.

The lava bowls (*d*) differ from them in that the bottom, instead of presenting a well-defined, flattened floor, is concave, the curvature being continuous with the walls. They are identical in appearance with most of the smaller lunar craters.

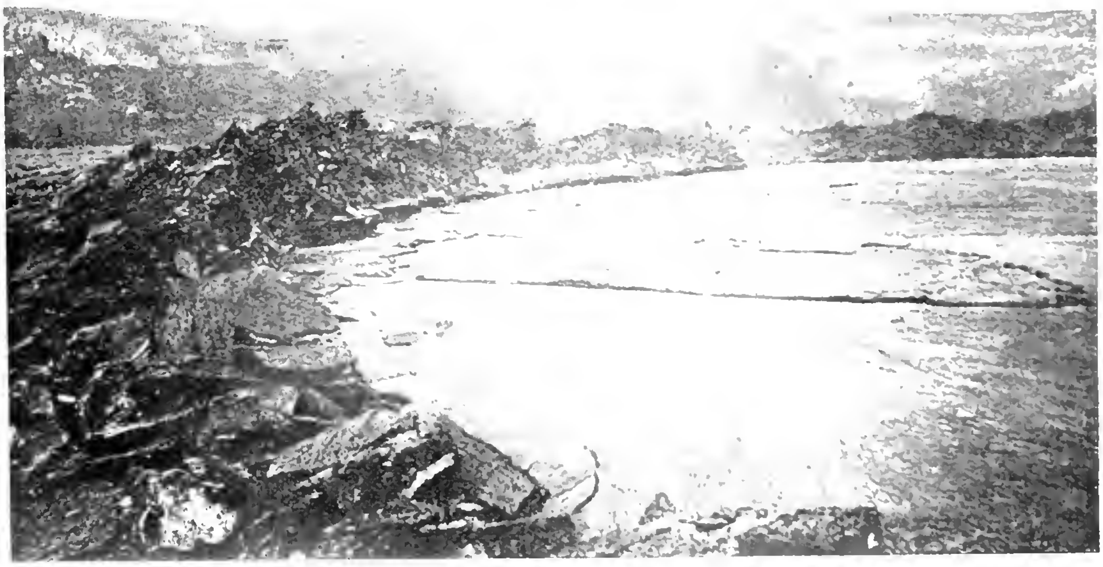


Fig. 6. Lava Lake in Kilauea.

With these preliminary remarks we may introduce some of Professor Pickering's photographs of Hawaiian volcanoes. Mud volcanoes and cinder volcanoes are represented in Hawaii. The Diamond Head crater is of volcanic tufa, and bears an exterior resemblance to the craters of the Moon; but its floor is at a higher level than the exterior plane and its outer slope steeper than its inner one, so that this crater, together with all the cinder cones, may be dismissed as having no known counterpart on the Moon.

The Hawaiian lava craters, however, on the other hand, present a close resemblance in many respects to lunar formations. The first subdivision (*a*), the lava cones, are most strikingly represented by Mauna Loa, by far the world's largest volcano. Its base lies 15,000 feet below the level of the sea. Nevertheless, its summit

Fig. 7.—Schickard and Phocylides.

crater is so large compared to its depth that photography could not very well show its characteristic features, and accordingly Professor Pickering chose a smaller example, a small lava cone in Haleakala as the typical example of this form of crater.

The terrestrial tall volcanic cone, with the comparatively minute crater at the top, was supposed to be absent from the Moon. But a recent examination of a lunar photograph taken at the Yerkes Observatory by Professor Ritchey shows that there are some small examples. One of these is probably visible in fig. 3, which is a lunar photograph of Kies and Mercator. Between them is to be seen a small cone with a minute crater at its summit. It is not unlike Vesuvius in size and shape.

We next come to lava pits (*b*). In the lunar photograph of Bullialdus is a pair of coneless lava pits, just above the huge crater. A few other very minute pits are shown on the photograph, but all the larger ones have cones.

In Fig. 4 we have a small terrestrial pit of this type. It is known as Kauhaku; and has no exterior cone whatever; it is simply a hole in the ground.

Great attention was bestowed by Professor Pickering on the method of formation of crater rings, the third subdivision of lava craters; and he experimented with iron slag to obtain object lessons of the methods of formation of craters. But the great central pit of Kilauea, Halemaumau, supplies object lessons on a larger scale. When Halemaumau is really active, the sight is said to be grand beyond description. Lakes of liquid lava occur both within and without it. Numerous fire fountains from 10 to 50 feet in height play over the surface of these lakes. At times the surface solidifies, then suddenly a crack will run across it, and in a few minutes the whole solid material will break up into separate cakes, which will presently turn on edge and sink beneath the surface of the lake. These lakes are specially interesting, since about them are found crater rings which seem to be analogous in appearance to the larger crater formations in the Moon.

In 18,0 the pit overflowed, the lava pouring down and filling a neighbouring depression. At the time of an eruption such as this the lava rises, overflows, and cools, thus forming a raised rim or circular dam. Such a rim is shown on a large scale in figs. 5 and 6, the cakes of lava appearing like broken cakes of ice. In fig. 7 is shown a portion of the Moon near the limb so as to present the craters obliquely. It will be noted that the two large craters there depicted, namely, Schickard and Phocylides, both present a form similar to the craters of Halemaumau. The chief one, Schickard, measures 134 miles in diameter.

(To be continued.)

The Bogoslofs and Earthquake Disturbance.

Mr. F. A. Black writes in regard to the article in last month's "Knowledge" on the Bogoslof Islands:—Whether there is any direct connection between the birth of this island and the recent severe earthquakes at San Francisco and Valparaiso—not to mention the activity of Vesuvius in our own continent—can only be conjectured. The new island would seem to be about 3,500 miles from Valparaiso, and about 1,500 miles from San Francisco. It certainly cannot be overlooked that the emergence of this island synchronizes with the occurrence of severe earthquakes on the eastern shores of the Pacific, though at a great distance from the position of the island, just as the sudden appearance of Greywingk synchronized with the occurrence of earth-tremors and eruptions in Alaska, and with the terrible eruption in Krakatoa. Krakatoa is situated in the neighbourhood of the south-western shore of the Pacific, and, like San Francisco and Valparaiso, it is at a very great distance from the position of the Bogoslof Islands. Whether the emergence of the first of the three islands also synchronized with similar phenomena is uncertain.

The appearance of this new island emphasises what we are often apt to overlook, notwithstanding our knowledge of the volcanoes and geysers of Iceland, at the Arctic Circle, and of the activity of Mount Erebus, far within the Antarctic Circle. That is, that in high latitudes, as in low latitudes, subterranean forces are still actively at work, and that terrestrial disturbance, in the form of earthquake or volcano, in one region may, not improbably, be accompanied by sympathetic activity in other regions, especially in regions of volcanic origin or geological weakness. It is an ascertained fact that the vast hollow of the Pacific Ocean is encircled in all latitudes by a ring of volcanic foci, whether active or dormant.

It is interesting to notice that the situation of the Aleutian Islands, is, in certain respects, very similar to the situation of the British Islands, so that geographically, they represent our islands on the other side of the Northern Hemisphere. The latitude of Bogoslof proper is about 54° N., which is about the latitude of York. Assuming, as is indicated by the information received, that the new island is about 120 miles farther north, its latitude will be rather less than 56° N. This is virtually the latitude of Edinburgh, the latitude of the summit of the Calton Hill being 55° 57′ 23″ N. In longitude the Aleutian Islands extend a great distance both east and west of the 180th meridian. That meridian, as every schoolboy knows, is simply an extension of the meridian of Greenwich, the Greenwich meridian and the 180th meridian forming together one great circle around the earth passing through both Poles.

The Bogoslof Islands themselves are, however, somewhat to the east of the 180th meridian, their longitude being about 168° W.

The correspondence in the latitude and the similarity in the longitude of the British Islands and the Aleutian Islands are rendered the more noticeable in view of the relative position of each group of islands to the great continents. The British Islands, including the neighbouring small islands, form (as regards longitude) an archipelago lying between the continent of Europe and the continent of North America; while the Aleutian Islands form an archipelago lying between the continent of North America and the continent of Asia. The British Islands, however, are a consolidated group, while the Aleutian Islands are a fragmentary chain. The British Islands extend chiefly northward and southward, while the Aleutian Islands extend eastward and westward. The total area of the Aleutian Islands is estimated at about 6,391 square miles, while the United Kingdom has an area of 120,677 square miles. Of course, the area of each of the three islands forming the Bogoslof group is quite trifling, probably not more than two or three square miles, if so much.

The resemblance which the geographical position of this insignificant archipelago bears to the geographical position of our own country brings into more striking contrast the tremendous difference which, in almost every other respect, exists between the British Islands and the Aleutian Islands. Although the latitude of the Aleutian Islands is similar to our own, the climate is very different, being more like that of Iceland than that of Great Britain. The mean temperature in Unalaska is 38.3° F., and, as is usual in the case of small islands some distance away from any large extent of land, the range of the temperature is not excessive. In the British Islands the soil generally is good, and it is highly cultivated; in the Aleutian Islands the land generally is rocky and barren, and fishing and sealing are almost the sole industries. In this country the population is dense, and the people are advanced in civilisation; there the population is scanty, and the people are but partially civilised. The crowning feature of the strange contrast is supplied by Nature herself. The complement of the British Islands, from a geological point of view, was made up untold centuries ago; while the Aleutian Islands are still on the increase, having grown by three since the time of the French Revolution, by two since the battle of Tel-el-Kebir.

The Late Miss Agnes M. Clerke.

WITH the deepest regret we have to announce the death of Miss Agnes Mary Clerke, which took place on Sunday, January 20. Miss Clerke was sixty-four years of age.

In the columns of "KNOWLEDGE," to which Miss Clerke was so often an inspired contributor, it is hardly necessary to speak of her commanding gifts as an expositor of science; it is hardly more necessary, in addressing an audience which embraces so many astronomical readers, to refer to her position in the astronomical world. It was said by an appreciative critic of her work, in one of the obituary notices that have already been written concerning her, that she was not a practical astronomer in the ordinary sense. That is quite true; and it is probably also true that the absence of the hard, grinding, day-by-day study of details which are an indispensable part of the equipment of

Photograph by Elliot & Fry.

The Late Miss Agnes M. Clerke.

(Reproduced by permission of the "Daily Graphic.")

those who laboriously disclose the truths of science may detract from the lasting value of some of her work. But these qualities, the absence of which mars the man of science, may make the philosopher; and, as the handmaiden of astronomy, as one who held a lamp aloft that others might examine its discoveries and its theories, Miss Clerke, in our belief, stands unrivalled in her day. We may enumerate some of her works to show the solidity of what she did:—"Problems in Astrophysics," "A History of Astronomy in the Nineteenth Century," "The System of the Stars," "The Herschels and Modern Astronomy," "Modern Cosmogonies" (which appeared in "KNOWLEDGE"), and unnumbered articles, essays, and reviews. But the enumeration conveys little idea of the work that she did; for she brought to bear on the systematisation of such subjects as therein are indicated an unrivalled power of interpretation. We gratefully acknowledge the justice of the appreciation in the *Times*:—"No worker in the vast field of modern sidereal astronomy opened by the genius of Herschel and greatly widened by the application of the spectroscope to the chemical and physical problems of the universe lacked due recognition by Miss Clerke, who performed as it seemed no other writer could have done the work of collation and interpretation of this enormous mass of new material, ever pointing the way to new fields of investigation, often by one pregnant suggestion sweeping aside a whole sheaf of tentative conjectures and indicating, if not the true line—for in many cases the truth is yet to seek—at least a plausible and scientific line well worth pursuing." There is one other point on which we should like to dwell. No writer of her time had a juster sense of style. In a nation which consumes fiction as its staple literary food, the quality of literary style when apparent in other kinds of literature is likely to be overlooked. But Miss Clerke possessed it in the highest degree. There is a passage in one of the chapters of Modern Cosmogonies, "The Inevitable Ether," which has always seemed to us a model of style, elegant without affectation, fastidious without sacrifice of meaning, inevitably right in its choice of words. We quote it:—

"To the very brink of that mysterious ocean the science of the twentieth century has brought us; and it is with a thrill of wondering awe that we stand at its verge and survey its illimitable expanse. The glory of the heavens is transitory, but the impalpable, invisible ether inconceivably remains. Such as it is to-day, it already was when the *Fiat Lux* was spoken; its beginning must have been coeval with that of time. Nothing or everything according to the manner in which it is accounted of, it is evasive of common notice, while obtrusive to delicate scrutiny. Its negative qualities are numerous and baffling. It has no effect in impeding motion; it does not perceptibly arrest, absorb, or scatter light; it pervades, yet has (apparently) no share in the displacements of gross matter. Looking, however, below the surface of things, we find the semi-fabulous quintessence to be unobtrusively doing all the world's work. It embodies the energies of motion; is, perhaps, in a very real sense, the true *primum mobile;* the potencies of matter are rooted in it; the substance of matter is latent in it; universal intercourse is maintained by means of the ether; cosmic influences can be exerted only through its aid; unfelt, it is the source of solidity; unseen, it is the vehicle of light; itself non-phenomenal, it is the indispensable originator of phenomena. A contradiction in terms, it points the perennial moral that what eludes the senses is likely to be more permanently and intensely actual than what strikes them."

That is not fine writing; it is literature; and whatever Miss Clerke's place in the history of astronomy, it will be a high one in the history of letters.

E. S. G.

In Memoriam—Agnes Mary Clerke.

Hers was the part to glean the scattered grains
Of truth, which reach us from the starry field;
To weigh results which calculations yield,
See where they tend and gather up the gains
Of many a night-long watch. She remains
The mistress of a style, whose greatness sealed
It to sublimest science, which revealed
Deep study, and far-reaching thought contains.

And she who, judging the cosmogonies,
Marked what they lacked, dimly preceivèd how
A Power outside of Nature guideth all
By ordered paths—a Power which vivifies
And upwards leads. She has gone from us now,
And from her eyes earth's darkening glasses fall.

T. E. Heath, F.R.A.S.

Photography.

Pure and Applied.

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

Energetic Developers. Many of the developers that are remarkable for their energy and rapidity of action, such as metol and paramidophenol (the latter is the active agent of rodinal and unal) are, chemically speaking, basic substances, and are supplied in combination with acids, as salts, because the free bases are too unstable for practical purposes. They are generally sold in combination with hydrochloric acid or sulphuric acid, and when dissolved with alkali give rise to alkaline chloride or sulphate, which may have, and, doubtless, sometimes does have, a retarding action. Messrs. Lumière and Seyewetz have sought to overcome this drawback without the loss of stability in the solid material, by combining the bases with sulphurous acid instead of sulphuric or hydrochloric, so that the alkali in the mixed developer shall give its sulphite instead of its sulphate or chloride. As alkaline sulphite is always added in considerable quantities to such developers, the small amount so produced has no appreciable effect. They report that the products are stable enough for commercial purposes, and behave in developers as if the free bases had been used. The compounds do not appear to be very definite, as they contain several molecules (six to ten) of the organic base to one of sulphurous acid. Experience alone can show whether these new compounds will prove advantageous, and we certainly should feel grateful to these investigators for working at the subject. But as alkaline sulphates in small quantities do not notably retard development, and the simultaneous reduction in the restrainer and alkali is often of very doubtful benefit, there does not appear to be much room for improvement in this direction.

Colour Photography. We learn from a letter sent by Mr. Julius Rheinberg to *Nature* (November 29), that the method of colour photography with a lined screen and narrow angle prism recently described by Professor Lippmann, and referred to in this Journal for October last, was the subject of a patent by F. W. Lanchester in 1895, was described by Julius Rheinberg in January, 1904, and was patented in France early in 1906. Thus, it appears that the process has been invented, according to records, four times, and it is stated that others than those named have been working on similar lines.

The Hardening of Gelatine. When formaline was first introduced, it was thought that it might perhaps displace common alum and chrome alum as hardeners of gelatine. But further experience with it has shown that it also has its weak points. One essential difference between it and the alums is its volatility, and this is not only annoying to the user, but remains a source of uncertainty in its effects. It appears from some recent work of Messrs. Lumière and Seyewetz that the treated gelatine is a more or less loose combination of gelatine and formaldehyde, and that the formaldehyde is always ready to pass off and leave the gelatine in its original soluble condition. It may be separated slowly, but completely, by hot water, by cold dilute hydrochloric acid, or by heating it to 110° C.

The Metric System of Weights and Measures. The recent action of two or three large manufacturing firms has brought this subject prominently to the front. Photographers are peculiarly unfortunate in having to use an ounce that is divided into $437\frac{1}{2}$ grains, a figure that no one can suggest is convenient for division, much less sub-division. The figure is impossible, and other figures, such as 440, 450, or 480, are substituted for it when necessary, in spite of the error involved. The metric system appears to be the one practical way out of this and many other difficulties. But the present metric system is founded upon arbitary stardards, and so is fundamentally no better than the English systems. It appears that when the metre was defined, those interested set to work to make a model of it, and when later the model was found to be a little wrong, the real standard was neglected, and the incorrect model adopted instead of it. A vessel to hold a litre was also made, and this was subsequently found not to hold a cubic decimetre as it should, but instead of correcting the error, that particular vessel was made the standard. I suggest that we want only a standard of length, and that that should be defined, if possible, without reference to any particular bar of metal. There must, of course, be secondary standards of length, weight, and capacity, and from these other standards are needed to make the measures from that are used in every-day work. But I would suggest that all secondary and other standards should be regarded merely as practical conveniences, and if found to vary from *the* standard, should either be corrected or so marked that their error may be allowed for. Such errors as these would only exceptionally be of importance, and would, of course, be known to all concerned. The disadvantages of having standards of length, weight, and capacity not simply related to each other are so obvious that they hardly need pointing out. We have, for example, already in the metric system two standards of capacity, the litre and the cubic decimetre, and we shall perhaps get half-a-dozen others as time goes on, unless we mend our ways. The trouble of these many competing units is shown in the disregard of their differences even in scientific work.

Laying the Dust in Cameras. That portion of dust that cannot be kept out of scientific instruments, such as cameras, it is well to trap or catch, that its presence may do as little harm as possible. One method recommended for this purpose is to smear the wood-work with a trace of glycerine, so that whatever dust comes into contact with it, sticks to it. Doubtless this is effective, but the method does not commend itself to many because of the trouble of cleaning the dust-laden surface. Velvet catches dust and holds it tenatiously, it is not messy, it does not need renewal, like glycerine, and it is not very difficult to clean by brushing. If black velvet is used, its light-absorbing power is an additional advantage as a lining for optical instruments. In all cases where dustless air is required in order to prevent as far as possible the scattering of light, black velvet offers the double advantage of being the best non-reflecting surface as well as an efficient dust-trap.

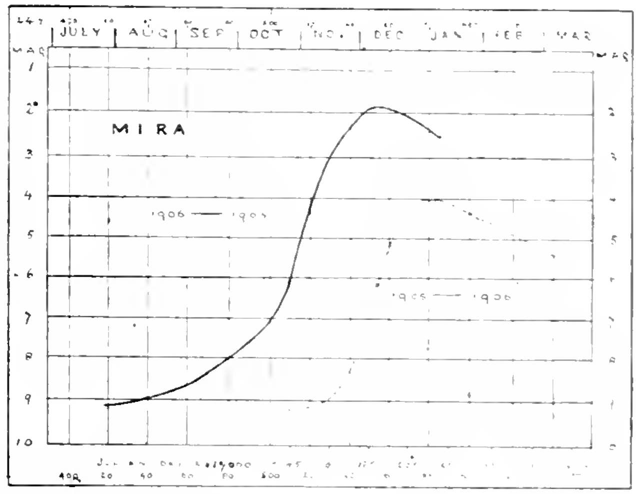
Received. "The Photo-Miniature," to hand, almost a year after the date it bears, deals with the "Hand Camera," and gives a considerable amount of practical information.

Maximum of Mira Ceti.

By P. M. Ryves.

The variable star Mira (o Ceti) has lately passed an unusually bright maximum, having remained for three weeks fully second magnitude, which is about the same as at the time of its discovery by David Fabricus in 1596. When observed on July 30 last, the brightness was estimated as just under the ninth magnitude. It increased, at first slowly then more rapidly, and reached the seventh magnitude by October 17. About this date a more rapid rise set in: the star rushed up to the second magnitude by December 2, a change corresponding to an increase in light of a hundred times in less than fifty days. The most rapid portion of this rise was from the 6th to the 3rd mag. in 19 days (October 26-November 14).

A similar rapid rise to maximum occurred last winter and is, in fact, a characteristic feature of the variation of this and certain other of the variable stars of long period: but it is not always so well marked as in the present



Light curve of Mira (o Ceti) 1906-7 compared with previous maximum. Each curve is based upon about 40 observations.

case. This star may only reach the 5th mag. at maximum, and frequently does not exceed the 4th mag., but when a bright maximum, like that of December last, occurs, Mira surpasses in brightness any other variable star of regular period.

On account of the general interest which attaches to this variable and also the ease with which it may be observed, it usually receives a good deal of attention from amateurs when the epoch of maximum falls at a season of the year when it can be conveniently observed. Unfortunately, the position of Mira south of the ecliptic and the period which brings the maxima about a month earlier each year render it impossible to observe the maxima well for several years together when they fall in the spring and summer months. A good series of observations, extending well on either side of the epoch, can only be obtained in the case of about half the maxima, and those observers who do not work after midnight will be restricted to a still smaller proportion. It is, therefore, very desirable that a careful watch should be kept upon this variable during the present and next few years while the conditions are favourable. A special interest pertains to observations this season on account of the brightness of the maximum. Such a bright maximum is not likely to occur under equally favourable conditions more often than once in twenty years. It is to be hoped, therefore, that those who have made careful observations will publish the results, and thus contribute towards a solution of that great problem, the cause of variation of these mysterious bodies.

A provisional curve is given herewith, which shows the general nature of light change during the past six months, and, for comparison, an approximate curve for the preceding season is superposed, the months being the same for both. These curves are based upon 85 observations made by the writer in Spain. Those for the present season are appended in tabular form. The magnitude scale is that of the Harvard College Observatory, and Harvard magnitudes have been adopted for the comparison stars used. When possible, stars similar in colour were used for comparison purposes in preference to white or bluish stars. The change of colour is not the least interesting feature of variable stars. Most of them are red or orange, and some appear to become redder as maximum is approached, but Mira, intensely ruddy in its fainter stages, loses much of its colour when the brightness increases. On September 15, the colour was noted as a strong red, but about the time of maximum it had changed to a rather pale yellowish orange.

Observations of Mira, 1906-7.

Date.	Mag.	Julian Day 2417000+	Date.	Mag.	Julian Day 2417000+
1906.			Nov. 17	2·80	532
July 30	9·07	422	,, 19	2·68	534
Aug 1	9·10	424	,, 20	2·55	535
,, 17	8·88	440	,, 22	2·58	537
,, 19	8·83	442	,, 23	2·51	538
,, 21	8·92	444	,, 26	2·15	541
,, 25	8·75	448	,, 28	2·19	543
,, 30	8·76	453	,, 29	2·09	544
Sept. 10	8·80	464	,, 30	2·06	545
,, 14	8·44	468	Dec. 1	2·09	546
,, 15	8·36	469	,, 3	1·92	548
,, 27	7·92	481	,, 9	1·85	554
Oct. 8	7·40	492	,, 11	1·85	556
,, 15	7·15	499	,, 15	1·96	560
,, 16	7·10	500	,, 16	1·88	561
,, 21	6·67	505	,, 19	1·92	564
Nov. 3	4·23	518	,, 24	2·00	569
,, 7	3·79	522	1907.		
,, 9	3·60	524	Jan. 1	2·24	577
,, 13	3·26	528	,, 3	2·41	579
,, 14	3·20	529	,, 5	2·41	581
,, 15	3·00	530	,, 10	2·50	586

New Prism Binocular.

Messrs. A. E. Staley and Co., of 19, Thavies Inn, Holborn Circus, E.C., have sent us for inspection a new prism binocular, of the type now so popular, made by the firm of E. Krauss and Co., Paris, for whom Messrs. Staley are the British representatives. The binoculars magnify eight times, and have an adjustable milled bar for focussing, which moves both oculars, whilst one ocular has, in addition, a graduated adjustment to enable a difference in the sight of the eyes to be separately rectified. The glasses are also adjustable for width between the eyes—an equally important matter. A minor improvement is a stud enabling the binocular to stand upright on a table without damage. The definition of these glasses is excellent, and they are very light, compact, and dainty, so that they could be used either out of doors, for which they are, of course, primarily intended, or in a theatre. The price, moreover, is only £6 10s.

The Bride-Stones—Cleveland Hills.

By E. J. Sumner, B.Sc.

There are several groups of stones in various parts of the Cleveland Hills which are known as Bride-Stones, of which the most imposing are those which look down on the head of the valley named from them—Staindale—about 8 miles north-east of Pickering.

The photograph shows in the foreground one of the quaintest of these stones, known as the "Salt-cellar," and to the left of it, more distant, is visible a round boss of the "Cheesewring" type. The material is a

kind of gritstone, belonging to the oolitic series of rocks, and consists of a number of layers of greatly varying hardness. It is generally supposed that the sea is responsible for these curiously formed rocks, for they resemble those upon which the sea is engaged on the Yorkshire coast at the present day, though, of course, the weathering action of wind, rain, and frost will have largely altered them since the time when the sea left them in their rough-hewn state.

The "Salt-cellar" is some 20 feet high, about 10 yards round the waist or lowest part, and 20 or 30 yards round nearer the top.

Some particulars have been published of the abortive experiments in Transatlantic wireless telegraphy which were cut short by the fall of the tower at Machrihanish. Messages had been received and sent between Machrihanish on the Mull of Cantyre, and Brant Rock, near Boston, U.S.A., but it was found subsequently that not sufficient allowance had been made for the atmospheric absorption of the Hertzian waves on all occasions, and in possibly unfavourable conditions. At 1,500 miles 10 per cent. of the radiation got through; but when 3,000 miles was the distance it was found that not 1 per cent. of the radiation could always be depended upon. Indeed, during daylight the absorption was sometimes so great that not more than one-tenth of 1 per cent. of the energy got through. As an illustration of the complexities of atmospheric interference it is stated that, with the same sending power, on some nights messages were received 480 times stronger than was necessary for audibility, and the messages could be read with the receiver six inches away from the ear. On other nights with the same sending power the messages were so faint that they could not be read. A satisfactory factor of safety in transmission had been achieved when the antennæ blew down.

A Fish Out of Water.

By Felix Oswald, D.Sc.

The well-worn saying, "to feel like a fish out of water," obviously embodies the general belief that fishes are absolutely confined to the watery element. Nature, however, never allows herself to be cramped by hard and fast rules deduced from insufficient observation; for, although a typical fish is eminently adapted for swimming and breathing under water, yet there are several striking deviations from this normal state of things. For instance, the hopping gobies (in which the fore-fin has developed a distinct elbow-joint) can leave the sea and habitually skip along the shore in pursuit of insects and molluscs; the climbing perch can exist for days out of water, and is even said to climb palm trees, whilst the aerial flights of the flying fish are known to all. These exceptions to the ordinary habits of fishes are not merely of individual interest, but help us materially to realise the somewhat analogous, but more successful, struggle to invade the land which occurred long ago, in pre-Carboniferous ages, on the part of far less highly specialised fishes.

The radical organic changes resulting from this invasion of a different element were mainly two-fold; firstly, in respiration—breathing by gills being exchanged for breathing by lungs, and secondly, in locomotion—fins being superseded by five-fingered, jointed limbs.

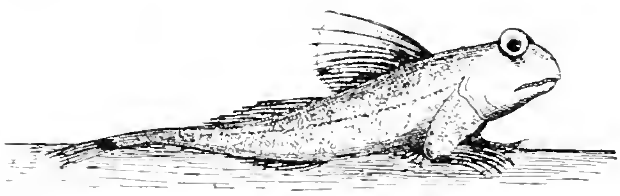


Fig. 1.—The Hopping Goby (*Periophthalmus*).

In the modern invaders, such as the climbing perch (*Anabas scandens*) and the hopping gobies (*Periophthalmus* and *Boleophthalmus*), gills still continue to be the seat of respiration, but their structure is much modified. In the case of the hopping gobies (Fig. 1) the only change in structure of the breathing-organs is an increase in the size of the gill-cavity, which is thereby able to contain air as well as water. The gills, however, are much reduced; and respiration seems also to be carried on by the thin skin of the tail-fin. A more advanced state of things occurs in the climbing perch, in which there is an accessory organ in the gill-cavity, consisting of labyrinthine folds of mucous membrane (Fig. 2), so as to expose a larger respiratory surface to the air—a direct result of terrestrial conditions. This organ functions as a lung, by means of which the fish is able to exist out of water for a long time, a fact which Indian jugglers have made use of in adding this fish to their stock-in-trade.

These labyrinthine organs may be profitably compared with the somewhat analogous lung-like outgrowths in the upper half of the gill-cavity in land-crabs (*Gecarcinus* and *Birgus latro*).

The lungs of land-vertebrates have, however, been derived, not from the gills, but from the air-bladder of fishes. This theory is based essentially on the facts of development, and is now generally admitted. Both lungs and air-bladder are formed by an outgrowth from the gullet, but the lungs arise ventrally, while the air-bladder in most fishes has a dorsal origin. This difference in position is not, however, so serious an objection to the theory as it would appear at first sight, for in *Erythrinus* it arises laterally, in *Ceratodus* it becomes more ventral in position, and, finally, in *Polypterus*, *Calamoichthys*, *Lepidosiren*, and *Protopterus*, it has actually the same median ventral position as in all true lungs (Fig. 3).

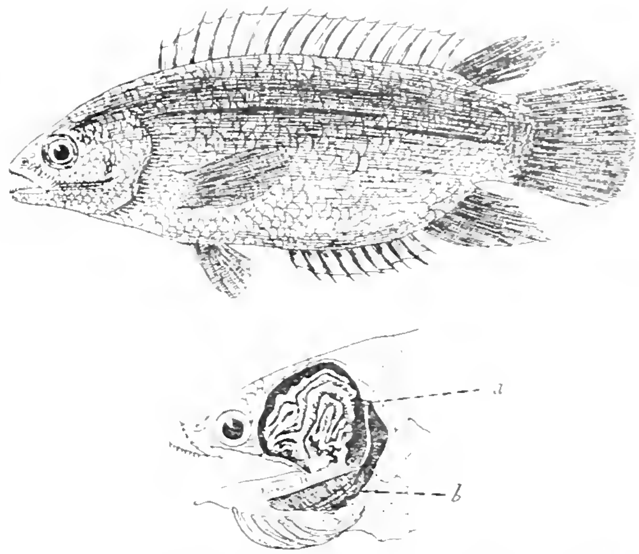


Fig. 2.—The Climbing Perch (*Anabas scandens*). The lower figure displays the gill-chamber; *a*, the labyrinthine supra-branchial organ; *b* the gills.

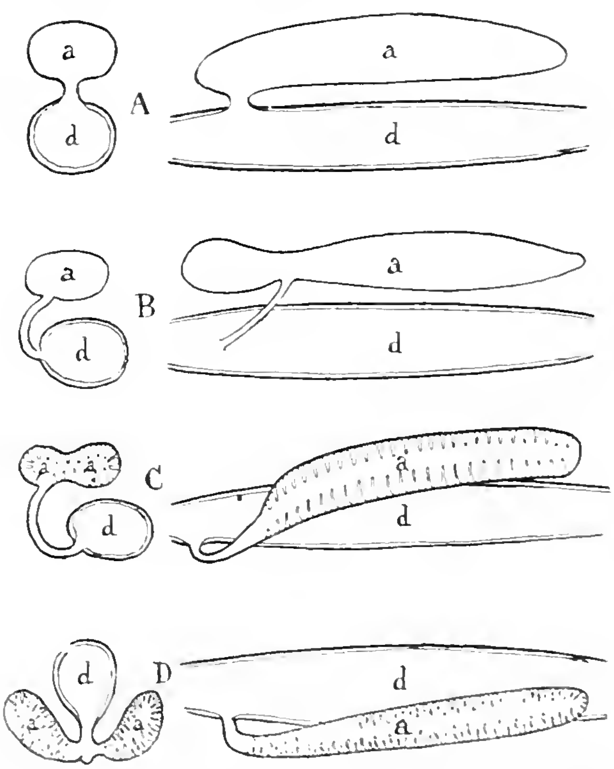


Fig. 3.—Diagrammatic transverse and longitudinal sections (after Dean) of air-bladder (*a*) and adjacent digestive tract (*d*) of *A*, Sturgeon and many Teleosts (Physostomi); *B*, *Erythrinus*; *C*, *Ceratodus*; *D*, *Lepidosiren* and *Protopterus*.

Now, when one organ is evolved from another, there is usually either a concomitant change of function, or else a subordinate function may become exalted by the altered circumstances into the first place.

The air-bladder in the majority of cases has a purely hydrostatic function, and seems to prevent the fish from too suddenly altering the depth at which the conditions of life are most advantageous to it. But if the change in level be made gradually, the necessary compensation is obtained by the secretion or absorption of the gas in the air bladder through the abundant blood-capillaries (*retia mirabilia*), which usually line the walls. For instance, Moreau has shown by his experiments that if the air-bladder is emptied of the gas it contains, the fish sinks to the bottom of the vessel in which it is living, and cannot regain its equilibrium until it has secreted a fresh supply of gas. With regard to this hydrostatic function, it is interesting to note that the air-bladder is not possessed by flat-fishes, owing to the reason that they habitually rest on the ground and lead a very sluggish existence. But it is equally absent in the large and ancient group of Elasmobranchs (sharks, dog-fish, etc.), unless the obscure pharyngeal pouches should be regarded as degenerate rudiments. Perhaps the notoriously predatory habits of these fishes would have rendered it a disadvantage for them to have acquired an organ which restricts a fish to a definite zone-level.

Although the secretion of gas is the chief function of the air-bladder, yet (as already indicated) some absorption can, and does, take place in those fishes in which the walls of the bladder are lined by blood-capillaries (*retia mirabilia*).* The two processes of secretion and absorption have only to take place alternately and rhythmically in order to be equivalent to the expiration and absorption of a true lung. Of course, any actual breathing by means of the air-bladder can only take place in those fishes in which the duct between the throat and the air-bladder still remains open (the *Physostomi*). This connection with the exterior becomes of the greatest importance to the species whenever the water it inhabits becomes muddy or insufficiently aerated. Thus many of the members of the great fresh-water family of cyprinoids (bleak, carp, etc.) need to come periodically to the surface to swallow air, owing to the frequent paucity of oxygen in the still and stagnant waters which they inhabit. Many siluroids, too, may be buried in mud for a long time during the dry season, or can also travel on land from one lake to another. Even our eel is known to traverse considerable distances overland.

A still closer approximation to normal atmospheric breathing is exhibited by a ganoid (*Lepidosteus*), and by certain Brazilian fishes (*Sudis gigas*, *Erythrinus taeniatus*, and *brasiliensis*), which, according to Jobert, speedily suffocate if the air-duct between the air-bladder and the throat is ligatured, because in these fishes gill-breathing does not alone suffice for the necessary oxygenation of the blood.

But even in these cases the general course of the circulation has not been fundamentally altered. To find this state of things we must turn to the dipnoi, the double-breathers, or lung-fishes as they have been aptly termed. In this ancient group of fishes, we are able to trace transitional steps in the supplanting of gill-respiration by lung-breathing.

In *Ceratodus* (the least specialised genus), the air-bladder is still unpaired and dorsal in position, but a slight median longitudinal depression foreshadows the paired condition of the lungs of higher animals. The opening of the air-duct, although lateral, opens at the glottis on the right side of the pharynx approximating to the median ventral position of true lungs (Fig. 3 *C*). The latter condition is attained by the African *Protopterus* and the South American *Lepidosiren*; and in addition, the lung is paired (Fig. 3, *D*). The plan of the circulation is modified, for the lung is now supplied with blood by a true pulmonary artery arising from the point of union of the fourth efferent branchial artery with the aortic root, while in *Ceratodus* it is still given off from the former alone. The aërated blood returns by a pulmonary vein to the heart through the sinus venosus. In *Protopterus*, too, the conus arteriosus is completely divided into two halves, so that an arterial and a venous current pass out from the heart side by side, while in *Ceratodus* this division is still incomplete. In all the members of the dipnoi, the lining membrane of the air-bladder is thrown into ridges and folds just as in the hollow, sack-like lungs of typical amphibians.

To this transitional group, therefore, we must turn to find fossil remains intermediate between fishes and amphibians. Their antiquity is great; the few existing species are the widely distributed remnants of a group which flourished in the later Palæozoic ages. The Australian Barramunda (*Ceratodus*) is, indeed, a highly remarkable instance of the persistence of a generalised type, for the genus existed in the Trias of Europe, and even in the Permian of North America; the very fact of its possessing low generalised characteristics has enabled it to survive changes fatal to more highly developed and specialised creatures.

* In the air bladder of Siluroids and of some other fishes (e.g., Tench) the *retia mirabilia* are absent; in these cases a peculiar chain of tiny bones (the Weberian ossicles) connects the air-bladder with the inner ear. By means of these ossicles the fish is made aware of any increased pressure of air in the bladder caused by sudden proximity to the surface of the water. Relief from this pressure is obtained by the emission (doubtless by reflex action) of bubbles through the air-duct and the mouth. The fish is thus able to regulate its position to a plane of least muscular effort, in which it becomes of the same weight, bulk for bulk, as the surrounding water.

The Pleiades.

FOR comparison with the plate in the January number, we reproduce this month another photograph of the Pleiades, taken by G. W. Ritchey with the 2-feet reflector at the Yerkes Observatory.

The plate had an exposure of three-and-a-half hours, and shows the principal stars involved in a fine tracery of nebulosity; the star Atlas,* with its companion Pleione, which brings up the rear of the Pleiades, is not shown in this reproduction.

The small photograph, taken by W. Shackleton with a 3½-inch lens, exposure 33 minutes, shows the group as seen with a pair of opera-glasses, or a little more than the naked-eye view.

* The names of the Pleiades stars, with diagram, are given in "KNOWLEDGE" for January, 1889.

(Reproduced from Vol. II. of the Publications of the Yerkes Observatory ...)

Nebulosity in the Pleiades.

Basis of the Will.

Far greater difficulties have been met with in the attempt to fathom the mysteries of psychic or conscious action, than with any other branch of Elementary Biology. This seems to be due to the following causes :—

(1) Conscious action possesses no nervous grounds. This gives support to the prevailing idea that, physiologically, its source is to be localised in such constituents as form the elements of physical or chemical action.

(2) Conscious action, though no doubt in possession of a structural basis, affords but very complex clues with regard to such a basis.

In the first place, conscious action is always synthetic or complex. Conscious changes are produced without any consciousness of form. In respect to action, all consciousness must be structural. For, how would it be possible for changes of consciousness to occur, otherwise than by means of sense of structure? But it does not follow that, because all consciousness is structural, structural action is conscious action. For, on the contrary, structural action is united action, a compound of that which forms and that which is formed.

Physically, there are no changes of consciousness. Energy has no nervous substance of change, otherwise such change would be found to have some nervous form of transmutation, which is not the case. Changes of consciousness, therefore, are not relative of structural action. What is called the "Monism of energy," represents a fundamental principle now generally recognised throughout the province of physics and chemistry.

There must, therefore, be some principle to answer for the action of conscious structure. The test of such a principle will be in the structural difference of action. Thus, the source of all changes of consciousness must be a non-substantial of non-vital principle.

Now, there is strong scientific evidence which points to man as being in possession of this principle. For instance, it is through him that we arrive at last to a structural transmutation of consciousness, to a psychic form, which, in its relation to structure, has been productive of pathological results.

In his Cumulative Evidences of Divine Revelation, page 182, Mr. March Phillips gives the following significant facts :—

"There is this peculiarity in the condition of man, as compared with the other mammalia, that his life is shorter now than by analogy it ought to be. In other animals the period of growth is about one-tenth to one-fifteenth of the whole life. The lion, which is full-grown at five, lives for seventy or eighty years. The dog, full grown at eighteen months, is as old at fifteen as a man at eighty. Man, living as long as the lion, is not full grown till twenty. The same proportion would give men from three hundred and twenty to four hundred years. Thus, his physical life is not in this respect the normal life; it is cut very short, and its brevity points to some primeval failure of vigour—to the presence of some non-natural, *i.e.*, some diseased condition, sapping his vitality."

Again, in his "Freedom of Science in the Modern State," Professor Virchow says :—

"If we gather together the whole sum of the fossil men hitherto known, and put them parallel with those of the present time, we can decidedly pronounce there are among living men a much greater number of individuals who show a relatively inferior type than among the fossils known up to this time."

Evolution, upon this evidence, can be said to have had most astounding grounds for its moral tendency, from such natural action as human physics here supplies. However, it is not my intention to query any point of physical ethics, but, rather, to bring into prominence what are actually contradictory results produced under similar action. Apart from reason, consciousness is structurally unvarying in action—energy is monistic. Combined with reason, there is conscious change of action. Consequently, there must be some principle through which man is structurally conscious. Physically, he is monistic; that is, an unvarying unity. Rationally, he is a multiple, a being of character.

Where, then, is the source of this difference? As we have seen, it is not a real or structural principle. It is something abstract, something foreign to his normal form of vitality. It must be some phantasy or myth, otherwise, what is to answer for the prevalence of such a degenerate and diseased condition of his life?

Suppose we examine the conscious grounds of structure, and by this means locate the source of this evil and non-natural element.

It is by means of the sensor nerves (properties of the will) that consciousness structurally acts. Sensibility is responsible for all structural actions. The motor nerves, which determine structural actions, act without any sense of structure, yet there must be a conscious basis to structural action. Structural action is not physical action; that is, action of growth. For, in order that action may be consciously formed, the sense of structure must exist as a foundation.

Consequently, structural action cannot result from growth forms; but, on the contrary, these are themselves only possible through structural action.

Structural action is relative of the sense of induction —unity. Growth action is relative of the sense of structure. Consequently, the conscious grounds of structure is a unit of consciousness or vital cell. Upon this unit of consciousness all reflex action depends, and it must, therefore, be held to contain the elements of all structural action.

Instinctive (adaptive) actions are never consciously formed, but are relative of this unit of consciousness.

Conscious action is, structurally, unvarying, for all action of sensibility is so formed, as sense of unvarying sense of form, which is consciousness of conserved energy. Consequently, the conscious ground of structure is unvarying action of consciousness, and non-cellular; that is, action of infinite reflexion.

Upon what principle, therefore, must the rational or conscious action of reflexion rest?

It certainly is not a structural principle, for this reason, structural action is unvarying will, whilst rational actions are varying of adjustment; and, consequently, such actions must emanate from an unvarying and not a varying unit of conscious form.

How, therefore, can an unvarying consciousness, prior to consciousness, and by which consciousness is consciously formed, be consciously willed (united)?

Rationally, not otherwise than by free will, as an infinite unit of conscious structure; consequently, only as a subject of structure.

Thus, by analysis, no difference is to be found between instinct and reason, but, at the same time, it exposes the source of the latter's contradiction, which is contained in the freedom of will.

In conclusion, it appears hardly necessary to add that, wherever man's freedom has run counter of his normal or structural sense, there has ever been loss not gain, pain not pleasure, disease not vigour, insanity not control.

NOTES

ASTRONOMICAL.

By Charles P. Butler, A.R.C.Sc. (Lond.), F.R.P.S.

Solar Disturbances and the Corona.

An interesting paper is communicated to the *Astrophysical Journal* for December, 1906, by Father A. L. Cortie, in which he discusses the relation of certain well marked features of the corona with areas of disturbance on the solar surface as evidenced by various phenomena. That there exists a general connection between the state of disturbance of the sun's surface and immediate surroundings and the form of the coronal appendages is sufficiently well established. There is a great similarity in type in the photographs of the solar corona as photographed in the years 1870, 1882, 1893, and 1905, all of them years of maximum sun-spot activity, marked by many and great outbursts of spots and prominences. A quite different type of corona corresponds to the years of minimum solar activity, as illustrated by the photographs of 1878, 1889, and 1901, while we have also examples of intermediate or transition types in the eclipses of 1886 and 1896. The uncertainty comes in when we attempt to decide whether the spots or prominences are the more intimately connected with the changes. Careful examination of the Stonyhurst photographs (taken on a large scale) of the solar corona of August 30, 1905, at Vinaroz, Spain, shows that the streamers appear in general to mark the regions of the prominences rather than of the sun spots. The longest streamers, consisting of two long wings with an intermediate shorter streamer, extend from latitude − 40° to − 90° S., quite outside the spot zone, while another streamer is located near the sun's north pole. The fine group of prominences in the north-east quadrant was manifestly associated with three fine coronal streamers. In the lower corona the complicated structure of arches and vortex rings are seen to be attached to the prominences.

Detailed measurements have been made on several of the photographs in order to determine as accurately as possible the exact area on the sun's surface from which the chief streamers appear to be projected, and comparisons made with other measurements made on the standard series of drawings of the sun at Stonyhurst, thereby enabling the history of the various spots visible before and after the eclipse to be studied. The results apparently confirm the coincidences, and further studies of the eclipse photographs of 1893 giving the same conclusions, the author considers that not only in general is a characteristic type of solar corona associated with sun-spot and prominence activity, but that definite structures in the corona are associated with definite areas of activity of sun spots and faculæ.

Prominences Observed During 1905.

In Bulletin No. VII. of the Kodaikanal Observatory, the Director gives the individual observations of prominences observed during the latter half of 1905 and an abstract summary, showing the mean daily values and zone distribution for the whole year.

Observations being made on 305 days, the total number of prominences measured was 4757, giving a mean daily frequency of 15·6.

A very noticeable feature is the slight variation noted in the mean height for each month, the minimum of which is 28·4″ and the maximum 35·7″, giving a mean for the year of 31·4″.

The distribution with respect to the Solar equator is shown to be very nearly balanced, being 7·8 for each hemisphere. The mean latitudes vary slightly in the two hemispheres, being 37·3° for the North and 38·3° for the South.

A detailed analysis of the numbers of prominences observed for each quarter and half-year in zones of 10° width from pole to pole is also included, enabling the prominence record to be compared in detail with other solar phenomena.

Observations of Phœbe.

Professor E. C. Pickering gives a list of nine additional photographs of Saturn, showing images of the ninth satellite, Phœbe, which have been obtained with the 24-inch Bruce telescope at Arequipa during August and September, 1906. The exposures for these plates varied from 105 to 120 minutes. Reductions of the photographs showing the position angles, and distances are given, these varying from 251° and 12·4′ on August 11 to 300° and 2·0′ on September 17. (Harvard College Observatory Circular No. 119.)

Nova Velorum.

During the examination of photographs taken at the Harvard College Observatory with the 1-inch Cooke lens, a new object was found in the Constellation Vela, with position as follows: R.A. = 10 h. 58 m. 20 s.; Decl. = − 53° 51·9″ (1900). It follows a fifteenth magnitude star by about 2 s., and is 15′ south of it. Owing to the small scale of these plates, measurements of position and brightness were difficult. The object does not appear on any plate taken before December 5, 1905, but is seen on fourteen plates since that date; and on July 2, 1906, it had again fallen below magnitude 11·2. The greatest brilliancy occurred about January 1, 1906, when the magnitude was 9·72; but during the period covered by the observations the Nova exhibited considerable fluctuations in light, and it seems not impossible that it may again become sufficiently bright for its spectrum to be obtained, but even without such proof there is apparently little doubt that the object observed is actually a Nova. (Harvard College Observatory Circular No. 121.)

Companion to the Observatory for 1907.

Except for a few minor alterations the present issue of this most useful compendium resembles closely those of previous years.

The section dealing with variable stars has been slightly re-arranged, this being necessitated by the continued increase in the number of known variables, which now total 574 in M. Loewy's list. The complete list of stars with their places is not now given, and the dates of maxima and mimima of long-period variables are shown in a somewhat different form. These Ephemerides are given in *Greenwich mean astronomical time, counting from noon to noon*, and not from midnight to midnight, as in former years. The range of magnitude is added at the top of each column.

The occultations of stars by the moon are also increased in number by the inclusion of stars fainter than 6·8. No diagram of the orbit of Saturn's satellites is given, as their plane passes through the Earth during 1907.

New Variable Stars.

The study of the distribution of variable stars by superposing a negative on a positive of different date has been continued by Miss Leavitt at Harvard College Observatory with very interesting results. From photographs taken with the 24-inch Bruce telescope thirty-one new variables have been discovered, including one in the region of the Pleiades, two near the nebula of Orion, and twenty-eight in the region of the "Southern Cross" and "Coalsack." From the absence of variables in the first group it would appear that the conditions in the vicinity of the Pleiades favour unusual constancy in light, as no other stars were ever suspected of variability, though there are many suspected variables in the other regions examined in this way.

On photographs taken with the 1-inch Cooke lens, covering a region 30° square, and showing stars down to the eleventh magnitude, thirty-six new variables have been discovered, and in addition most of those already known have been re-detected. Six of them belong to the Algol type, and a full discussion of their periods will be given later in the annals. (Harvard College Observatory Circulars Nos. 120, 122.)

Total Eclipse of the Sun, January 14, 1907.

Only meagre reports are to hand as to the total solar eclipse which took place on Monday, January 14. In a message from Reuter's Agency at Samarkand, it was stated that the eclipse of the sun was observed from a point on the railway between Kuropatkino and Mijnlnskaja. The first stage of the eclipse was noted a few minutes after nine o'clock; totality occurred at seven minutes to ten, and lasted for two minutes, the sun being clear again shortly after ten. As it is also reported that snow was falling throughout totality, it seems probable that most of the observations depending on photographic delineation will have been at a disadvantage. Other observers were to be stationed at Tashkend, but no report is as yet available from there.

Artificial Reproduction of Lunar Craters.

M. Gaston Hauet describes an interesting method of producing artificially variously figured structures which are strongly suggestive of lunar formations. Placing a quantity of wax in a copper vessel heated by a gas flame, as soon as the mass commences to soften a metallic rod moistened with water is plunged into the mass and quickly withdrawn, taking care to close the orifice caused by the insertion of the rod.

After a few seconds the gas is turned on stronger, so as to heat the lower part of the wax, and a swelling is seen forming on the surface of the wax. This increases and at a certain stage in its development bursts about its upper part. A jet of steam escapes, and the swelling subsides in the form of a circular ridge with vertical walls. By this the action of the steam inside the mass has been relieved for a time, but after a short interval a similar series of phenomena will be repeated; if the new swelling happens to come up inside the former there will be formed a central cone very strikingly similar to those so characteristic of true lunar formations.

BOTANICAL.

By G. MASSEE.

Delayed Germination.

It is a well-known fact that in the case of many plants the seeds produced by one crop do not all germinate promptly when placed under favourable conditions for doing so. Instead of this the seeds germinate at irregular intervals, extending through a period of weeks, months, or even years. In other plants the seeds will not germinate under what may be termed normal conditions within a year of their production, and in such instances certain of the seeds show a further marked delay in germination. Numerous experiments have been made, and suggestions offered as an explanation of this erratic behaviour of seeds. Arthur has described a very interesting case of delayed germination in the seeds of the cockle bur (*Xanthium canadense*). The two seeds present in the bur are not exactly counterparts of each other, and are produced at different levels. All the lowermost seeds germinated the first year after ripening, whereas those seeds produced higher up in the bur did not germinate until the second year after ripening, and a few were delayed until the third or fourth year. The author considered that the seed coats did not differ in the two seeds, and suggested that enzymes are produced readily in the lower seeds, and that, therefore, they had food available for immediate germination, whereas the upper seeds are only able to form digestive ferments after a considerable period of rest. To determine this question more exactly, Dr. Crocker, of the Hull Botanical Laboratory, U.S.A., carried out a series of experiments with the seeds of various plants, including five kinds of *Xanthium*, and the dimorphic seeds of *Axyris amaranthoides*. His conclusions are as follow: Delayed germination is, as a rule, due to the seed coats rather than to the embryos; in other words, it is more dependent on mechanical than physiological causes. In some instances retardation is due to the seed coat excluding the required amount of oxygen. This is the case in *Xanthium*, but the exclusion of oxygen is much more marked in the case of the upper seeds than in that of the lower ones, hence the difference in time required for germination. A high temperature brings about the germination of the upper seeds of *Xanthium* at once by increasing the rate of diffusion of oxygen. In *Axyris amaranthoides*, *Abutilon*, *Avicennia*, and many other seeds, retardation is due to the exclusion of water by the seed coats. In *Iris* seeds the failure to germinate quickly is due to the endosperm and cap arresting the absorption of water, and it is only when a certain amount of decay in these structures has taken place that germination is possible.

Seed coats which exclude water are better adapted for retarding germination than when oxygen alone is excluded, because of the much greater reduction of transpiration in the first case.

Hawthorn seeds would not germinate immediately after ripening, even when the seed coats were removed, and after subjection to high temperatures and high oxygen pressures. In this case it was obvious that the changes necessary for germination were located in the embryo; nevertheless, it is also, to some extent, due to disintegration of the seed coats, because germination in the end is only effected after long exposure to conditions favourable to germination, and not when the seeds are kept dry.

Treatment of Deteriorated Tea.

Dr. H. Mann, in *Bull.* No. 4, of the Indian Tea Association, deals with the gradual deterioration of the tea plant a few years after planting, the bushes rapidly losing their early vigour, and after a period varying from 10 to 20 years they are past their prime. The old method of restoring such waning bushes by hard pruning is not always successful, because in some instances hundreds, or even thousands, of acres have been collar pruned when the bushes are suffering from causes for which collar pruning is no remedy. The signs of deterioration are a change in colour of the foliage, which assumes an unhealthy, yellowish appearance; at a later stage the young shoots soon cease to grow, and do not produce leaves.

Among causes of deterioration the principal are, exhaustion of available plant food in the soil, exhaustion of the bush, and incorrect pruning. A detailed account of the methods by which the primary cause of failure may be detected is given; also the practical methods, including drainage, manuring, pruning, &c., which seem best adapted for bringing back to a profitable condition much of the tea in India which has now declined from its former value.

CHEMICAL.

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

Action of Plants on Photographic Plates in the Dark.

DR. W. J. RUSSELL has extended his experiments on the action of wood upon photographic plates in the dark (see "KNOWLEDGE & SCIENTIFIC NEWS" Vol. II., 119, 235), and has tried the effect of various seeds, leaves, and roots. He finds that the reducing power is very widely distributed, and that many parts of the plant produce as marked an effect as the wood itself. In the embryo state seeds appear to be inert, but as soon as growth begins the reducing property manifests itself, and continues until the death of the plant. All leaves were found to have this property, even those lying dead beneath the trees still possessing it, though to a reduced extent. The best method of preparing leaves is to press them between blotting paper under a pressure of one to five tons to the inch; the liquid absorbed by the paper is also able to act upon the plate. Dr. Russell's hypothesis is that the active agent in the reduction is hydrogen peroxide at all events, the activity of the plant is comparable with that of hydrogen peroxide. Thus the seed leaf of the runner bean has practically the same action on a plate at a distance of an eighth of an inch as a solution of one part of hydrogen peroxide in 100,000 acting at the same distance for the same length of time (24 hours). The kernels of nuts are inactive at first, but after exposure to the air produce a very dark picture. Castor oil seeds are the least active in this respect, and the liquid expressed from them may be exposed to the air for a month or more without becoming active. It is not unlikely that some connection may be traced between the drying capacity of the oil in the seed and its reducing power. The outside shells of seeds are quite inactive. In the cocoanut shell, for instance, the light-coloured portion has no effect upon a plate, whereas the darker parts are very active. In many cases the roots of plants have a very strong reducing action, the root of the Scotch fir, for example, giving a picture similar to that produced by the wood.

Natural and Artificial Mineral Waters.

It might be thought that by dissolving the right salts in the right proportion in distilled water any natural mineral water could be exactly imitated; and, in fact, special salts are sold to be used in the preparation of water from various well-known mineral springs. It has been shown, however, by M. Negreano that the natural waters differ from the artificial imitations in an important physical characteristic, so much so that this can be used as a test for distinguishing between the two. The resistance offered to the passage of an electrical current appears to be practically a constant in the case of a natural mineral water, and will differentiate it from other natural waters. For instance, Vichy water was found to have a resistance (in ohms c.c. at 18° C.) of 140; Vittel water, 500; and Evian water 1,280. Artificial waters with practically the same chemical composition gave very different results, however, such as, for example, 112 in the case of artificial Vichy water, and 1,120 in that of artificial Evian water.

A Test for the Blood of Different Animals.

A simple modification of the serum method of differentiating the blood of different animals (see "Knowledge & Scientific News" Vol. II., 80, 100) has been devised by Herr Piorkowski, and has the great advantage of not requiring the use of a living animal. A small quantity of serum from a given animal, say a horse, is placed in a very small test tube into which is then introduced one drop of the fresh blood under examination, diluted 10 to 15 times, or of a solution of the dried blood in a solution of salt. The tube is allowed to stand for about 45 minutes, after which its contents are examined. If the blood introduced was from an animal of the same species as supplied the serum (a horse in our hypothetical case) a faint red precipitate of coagulated blood will be seen, while the liquid above will have remained clear. On the other hand, the blood of an animal of any other species will have dissolved in the foreign serum, colouring it red. The reaction is made more conclusive by shaking the tube at intervals of 30 minutes after the first coagulation, a fresh precipitate being formed each time. The method is stated to have given very satisfactory results in the examination of old stains of human blood, the test tubes being previously charged with fresh human serum.

The Gases Enclosed in Coal.

Analyses have been made by Mr. F. Trobridge of the gases enclosed in coal from Birtley, in Durham, in the dust left on screening the coal, and in that deposited on the timbers in the mine. The air was first removed by means of a mercury pump from the flask in which the coal was placed, and the gases subsequently given off by the coal in the exhausted flask collected over mercury measured and examined. Finally the flask was heated by boiling water to expel the residual gases. It was found that the samples of bright coal yielded the largest amount, and that these gases contained the largest proportion of combustible constituents, the latter consisting almost entirely of marsh gas. The gases occluded by the surface dust and the dust on the timbers amounted to about one-twelfth of the quantity in the bright coal, and contained other hydrocarbons of the same series as marsh gas. An interesting point was that the proportion of oxygen in the portion of air last removed from the flask was greater than in air. Further experiments showed that freshly-hewn coal exposed to the air gradually parted with its enclosed gases, and at the same time absorbed nitrogen and oxygen from the atmosphere, the latter in the greater proportion. Nitrogen formed a considerable part of the gases obtained from the different samples, and experiments are being made to determine whether this nitrogen contained argon and other inert gases that accompany nitrogen in the air.

GEOLOGICAL.

By Edward A. Martin, F.G.S.

A Small Triassic Dinosaur.

Dr. A. Smith-Woodward, the Keeper of the Geological Department of the British Museum, has described in detail to an enchanted audience, at the meeting of the Geological Society, two small skeletons of a new reptile from the Triassic sandstone of Lossiemouth. The specimens were discovered by Mr. W. Taylor, of Elgin, and appear to be the same as two imperfect skeletons which are already in the British Museum. The head and trunk measure only 4 inches in length, but there is a very long and slender tail. The head is relatively large, and resembles that of *Ornithosuchus* in many respects; but the fossils do not exhibit any teeth. There are about twenty-one presacral vertebræ, of which nine are cervical. There are distinct traces of a plastron of delicate abdominal ribs. The limb bones exhibit a large internal cavity. The fore-limbs are very small, with a humerus as long as the radius and ulna. The hind-limbs are relatively large, and the ilium is extended antero-posteriorly for the length of four vertebræ. The femur is almost as long as the tibia and fibula; while the metatarsus is especially remarkable, being half as long as the tibia and consisting of four metatarsals of nearly equal length firmly fused together. The toes are long and slender, with sharply-pointed claws. The most remarkable feature is undoubtedly the elongated metatarsus, and the fusing together of the bones suggest that the creature was in the habit of squatting thereon, and that their united breadth would prevent it from sinking into its boggy haunts or into the soft sands of a shore. At the same time the distinct internal cast which appears of a limb bone suggests adaptation for flight, and the whole structure would on account of its lightness seem suited for it. The smallness of the fore-limbs seem to show that these were seldom put to the ground, but this of course agrees with similar limbs in other dinosaurs. The creature has been classed with the dinosaurian reptiles on perhaps somewhat negative testimony, and the suggestion that it might have possessed some means of avian flight, although there were no traces of wing-feathers or membrane, will no doubt not be lost sight of, should any further specimens be discovered.

A Neolithic Burial at Whyteleafe.

A reprint has reached me of a paper read by Mr. A. J. Hogg before the Croydon Natural History Society, "On Human and other bones found at Whyteleafe in Surrey." The site is in the well-known Caterham Valley, along which the intermittent Bourne flows from time to time. The bones were found in October, 1896. They lay on the undisturbed surface of the chalk, but at the base of 8 ft. 3 in. of superincumbent dark brown or red loam, and grey marly chalk rubble. The burial was made in the usual neolithic crouching position, and the body seems to have been let down a shaft into a dome-shaped excavation about 4 ft. 6 in. in height.

The bee-hive or dome-shaped form of the hut, or the sepulchral chamber, appears to represent everywhere the ideal architecture of the Neolithic period, and was well exemplified by the underground chambers discovered at Waddon in 1902, which were ably described by Mr. George Clinch, F.G.S., before they again disappeared from view.

The human remains recovered at Whyteleafe consist of:—

1. Portions of the occipital and parietal bones of the skull.
2. The right ramus of the lower jaw, with eight teeth.
3. The shaft of the right femur, or thigh-bone.
4. The shaft of the right tibia, or shin-bone.

The bones of the skull which are preserved are thick—in the thickest part (the upper curved line of the occipital) five-eighths of an inch. The remarkable rugosity of the occipital appears to indicate the attachment of powerful muscles.

The animal remains which were exhumed from the brown loam included those of the *equus* (small horse), *boslongifrons*, *cervus*, and *ovis*. Mr. A. J. Hogg concludes his paper by remarking that the age of the Whyteleafe interment may be taken approximately as that of the close of the Stone Age, as determined by observations made in Switzerland namely, about seven thousand years ago.

A Wealden Crocodile.

Although the species of fossil crocodile, *Goniopholis crassidens*, was founded many years ago, it has only been quite recently that the skull was discovered for the first time. This fortune fell to Mr. R. W. Hooley, F.G.Z., who by great carefulness and patience collected the remains of this fossil crocodile from a disintegrating mass of Wealden Shales from Atherfield in the Isle of Wight. This mass, comprising many thousand tons, subsided, pushing its foot across the beach until below low-water line. As the sea washed away the base. the mass continued to sink, and fresh horizons were denuded. In 1905 a series of heavy "ground-seas" cast up blocks of limestone and ironstone, containing crocodile bones, which were discovered on the sand between high and low-water marks. The skull came ashore in six pieces, whilst fragments of bones and scutes were constantly picked up, and Mr. Hooley spent many days collecting the remains as the sea sorted them out and cast them up on shore. The specimens were derived from a horizon 80 to 90 feet below the top of the Wealden Shales.

The paper describing the discovery was read before the Geological Society of London, and Dr. A. Smith-Woodward in commenting favourably on it remarked that although the remains of *Goniopholis crassidens* were among the commonest Wealden fossils, the precise characters of the species had remained unknown, until the discovery which the author had described. The new observations were of all the greater value because the Goniopholidæ represented an entirely new departure in the evolution of the Crocodilia at the end of the Jurassic Period, and biologists needed an exact knowledge of the skeleton of these reptiles before they could discuss the meaning of the development in question. The late Sir Richard Owen thought that the first appearance of alligator-shaped crocodiles such as *Goniopholis* was correlated with the incoming of warm-blooded quadrupeds and birds.

ORNITHOLOGICAL.

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

The "Drumming" of the Snipe.

At the last meeting of the Zoological Society, Mr. Philip H. Bahr gave a most interesting demonstration, illustrating the results of his inquiry into the vexed question as to the mechanism which causes the remarkable sounds made by the Common Snipe during the breeding season—sounds which are described by some as "drumming," by others as "bleating."

While the older naturalists believed these sounds to be vocal, later observers held that they were produced by the wings, and others by the tail. The latter view has been widely accepted for many years, and the experiments which Mr. Bahr made to test the truth of this should remove the last doubts on the subject which some yet maintain.

He showed conclusively that the principal agents in this matter are the outer tail feathers, which are peculiar, not only in having an unusually thickened and peculiarly curved shaft, but also in the great width of the inner vane. This is furthermore strengthened by means of very large and numerous "booklets"—microscopic structures which hold the backs of the feather in position by reason of the grip they take of certain specially modified barbules.

He extended his examination so as to include every known species of Snipe, and found that in many species the sounds produced are extremely high-pitched, by reason of the narrowness of the feathers concerned. This decrease in the width of the vane reaches its maximum in the Pin-Tailed Snipe (*Gallinago stenura*), which has further increased the number of the tail feathers to 26 pairs! But here the development has been carried to such an extreme that all sound-producing power has become lost.

House Martin in December.

Mr. C. H. Howard, in the *Field*, December 22, records the fact that he saw a House Martin hawking for flies on the Parade at Eastbourne on December 9.

Baillon's Crake in Kent.

According to the *Field*, December 22, a Baillon's Crake (*Porzana bailloni*) was shot at Lydd, Kent, on November 24, by Captain R. Alexander. It proved to be a female, and was flushed from a rush-covered pool near the sea.

Sea Eagle in Surrey.

An immature male Sea Eagle (*Haliaetus albicilla*) was shot at Cheverills, Surrey, by a gamekeeper on November 12, and was duly recorded, as usual, in the daily Press as a Golden Eagle. This makes the fourth authenticated record of this species for Surrey.

Honey Buzzard in Wales.

Mr. H. E. Forrest, in the *Zoologist* for January, gives a short account of a Honey Buzzard (*Pernis apivorous*) which was "inadvertently" shot by a keeper at Kerry, near Montgomery, on June 21, 1906. On dissection it proved to be a female. This appears to be the first authenticated record of the occurrence of this species in the county; while in the whole of North Wales it does not appear to have occurred more than eight times.

Mediterranean Black-Headed Gull.

Mr. Forrest, in the same issue of the *Zoologist*, brings to light two hitherto unrecorded instances of the occurrence of the Mediterranean Black-Headed Gull (*Larus melanocephalus*) in this country. These birds are now in the collection of Mr. Beville Staines, of Peplow Hall, Salop. They are described in the M.S. Catalogue of Harry Shaw as follows: "The pair of birds in this collection were killed near Falmouth in March, 1851; the only specimens of their kind recorded as obtained in the country." It is certainly remarkable that such rarities should so long have remained in obscurity.

PHYSICAL.

By Alfred W. Porter, B.Sc.

Poulsen-Pederson System of Wireless Telegraphy.

The great desideratum in wireless telegraphy is a system of waves which is practically continuous. In Hertzian telegraphy each spark in the sending apparatus lasts for only a small fraction of the time, and the corresponding waves are equally intermittent. A few waves pass, each one less intense than the one before it, there is then a long pause before a new series is excited, and this, in turn, rapidly decreases in intensity. The consequence is that the total effect in any moderate time is very small, and the greatest distance for easy signalling is correspondingly short. It is now claimed by Poulsen that this desideratum is supplied by making use of the singing electric arc.

Duddell some years ago showed that if a shunt consisting of a suitable inductance and capacity be applied to the terminals of a solid carbon continuous current arc lamp the arc will, under definite conditions, begin and continue to sing. The singing is the audible sign of an oscillatory current in the shunt circuit. By adjusting the inductance and capacity, Duddell was able to obtain very high frequencies of alternation amounting to 40,000 periods per second. But with a single arc he was unable to satisfy the necessary conditions with a larger current than five amperes. This frequency and current are small compared with what is required for distant wireless telegraphy. Poulsen now claims that by putting the arc in hydrogen or a hydrogen-containing atmosphere a much higher frequency is obtainable; for example, as high as one million per second; and, moreover, that succeeding oscillations are all of equal intensity. Improvement is also effected by applying a transverse magnetic field to the arc, and also by keeping the anode cool. The latter is effected by replacing the anode carbon by copper and cooling it with a stream of water. The externals at the sending station do not present much peculiarity. There is the usual antenna attached to the oscillating circuit. In a large station erected in Denmark the potential difference between antenna and earth amounted to about 2,000 volts, and the rate of radiation of energy from the antenna was about 100 watts, or about one-seventh of that supplied to the arc. With this good signals were received 300 kilometres away. Later still greater radiation has been obtained, sufficient to carry some thousands of metres. At the receiving end a special receiver is used which was devised by Pederson.

The radiation is received by an antenna whose circuit is accurately tuned to the frequency of the waves received, so that the principle of resonance is utilised to the fullest extent. To prevent the damping of these oscillations the indicating apparatus is only intermittently connected with the receiver. This intermittent connection is made by a small, electromagnetically driven interrupter called a Tikker. The indicator itself may be an electrolyte cell, a thermo-element, or a bolometric arrangement in combination with a telephone. The intermittence introduced by the tikker is so great that in the telephone a high note is heard. It is claimed that very fine tuning can be employed, with the resulting advantage that neighbouring stations may be closer together without disturbing one another.

Time alone will show to what extent the claims of this new system will be substantiated. In a leading article in the *Electrician* (December 21, 1906), which, in the main, is eulogistic, there is a considerable amount of cautious criticism of the claims and the methods of achieving them; and the opinion is expressed "that there need be no haste in scrapping plants at present in operation, and that it may yet be many years before the musical arc can sing the dirge of the spark."

Mr. Duddell, in the last of his Christmas lectures to juveniles at the Royal Institution, showed such a sending and receiving apparatus at work, and illustrated experimentally the sharpness of tuning which is necessary for producing the best effect.

Disintegration Products of Actinium.

The disintegration series of actinium has been thoroughly investigated by Dr. O. Hahn, and the following six stages have been determined:

PRODUCT.		TIME TO BE HALF TRANSFORMED.	RADIATION
Actinium			Rayless.
Radioactinium ..		About 19·5 days.	α rays.
Actinium X		10·2 ,,	α rays
Emanation		3·9 sec.	α rays.
Actinium A	Active deposit.	36 min.	Rayless.
Actinium B	Active deposit.	2 ,,	α, β and γ rays.

The Monochromatism of the Red Cadmium Spectrum Line.

While Michelson's echelon grating and also Fabry and Perot's interferometer indicated that the cadmium red line was single, doubt had been thrown upon this result by the fact that with Lummer and Gehrcke's apparatus it appeared accompanied by several components. The doubt was as to whether these components were real—in which case the red light of cadmium would be a much more imperfect source of pure light than had previously been hoped; or whether they were only ghosts or accidental appearances arising from imperfectness in the apparatus employed. This apparatus consists simply in a long parallel plate of glass. A parallel beam of light is admitted in a very oblique direction, and is internally reflected a large number of times, a portion of it escaping at each reflection so as to form an aggregate of parallel beams, between each of which a certain phase-difference exists due to difference of retardation in passing through the plate. A similar result to this is produced in other interference apparatus, and Lummer claimed great efficiency for his particular arrangement. Gehrcke and von Baeyer have now shown how to distinguish between a ghost and a true component by the use of an additional plate. The result of their test is to show that the apparent structure of the red line is wholly due to ghosts, and therefore all the different interference devices which are employed to test structure are now in complete agreement. Similarly with regard to the green mercury line. Lummer had obtained a much more complicated structure than other observers. Here again, when the new test is applied, the additional complication is shown to be spurious. It is very satisfactory to find the various devices all leading to concordant results. In order to indicate the superiority of interference apparatus over diffractive gratings it may be pointed out that no grating has ever been ruled which is able to reveal the structure which, with interference apparatus, is here being studied in detail.

ZOOLOGICAL.

By R. LYDEKKER.

Is there a British Freshwater Medusa?

ABOUT twenty years ago it was discovered that certain streams in Philadelphia were inhabited by a small polyp, which lives attached to stones at the bottom of the water. Twelve years later it was observed that this *Microhydra*, as it is called, reproduces itself by giving off free-swimming jelly-fishes or medusas. All this, it may be said, has nothing to do with a British jelly-fish. True, but in certain hot-house tanks there were at one time noticed small, fixed polyps, then regarded as the sedentary stage of the free jelly-fish previously observed in the *Victoria regia* tanks in the Regent's Park; and the suggestion now is, that these fixed polyps may possibly prove to be indigenous British representatives of the American *Microhydra*. Whether it is worth the while of amateur naturalists to commence hunting for this problematical creature must be left to the decision of members of that body.

British Bears.

Professor S. H. Reynolds, of Bristol, has done much to increase our knowledge of the bears which inhabited the British Isles during the Pleistocene and Prehistoric epochs, in a memoir issued among the Palæontographical Society's monographs for 1906. The author finds that all these bears are closely related, but considers it advisable, on the whole, to retain the great cave-bear, *Ursus spelæus*, as a distinct species. All the rest he groups under the title of *Ursus arctus*, as typified by the brown bear of Scandinavia. Of special importance is the opinion that the reference of certain British (including Irish) bears to the American grizzly (*U. a. horribilis*) cannot be substantiated. This is quite in accordance with what might be expected from other considerations; for the grizzly bear (as now restricted) does not occur in the higher latitudes of North America, where its place is taken by races more nearly akin to the European brown bear and its Asiatic representatives. If, then, any of the British bears exhibited marked resemblances to the grizzly, it is obvious that such resemblances could only indicate the existence in the British Isles of a race representing the American animal, and not that race itself.

The Attis Spider.

The Rev. O. P. Cambridge points out in the *Naturalist* that the power of changing the colour of their eyes possessed by certain spiders from Java (to which reference was made in our last issue) is not a new phenomenon. The same thing has been previously observed in other spiders of the Attis family.

Papers Read.

At the meeting of the Zoological Society on December 11, 1906, Messrs. J. Rennie and H. Wiseman contributed a paper on the "Ascidians of the Cape Verde Islands," in the course of which three species were described as new. The arterial system of certain frogs and toads formed the subject of a paper by Mr. L. K. Crawshay; while fifty-three new African weevils were named and described by Mr. G. A. K. Marshall. Results of considerable morphological interest were embodied in a paper by Mrs. O. A. M. Hawkes on the cranial and spinal nerves of the shark *Chlamydoselachus*. Two mammals, a cat and an elephant-shrew, collected by Major Powell-Cotton in the Ituri Forest of Central Africa, were discussed by Mr. Lydekker, who also described a race of the bruang, or Malay bear, from Tibet. Finally, Sir Charles Eliot furnished a supplemental communication in regard to the nudibranchiate molluscs of Southern India.

At the meeting of the same Society on January 15, 1907, the following papers were down for reading:—On a collection of mammals from Annam, by Mr. J. L. Bonhote; on the "bleating" or "drumming" of the snipe, by Mr. P. H. Bahr; on new or little-known marmosets from Amazonia, by Dr. E. A. Goeldi; and on the classification and anatomy of certain squamate reptiles (snakes and lizards), by Mr. F. E. Beddard.

CORRESPONDENCE.

Phenomenal Sunsets.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—On Monday, July 11, 1904, the sun set at 8.13, in a clear sky in the west, though in the south-east a heavy thunderstorm was working up.

About 8.30 p.m., from a light orange glow, there issued five distinct bands of light of a pale salmon-pink colour, which radiated like the spokes of a wheel from the sun, being definitely separated by five corresponding bands of pale blue.

The phenomenon lasted for nearly an hour, the bands gradually fading away.

The same night a violent thunderstorm broke over Exmouth.

On Monday, July 18, a similar sunset occurred, though in a modified form, which I saw from Okehampton, but the "bands" were reduced in number, though they had increased in width.

The following day a heavy thunderstorm broke over the town.

I saw a third sunset a few days after, which was limited to one broad band of salmon-pink light, slightly inclined to the right of the sun.

About the same time thunderstorms and heavy rains occurred in Paris, and a remarkable phenomenon was seen in the sky on the morning of July 25, between nine and ten o'clock, numerous coloured circles appearing round the sun, like haloes.

Faithfully yours,

C. SOMERVILLE WATSON.

Battersea Park, S.W.

Basaltic Columns.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—May I refer those who are interested in the formation of concretionary masses from organic nuclei to a communication on the subject which appeared in the *Geological Magazine* of August, 1892? I have not, as yet, had reason to change the views expressed therein.

Yours very faithfully,

CECIL CARUS-WILSON.

Royal Societies Club, S.W.

The "Flight" of Flying Fishes.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—The question of the flight so called of flying fishes is brought up again by the interesting notice of Colonel Dunford, who has not, however, in my opinion, made out his case. During twenty years passed at sea, and at intervals since then, I have specially studied this matter, and I am convinced that the fish does not, and cannot, fly as birds do.

The flying fish projects itself into the air by means of its powerful tail, and it is sustained there, often for a considerable time, by the extension of its large pectoral fins. A rise in the "flight" may sometimes be noticed, but that is merely due to a heave given by the air forced up by a wave crest. The fish, which apparently floats in the air at an angle of 35° with the sea level, will be seen to fall into the water, but instead of getting submerged, it receives a fresh impetus and again projects itself upwards. The active little anral fins assist the tail, but the pectoral fins are incapable of other movement than the fore and aft motion, which extends them when the fish rises from the water, and folds them close to the body when it swims in the sea.

In a calm sea flying fish are seldom noticed out of the water, and when they are the "flight" is extremely short, nothing more than a jump, in fact. As a rule, the fish flies up against the wind; should it catch them sideways they go off at a tangent, and a breath of air from an unexpected quarter will often turn them right over.

I had a flying fish alive for a time, and was able to study the motion of the fins in water. Out of water, the pectoral fins soon got quite dry, a fact which would of itself be a bar to real flight.

It is useless to look for information which might be turned to practical application in the construction of aéromachines by the observation of the movements of flying fishes. It is, however, quite possible that much might be learned from observations of the flight of the albatross and kindred birds.

Faithfully yours,

D. WILSON-BARKER, R.N.R.

H.M.S. Worcester, Greenhithe.

Average Rainfall.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Assuming the rainfall during the first six months of the year has far exceeded the average, is it not fair argument to assume at the beginning of the second six months that the remaining rainfall for the year will be deficient?

Faithfully yours,

R. M.

[From an analysis of the Greenwich rainfall records, for the 91 years 1815-1905, it appears that the rainfall for the first half of the year was above the average on 43 occasions; of these, the rainfall of the succeeding six months was above the average on 20 occasions, but below it on 23. There does not seem to be any reasonable data for founding a forecast of the coming season from these figures.—W.M.]

Brakes.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—The action of railway brakes was investigated at considerable length in a paper published a few years ago by Professor A. Sommerfeld, of the Technische Hochschule Aachen.

I cannot lay hands on my copy at the present instant, and should, therefore, not have referred to the matter but for the very inconclusive arguments used in the discussion in your columns. A reference to the paper appeared in *Nature* at the time, and I have no doubt Professor Sommerfeld would send a reprint to anyone interested in the matter.

A complete investigation requires account to be taken of the differences which exist between the co-efficients of rolling and sliding friction, and the fact that the co-efficient of sliding friction depends on the relative velocity of the parts that are sliding on one another. These differences are not mentioned in elementary text-books, and the data required for solving the problem are necessarily based on the results of experiment. I am practically certain that Professor Sommerfeld found that the maximum efficiency was not in general obtained when the wheels were locked.

G. H. BRYAN.

REVIEWS OF BOOKS.

ASTRONOMY.

Sixth Report of the Section for the Observation of Variable Stars (Memoirs of the British Astronomical Association, Vol. xv., pp. 140 with 14 plates; price to non-members 3s.).

Of the numerous observing sections of the B.A.A. the variable star section, under the energetic direction of Col. Markwick, is by no means the least flourishing. Variable star observation does not necessarily require any expensive outfit, and is, therefore, peculiarly attractive to workers unprovided with a telescope, or with only a small one, especially since the discovery of Nova Persei. The period covered by the present report is the lustrum 1900-1904, and a few previous observations are included. The work has naturally been confined to fairly well-known variable stars, of which 26 "long-period" and two "irregular" variables provide the whole of the 5,717 observations. The director himself, using a telescope of 2¾-inch aperture, is responsible for more than 2,000 of the number, so that he is something more than an armchair director. Of the stars in the list, χ Cygni is, perhaps, the best observed, with 508 observations by 13 observers. Harvard magnitudes have been used for the comparison stars whenever possible in order to make the results strictly comparable with those of Harvard College Observatory. The observations have been printed very fully, each day and each observer being given separately in every case, and the resulting magnitude compared with that calculated. The plates give the results in diagrammatic form with dots for measures and curves for observed and calculated light-curves. The labour involved in the computations and preparation for press must have been considerable, and in this the director acknowledges valuable assistance from Mr. C. L. Brook, who also contributed largely towards the expense of printing, which would have been too great for the Association, but which was met by grants and subscriptions from the Association and the Royal Society (Government Grant Committee), and two of the observers, Messrs. Brook and Worssell.

Astronomical Calendars for 1907.—We have received from Mr. Arthur Mee, of Llanishen, Cardiff, a copy of his "**Heavens at a Glance, 1907,**" price 7d., post free. On the one side appears two star maps, which, to use Mr. Mee's own words, are "intended only for those who have no access to a planisphere or a celestial globe or atlas," and on the reverse a calendar for the year together with useful astronomical information.

Also received, too late for notice in our last issue, was Hirschfeld's **Star Calendar** (Hirschfeld Bros., Ltd., Furnival Street, 1s. net) for this year. This consists of the 4 cards, as in previous issues, each card giving a rough but clearly marked chart of the constellations for three months, also a monthly calendar.

BOTANICAL.

New Creations in Plant Life, by W. S. Harwood (Macmillan and Co.).- Mr. Harwood is obviously to a great extent blinded by hero-worship, and his knowledge respecting the creation of plants, as he is pleased to style what is usually known as hybridisation, appears to be mainly confined to the work done by Burbank, otherwise the introductory remark that his hero "is the foremost plant-breeder in the world," and that "he has produced more new forms of plant life than any other man" would have been to some extent qualified. Burbank has undoubtedly done some good work, and has given to the world many improved plants of sterling value, and a straightforward account of his accomplishments and methods would have been welcomed by all, but unfortunately such practical matter is completely swamped by a superabundance of rhetorical flourish that the subject proper is somewhat difficult to locate. "Speaking of making a blue rose, he (Burbank) said it was one of the easiest things in the world if one should set out diligently about it, but it would consume very much time in the making, and it would be doubtful after all if it added much to the charm of this rare flower. He has studied the rose with great care, and he has seen in the consideration of its colouring an easy avenue to a land of blue roses." We sincerely trust that Burbank may be induced to reconsider his decision, and make a blue rose; many people have already attempted to do so, but without success. Everybody desires a blue rose, and if the only person in the world capable of creating one declines to do so, the opportunity will probably be lost for ever. We are told that Burbank has clearly demonstrated the utter fallacy of the Mendelian Laws, and has also brought to light the absurdity of the generally acknowledged statement that "acquired characters are never transmitted." On the other hand he has established the opposite, that acquired characteristics are the only ones that are transmitted. Fuller details on these points will be awaited with interest.

CHEMICAL.

Practical Physical Chemistry, by A. Findlay, M.A., Ph.D., D.Sc., pp. xii. and 382 (London: Longmans, Green and Co.; 4s. 6d.). Most elementary books of chemical analysis include a number of physical exercises, such as the determination of the specific gravity, molecular weight by different methods, and so on; but we know of none which deals solely with the physical side of the science. There are, it is true, several large manuals, such as Ostwald's text book, but these are far too advanced for the beginner, and hence there is every reason for the existence of a book like that of Dr Findlay which shall serve as a practical physical guide to the general student of chemistry. The work includes chapters on density, thermal and optical measurements, molecular weight, electrical conductivity, electromotive force, and the velocity of chemical reaction. It is very clearly written, and in each case good descriptions with illustrations of the necessary apparatus are given, together with test exercises in the use of this apparatus. The author, who is a lecturer on physical chemistry in the University of Birmingham, is to be congratulated on the success of his attempt to provide a suitable little text book for use in schools and universities.

Problems in Animal Metabolism, by J. B. Leathes (London: Murray, 1906; pp. viii +205; price 7s. 6d. net).—That the contents of this little volume—which is practically the report of a course of lectures given in the Laboratory of London University, a couple of years ago—are thoroughly to the point and up to date, we have not the slightest doubt. If, however, the work is intended to appeal to any other class of readers than the student—and students of a rather specialised type—it should have been written in a much less "cut-and-dry" style. When we first opened it, we hoped to find in this volume a readable account of the wonderful chemical processes which are constantly taking place in the human body. To our great disappointment, we found that the book is absolutely unreadable except by a professed chemist and physiologist. Had the author but taken as his model the admirable articles on the "New Chemistry" which have recently appeared in the *Cornhill Magazine*, he might have produced a work which would have been an acceptable and useful one to scientific men who are not specialists in chemistry and physiology, as it no doubt is to those who devote their attention to these branches of science. The author's style is also capable of much improvement; the commencement of two consecutive sentences on page 31 with the word "but," being a glaring example of one of his common failings. As we have said, the work is, no doubt, admirable for students of metabolism, but it may be hoped that in a second edition it will be so modified as to meet the requirements of a wider circle of readers.

METEOROLOGICAL.

Meteorology in Mysore for 1905. Thirteenth Annual Report, by John Cook, M.A., F.R.S.E. (Bangalore, 1906; 4to 56 pp. and 8 plates).—This volume contains the results of the meteorological observations made at Bangalore (3,021 ft.), Mysore (2,518 ft.), Hassan (3,091 ft.), and Chitaldrug (2,405 ft.) during the year 1905. The following are the averages of some of the results for the thirteen years 1893-1905:—

	Bangalore.	Mysore.	Hassan.	Chitaldrug.
Temperature—	°	°	°	°
Mean	74·0	75·5	72·1	76·8
Mean Maximum	84·9	86·4	83·2	87·0
,, Minimum	64·4	65·8	62·4	67·4
,, Daily Range	20·5	20·6	20·8	19·6
Rainfall—				
Total	34·68 ins.	30·77 ins.	36·15 ins.	25·22 ins.
No. of Rain Days	104	103	124	89

Observations and Investigations made at the Blue Hil Meteorological Observatory, Massachusetts, U.S.A., in the years 1903 and 1904, under the direction of A. Lawrence Rotch (Cambridge, 1906; 4to. 74 pp.).—The Blue Hill Observatory was founded by Mr. Rotch on January 30, 1885, and the main object of its existence is scientific research. Intimate relations have been cultivated with foreign meteorologists and institutions, and Mr. Rotch has attended the Meteorological Conferences held in Europe, and the meetings of the International Cloud Commission and of the Commission for Scientific Aeronautics, of both of which he is the American member. The exploration of the air by means of kites and lifting instruments, which record continuously, was originated at Blue Hill in 1894, and great attention has been paid to this subject ever since. The present volume (which forms Part II. of Vol. LVIII. of the *Annals of the Astronomical Observatory of Harvard College*) contains the observations made twice daily in the years 1903 and 1904, and also the results from the kite meteorograph and simultaneous records at the ground. In addition there are the following papers:—(1) Unusual Sky-Colours, by Mr. A. L. Rotch; (2) The Effect of Meteorological Conditions upon Optical Refraction in the Lower Atmospheric Strata, by Mr. L. A. Wells; and (3) The Errors of Absorption Hygrometers, by Mr. S. P. Fergusson.

MICROSCOPY.

The Principles of Microscopy, by Sir A. E. Wright, M.D., F.R.S., &c. (London: A. Constable and Co., Ltd., 1906, xxii. and 250 pp., 18 plates and 97 figs. in text; price 21s. net.).—With Sir A. E. Wright's intention in writing this book we are in complete sympathy. There can be no doubt that users of the microscope as a body are content with too much "rule of thumb" and too little "reasoned action," and that they fail accordingly to get the best results out of their instruments, even where such results are imperatively necessary to them. In endeavouring to persuade the worker with the microscope that his methods are capable of improvement, and in leading him up to such improvement by a careful enunciation of principles, based upon demonstration and experiment, Sir A. E. Wright has done much-needed work. It is, however, somewhat doubtful whether he has not over-shot the mark and gone over the heads of the larger audience whom he would no doubt have wished to reach. In the first place, the book, beautifully printed and illustrated though it is, is unquestionably costly, and this alone would limit its usefulness; in the second place, it may be questioned whether it does not deal too much with principle and too little with practice to attract the average worker. In this connection it must be borne in mind that the book is admittedly written for the "rule of thumb" worker, and not for the student of microscopical optics, but the average worker, unfamiliar with optics, would find it difficult to follow or appreciate the sequence of the reasoning, or to realise where he was to get his equivalent return for the "intellectual effort" which the author demands of him. The method of dealing with the subject is unfamiliar, and the phraseology, and sometimes even the words, more unfamiliar still, but the experiments are of the simple and easily performed, yet ingenious and instructive, character which we have learned to expect of the author. The optical principles, however, gain largely as addressed to the ordinary reader, from an almost entire avoidance of mathematical expression, and the exposition of them leaves upon the technical reader an impression of much originality. It is in the practical applications of the theories so carefully built up that the worker will find most disappointment, inadequacy, and in some instances even misdirection, as where he is instructed (on p. 174) to use a plane mirror with the sub-stage condenser with daylight, and a concave mirror with lamp-light; to obtain a "sharper" image by cutting down the condenser beams "severely" with the diaphragm; and by statements that a too thin cover-glass is corrected for by shortening the body tube, and a too thick one by lengthening it (p. 205). The author appears to consider the Abbe condenser with its enormous spherical and chromatic aberrations as effective as an aplanatic and achromatic condenser, and yet we see him in Chapter xv. endeavouring to get rid of the aberrations caused by the use of the former condenser combined with a concave mirror and an incandescent lamp, by cutting down the beams from the latter by a screen placed immediately before it, the lamp being apparently placed so close to the microscope as to be in the principal focus of the concave mirror. Methods of measuring the magnification of an object—though attention is not called to this—and the magnifications of objectives and eyepieces are dealt with in original ways, which, however, seem to us to have no superiority over the better-known but untouched-on methods. The author very frankly expresses his indebtedness to Mr. J. W. Gordon for much help and suggestion, but undue prominence would seem to be given to the latter's very interesting and ingenious, but none the less still debatable, theories. In particular, it would have been well if Sir A. E. Wright had laid greater stress on the limitations of Mr. Gordon's much-advertised method of improving the image given by high-power oculars, and his own appraisement of the "achievement" that it may "carry us to a higher limit of resolution" by enabling the optician to correct his lenses somewhat more easily! It would save much irresponsible talk as to a newly-realised magnification of 10,000 diameters, coupled with suggestions that Mr. J. Butler Burke's "radiobes" should be inspected by them without delay!

PHOTOGRAPHY.

The Complete Paotographer, by R. Child Bayley (London: Methuen and Co.; price 10s. 6d. net.).—This is the fourth volume of a series of which "The Complete Motorist," "The Complete Golfer," and "The Complete Cricketer," are the other three, but there is nothing of a sporting character in it. It is a straightforward treatise, beginning with historical matters and concluding with chapters on pictorial photography, exhibitions, and societies. It is neither an instruction book nor a guide to the science of the subject; it includes, as the author himself says in the preface, very few formulae, and yet it contains a great deal of information set down in a rather diffuse, but eminently readable style. Every few pages there is a reproduction of a notable photograph, printed on special paper, and of these there are more than sixty, intended presumably to show the reader some of the best work, that he may know the sort of result that he should aim at. The frontispiece is a fine photogravure portrait of Henry Irving, by William Crooke. After about four hundred pages of subject matter there follows a very copious index. As already stated, it does not claim to be what is generally understood as a student's book. He who seeks information on any particular subject will almost certainly find a suitable entry in the index, and on turning to the page indicated he may learn much, but, on the other hand, he may find that the subject is merely talked round, or that it is summarily dismissed with a mere reference, or an expression of disapprobation. The author holds some views that other authorities would regard as unsound, as, for example, that levels on hand cameras are of very little use because they cannot be seen at the same time as the finder, and that for architectural work they are not sensitive enough. Doubtless, this is occasionally true, because of bad design or inferior workmanship, but it ought not to be so. On the whole, the advice given is good, and in those cases where one is inclined to disagree with it, it is entitled to respectful consideration because of the experience of the author. Those who like reading about photographic methods and similar subjects, and are tired of the innumerable little guide books that are constantly being produced, will appreciate this volume, for it is essentially a book to be read, rather than a work of reference.

ZOOLOGICAL.

We have to acknowledge the receipt of a copy of an article on "Snake Feeding at the Zoo," reprinted from the January number of the *Humanitarian Review*. The practice of feeding these reptiles with living animals is strongly condemned; and it is urged, on the authority of the Director of the New York Zoological Park, that "dead meat" will equally well serve the purpose.

MISCELLANEOUS.

The Scientist's Pocket Book and Diary (James Woolley, Sons and Co., Ltd., Manchester; 1s., cloth; 6d., paper cover).

This is a capital little book, containing a number of useful tables in all branches of science, and a diary with a week on a page.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Royal Microscopical Society.

DECEMBER 19, Dr. D. H. Scott, F.R.S., President, in the chair. Mr. C. L. Curties presented to the Society a dissecting stand, made by the late Latimer Clarke, C.E., and a live-box. Mr. Conrad Beck exhibited a new form of hand demonstration microscope for low-power objects for use in classes. Some slides selected from the collection presented to the Society by Mr. Jas. Hilton, were also exhibited. Mr. S. Rogers read a paper on "Microscopic Study of Strain in Metals," which showed the nature of the fatigue of steels under alternating stresses of a certain magnitude. He finds that the nature of the effects in the ferrite of steels is different from that in soft iron, and the effects in pearlite depend upon the type of pearlite. It might be expected that incipient cracks would tend to select a course largely through ferrite, but important reasons show that caution should be exercised in accepting this hypothesis, and much experimental work confirmed the fact that the selection, though marked, is by no means exclusive. An important difference exists between steels rolled or annealed below about 750° C., and those annealed at higher temperatures, *i.e.*, more or less overheated. In the former, the outcrop of surfaces upon which slip has repeatedly occurred are very numerous, short and crooked, and the surface parallel to the direction of stress becomes ruffled. In the latter type, the outcrops are fewer, less crooked, and longer, and the surface is practically unruffled. A relation is found to exist between lines which are found upon statically strained pieces, and this leads to the theory that specimens of the "normal" group endure fatigue better than "overheated" specimens, because the permanent and injurious microscopic strains are more minutely sub-divided and uniformly distributed in the former than in the latter. It is conclusively shown that there is a stage in the life of a piece of steel enduring fatigue after which, though it is far short of final rupture, annealing is futile, if not actually harmful. Pieces in this stage, if heated to 250° C., or higher, and then fatigued to rupture, show heat tint-marks on the ultimate fracture, which map out the portion of fracture which was sufficiently open at the time of heating for air to enter.

Quekett Microscopical Club.

December 21. Mr. W. R. Traviss exhibited and described an expanding central stop for dark ground illumination. Mr. A. A. C. Eliot Merlin, F.R.M.S., communicated a paper on "New Diatom Structure." This dealt chiefly with the recent resolution of "veiled" markings on some three species of *Melosira*, and new secondary markings in species of *Navicula*, *Hyalodiscus*, *Aulodiscus*, etc. The author had also sent for exhibition two dark-ground photographs of *Triceratium nova Zealandica*, × 400, taken with a Zeiss 16 mm. apochromat, N.A., 0.35, and a Powell 26 projection eyepiece. The focus in both cases was adjusted on the image of the apochromatic substage condenser stop, formed in the central areolations, and the single bar arm of the central stop was well seen in many areolations of both specimens.

The meeting was preceded by a demonstration on "Dark Ground Illumination," by Mr. H. F. Angus. It was stated that to secure the best results, the numerical apertures of objective, condenser, and stop, should have the ratio respectively of $\frac{1}{3}$, $\frac{1}{2}$, and 1, *e.g.*, if the objective has N.A. 0.33, the value of the central stop should be 0.50, and the condenser, N.A. 1.0. Methods of determining the N.A. value of the condenser and of the stop required were given, and the rules laid down were illustrated by a number of specially arranged microscopes.

Collecting and Studying Flustrella Hispida.

In the "Quarterly Journal of Microscopical Science" R. M. Pace gives a method of study of the larval development of *Flustrella hispida* which may be of service in other directions. The material was collected on the South Coast, being found abundantly between tide-marks on *Fucus*, and occasionally on other algæ. For the study of larval development, colonies of one or two seasons' growth taken close to low water-mark proved the most suitable. Such colonies contain abundance of spermatozoa, or of ova or larvæ, according to the season, the reproductive period being from February to August. In pure running water *Flustrella hispida* may be usually kept alive in tanks for a few days to a week. The larvæ were examined in the living state and after fixation; the fixatives used were: (1) Saturated sublimate with 5 per cent. acetic acid; (2) 5 per cent. chromic acid, 100 parts, with 5 drops acetic acid; (3) Flemming; (4) Hermann; (5) Chromo-nitro-osmic mixture; (6) Acetic alcohol, with sublimate to saturation; (7) Kleinenberg. After fixation, the material was removed to 70 per cent. alcohol. Chrom-acetic acid and corrosive acetic gave the best results for fixation in bulk. Larvæ were isolated by slicing off the front wall of the colony with a razor; the larvæ lie just below this wall, enclosed in the tentacle-sheath. For isolated larvæ, the best fixatives were corrosive acetic and acetic alcohol, saturated with sublimate. Entire eggs and larvæ were examined during life and after fixation. The latter were stained with borax-carmine or with saffranin. In some cases the nuclear spindles and the yolk-nucleus were clearly brought out. Sections were made from isolated larvæ, and of colonies containing larvæ. Groups of isolated larvæ were embedded together, and sections obtained in various planes. In order to determine the direction of unorientated larvæ, a set of standard sections was prepared by carefully orientating single larvæ, which had been first studied entire. To ensure thorough impregnation of colonies with larvæ *in situ*, the material was left in xylol for about a week before being passed through xylol-paraffin to paraffin. The most useful stain for sections was Heidenhain's iron-hæmatoxylin, followed by eosin in 90 per cent. alcohol. Other stains were used, among which was Mayer's muci-carmine, for detecting the presence of mucin.

Differentiation of Typhoid Bacillus.

The "British Medical Journal" gives a summary of a method advocated by Lœffler for differentiating typhoid bacilli from nearly allied organisms, by the use of media to which malachite green has been added. One of these media contains 2 per cent. peptone and 1 per cent. nutrose in 100 c. cm. of distilled water, and is neutralised by the addition of 1.06 c. cm. of normal potash. To this is added 5 per cent. of milk sugar and 1 per cent. of grape sugar. After boiling for a short time, and then cooling to a gentle warmth, 3 c. cm. of a 2 per cent. solution of malachite green are added. When this medium is inoculated with typhoid bacilli, and with other organisms belonging to the typhoid family, striking differences are brought out. In the typhoid tubes, the nutrose is precipitated in a quite distinctive manner. The fluid is coagulated like acidified milk, and above the coagulated layer there is a clear, green liquid. With the majority of the other organisms, such as the *Coli* group, Gaertner's bacillus, and paratyphoid bacilli, active fermentation takes place, the precipitated nutrose adheres to the walls of the tube as dirty, green flakes, whilst some of it is carried to the surface by the gas formed, and floats as a dirty green layer. When grape sugar is omitted from the medium, only the *Coli* group cause fermentation, and they can, therefore, be differentiated from the rest, whilst other organisms have a reducing action on the green, turning it a pale yellow, more especially when the alkalinity of the medium is slightly increased. The typhoid bacillus does not change the medium, but only exerts a very gradual reducing action on the green. The paratyphoid bacillus A, on the other hand, turns the solution pale blue.

Journal of the Quekett Club.

The last (November) issue of the Journal of the Quekett Microscopical Club is in no way inferior to its predecessors, and contains, amongst much other matter, some most interesting notes and observations on the life-history of fresh-water mites, by Mr. C. D. Soar, from the egg to the larval, nymph, and adult stages; an illustrated paper by Mr. Julius Rheinberg, on "Stereoscopic Effect and a Suggested Improvement in Binocular Microscopes;" and a lucid account by Mr. D. J. Scourfield, of Mendel's "Law of Heredity," with special reference to its relation to microscopy, which any who are interested in this fascinating subject, but have had little opportunity of studying it at first hand, should read. The Laws of Mendel are very prominent just now amongst biologists, and have an important relation, not only to our conceptions of evolution and variation, but to many practical problems in economic botany and geology which the general public will realise with surprise when they are accomplished commercial facts. There are the usual reviews, once more restored to the Journal, reports of the Proceedings of the Club, and a list of members and office-bearers, together with some excellent plates and illustrations.

Microscopical Material.

Mr. J. Strachan, of Ballyclare, has very kindly sent me for distribution, some microscopic crystals of lead chloride ($PbCl_2$). Mr. Strachan says: "The crystals have taken several months to grow, and are in the form of rhombic plates, the usual form being that of rhombic needles. They contain numerous cavities, similar to those found in certain rock-forming minerals. There are also numerous undeveloped crystals, so-called 'crystal-eggs.' I find that Canada balsam is a very suitable mounting medium for crystals." I shall be glad to send some of these crystals to any reader who cares to send me a stamped addressed envelope, a *small* tin box (they are easily crushed), and the coupon to be found in the advertisement columns of this issue of "KNOWLEDGE," but I must warn applicants that the amount of material is very small, and they will only receive a *very* small quantity accordingly.

Notes and Queries.

Quekett Microscopical Club. Mr. Morland, having given up the post of Honorary Treasurer to the Quekett Club, the Committee have appointed Mr. Frederick J. Perks, of 48, Grove Park, Denmark Hill, S.E., as Treasurer in his place as from January 1, 1907. All subscriptions and other payments, together with notices of change of address, should, therefore, for the future be sent to Mr. Perks, as above.

C. J. D. (Hayward's Heath).—I cannot lay claim to any special legal knowledge, but I do not see how there can be any copyright in microscopic slides as such. It would be as reasonable to suggest that there is a copyright in a stuffed animal. Therefore, there can be no reason why you should not photograph or draw any slide you like, whether purchased or not, provided it is your own, failing which it would, of course, be at least courteous to ask the owner's permission to do so. Having photographed it, the usual laws of copyright will apply to the photograph or to the drawing when published.

F. R. H. S. (Munich). It would be impossible to say whether the times recommended in any book on Human Histology for fixing animal tissues are equally applicable to vegetable tissues, without knowing what fixatives and what materials are referred to. Generally speaking, a book on Human Histology would be a very unsatisfactory guide to the preparation of vegetable structure. There are so many modifications, but in nearly all cases the most frequent causes of failure are insufficient time in fixation and insufficient washing afterwards. It would be better for you to provide yourself with some well-known practical text-book, like Strasburger's "Das Botanische Praktikum."

T. H. M. (Hagley).—You will find very full instructions for the collecting and preparing of foraminifera in "KNOWLEDGE" for January and February, 1902, in a couple of articles written by Mr. A. Earland. Briefly summarised, it is necessary to wash and sort the material before proceeding to mount it. The material distributed last month has been already washed, but it will be convenient to pass it through gauze wire of various meshes. Mr. Earland recommends two sieves 40 and 120 meshes to the inch, the diameter of the apertures in the latter being about [illegible] of an inch. It is necessary to "float" and "rock" the material. The "floating" is done in bright daylight, the material being slowly poured into a jar of water. The sand sinks most readily, and the more slowly following foraminifera are then rapidly tilted over and through the finest sieve. By this means the material is roughly sorted. The "floating" is best done in a photographic developing dish, the residuum being placed in this for a depth of about a quarter of an inch and covered with about three-quarters of an inch of water. By rocking and circular movements the foraminifera are suspended in the water and manipulated into one corner of the dish, whence they are suddenly tilted into the sieve. The material must then be dried, and the foraminifera selected under the microscope, for which purpose Mr. Earland recommends a little shallow tray covered with coarse black-ribbed silk to keep the foraminifera from rolling about, the specimens being selected by means of a fine sable brush moistened with the lips, and then transferred to a prepared cell or slip.

As fixative for mounting, Mr. Earland recommends gum tragacanth, which is almost invisible when dry, and free from the objectionable glaze of gum arabic, and also less subject to variations of moisture in the air. He adds that the same gum, diluted to a watery consistency, can be used as a fixative for foraminifera before mounting in balsam, the gum, which must be thoroughly dried, being quite invisible in balsam. Dry mounts can be made in a similar way, the foraminifera being mounted between two cover-glasses, the lower one being blackened before being fastened to the slide, and the whole ringed round in the usual way. My own method is to mount all opaque objects with transparent backgrounds, and to have one or two plain slides with circular discs of dull black paper fastened on them which I can place behind the slides when I wish to illuminate them as opaque objects. By these means objects such as foraminifera, mounted dry, can be illuminated from above as opaque objects, or from below with annular (dark-ground) illumination, as required.

[*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 February.

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

THE SUN. On the 1st the Sun rises at 7.42 and sets at 4.46; on the 28th he rises at 6.51 and sets at 5.35.

Sun-spots may occasionally be observed, though they are not very numerous; solar activity appears to be diminishing, though at the time of writing there is a large scattered group visible.

The position of the Sun's axis and 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.
Feb. 5 ..	13° 41′ W	6° 20′	37° 5′
,, 10 ..	15° 36′ W	6° 37′	331° 15′
,, 15 ..	17° 22′ W	6° 52′	265° 25′
,, 20 ..	19° 0′ W	7° 2′	199° 34′
,, 25 ..	20° 20′ W	7° 10′	133° 43′
Mar 2 ..	21° 40′ W	7° 14′	67° 51′

THE MOON:—

Date.	Phases.	H. M.
Feb. 6 ..	☾ Last Quarter	0 52 a.m.
,, 12 ..	● New Moon	5 43 p.m.
,, 20 ..	☽ First Quarter	4 35 a.m.
,, 28 ..	○ Full Moon	6 23 a.m.
Feb. 10 ..	Perigee	7 6 a.m.
,, 22 ..	Apogee	0 54 a.m.

OCCULTATIONS:—

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Angle from N point.	Reappearance. Mean Time.	Angle from N. point.	Moon's Age.
			p. m.		p. m.		d. h.
Feb. 23	ζ Geminorum ..	var	7 11	70°	8 29	288	11 2
,, 24	85 Geminorum ..	5·3	7 7	50°	8 5	316°	12 1
,, 25	δ Cancri	4·2	5 30	69°	6 31	302	13 0

THE PLANETS.—Mercury (Feb. 1, R.A. 20^h 55^m; Dec. S. 19° 35′; Feb. 28, R.A. 23^h 46^m; Dec. S. 0° 9′) is in superior conjunction with the Sun on the 2nd and hence during the early part of the month is unobservable. Towards the end of the month the planet is an evening star in Aquarius and Pisces setting at 6.38 p.m. on the 20th and at 7.20 p.m. on the 28th.

Venus (Feb. 1, R.A. 17^h 39^m; Dec. S. 19° 23′; Feb. 28, R.A. 19^h 38^m; Dec. S. 19° 30′) is situated in Sagittarius and is a conspicuous object in the morning sky, rising at 4 38 a.m. on the 1st. The planet is at greatest westerly elongation of 46° 53′ on the 9th when it rises at 4 43 a.m.; on this date the telescope appearance is that of "half moon" ·5 of the disc being illuminated.

Mars (Feb. 1, R.A. 15^h 43^m; Dec. S. 18° 49′; Feb. 28, R.A. 16^h 47^m; Dec. S. 21° 51′) is situated on the confines of Libra and Scorpio and rises about 2.30 a.m. on the 14th. The apparent diameter of the planet is increasing as the opposition, which takes place in July, approaches.

Jupiter (Feb. 1, R.A. 6^h 9^m; Dec. N. 23° 25′; Feb. 28, R.A. 6^h 4^m; Dec. N. 23° 29′) is a very conspicuous object in the evening sky and is describing a short retrograde path near the star η Geminorum. On the 25th the planet is at the stationary point. Throughout the month the planet is well placed for easy observation in the evenings, being due South at 8.30 p.m. on the 14th.

The equatorial diameter on the 15th is 42″·9, whilst the polar diameter is 2″·8 smaller. On the evening of the 22nd the Moon is in conjunction with the planet at 6.37 p.m.

The following table gives the satellite phenomena visible between 6 p.m. and 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.
Feb				Feb				Feb			
1	III.	Oc. D.	9 28	12	III.	Sh. E.	10 6	21	II.	Sh. I.	7 38
3	II.	Tr. I.	11 18		I.	Tr. I.	11 23		I.	Tr. I.	7 40
5	III.	Sh. E.	6 5	13	I.	Oc. D.	8 35		II.	Tr. E.	8 9
	II.	Oc. D.	6 6		I.	Ec. R.	11 52		I.	Sh. I.	8 48
	I.	Tr. I.	9 35	14	I.	Sh. I.	6 53		I.	Tr. E.	9 57
	I.	Sh. I.	10 20		II.	Sh. E.	7 52		II.	Sh. E.	10 30
	II.	Ec. R.	10 41		I.	Tr. E.	8 7		I.	Sh. E.	11 5
	I.	Tr. E.	11 52		I.	Sh. E.	9 10	22	I.	Ec. R.	8 17
6	I.	Oc. D.	6 17	15	I.	Ec. R.	6 21	26	III.	Tr. I.	10 12
	I.	Ec. R.	9 57	18	IV.	Tr. I.	6 26	28	II.	Tr. I.	7 49
7	I.	Tr. E.	6 19	19	III.	Tr. I.	6 31		I.	Tr. I.	9 30
	I.	Sh. E.	7 15		III.	Tr. E.	9 33		II.	Sh. I.	10 16
10	IV.	Ec. R.	7 25		II.	Oc. D.	10 51		II.	Tr. E.	10 39
12	III.	Sh. I.	6 57		III.	Sh. I.	10 57		I.	Sh. I.	10 43
	II.	Oc. D.	8 28	20	I.	Oc. D.	10 25		I.	Tr. E.	11 48

"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 (Feb. 1, R.A. 23^h 2^m; Dec. S. 8° 14′; Feb. 28, R.A. 23^h 13^m; Dec. S. 7° 0′) is only observable for a short time after sunset, as he sets at 7 p.m. on the 14th. The ring, as seen in the telescope, appears to be nearly closed and we almost have an edge view; the northern surface of the ring is visible at angle of only 3° to our line of vision.

Uranus (Feb. 14, R.A. 18^h 48^m; Dec. S. 23° 18′) is a morning star, rising about 6 a.m. at the beginning of the month.

Neptune (Feb. 14, R.A. 6^h 44^m; Dec. N. 22° 10′) is situated in Gemini not far from the star 36 Geminorum. On the 14th the planet is due South at 9.15 p.m.

METEOR SHOWERS:—

Date.	Radiant R.A.		Radiant Dec.	Near to	Characteristics
	h.	m.			
Feb 5-10 ..	5	0	+41°	η Aurigæ	Slow; bright.
,, 15 ..	15	44	+11°	α Serpentis	Swift; streaks.
,, 20 ..	12	4	+34	Cor Caroli	Swift; bright.

Algol may be observed at minimum on the 9th at 10.3 p.m., and on the 12th at 6.52 p.m.

DOUBLE STARS.—*Castor*, separation 5″·6, mags. 2·7, 3·7. Excellent object for small telescopes. The brightest pair to be observed in this country; can always be relied upon as a good show object.

κ Geminorum, separation 6″·3, mags. 4, 8·5; very pretty double.

ζ Cancri, separation 1″·1, 5″·1, mags. 5·5, 6·5, 7·5; with small telescopes the wider component is readily seen.

ν Draconis, separation 61″·7, mags. 4·6, 4·6; a pretty and easy double, can be separated by observing with a pair of opera glasses.

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